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ARTHUR D LITTLE

PRISM

BIG THINKING,
IMAGINING WHAT
IS COMING NEXT

THE NEW RESILIENCE

INNOVATING FROM RESOURCES TO CUSTOMERS

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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.

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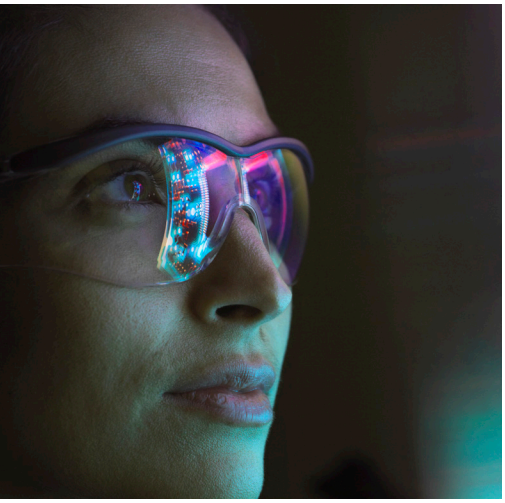
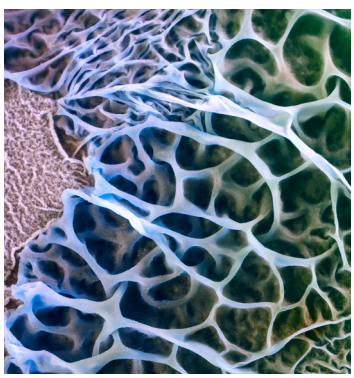


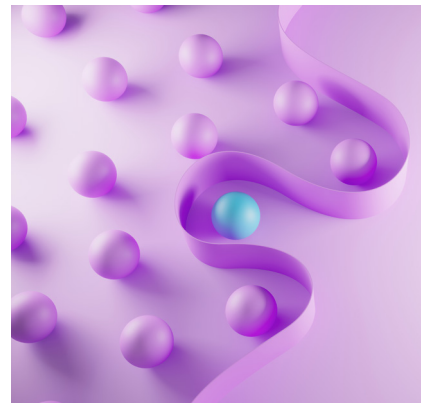


DISRUPTION – CAN BANKS STRIKE BACK?

Many believe the traditional universal bank is dead and the future belongs to a new breed of fintechs. But there is still time for banks to strike back – if they act fast and transform rapidly. The authors explain the six priorities traditional players need to embrace if they are to have any chance of surviving.

Philippe DeBacker, Juan Gonzàlez

CLOSING THE INNOVATION GAPS BETWEEN BUSINESS UNITS



When it comes to innovation, you would expect business units within the same organization to work consistently, sharing best practices. However, ADL research finds this is far from the case, leading to a potential 5 percent revenue loss in affected business units. This article outlines the causes of this innovation gap, and how it can be bridged.

Dr. Habib Hussein, Ben Thuriaux-Alemán, Dr. James Semple, Elis Wilkins, Professor Joe Tidd

CREATIVE THINKING FOR LEADERS – CHANGING YOUR PERSPECTIVE

Business leaders face a triple challenge of increasing complexity, a need to move faster, and a requirement to overcome their own cognitive biases. Creative thinking is essential to cope with these challenges, but the whole concept is widely misunderstood. The authors explain the common myths around creative thinking and demonstrate how it contributes to business success.

Albert Meige, Rémi Larrousse

HOW INSECTS CAN HELP REINVENT THE FOOD CHAIN – AN INTERVIEW WITH ANTOINE HUBERT

Ÿnsect is a rapidly growing agri-food company based in France, set to become one of the global leaders in transforming insects into high-performance natural protein solutions for pets, fish, plants, and human beings. Antoine co-founded the company in 2011. In this interview with Arthur D. Little, Antoine shares some fascinating insights into the company and the exciting opportunities for the future in the insect-based food industry.

Arnaud Jouron

EDITORIAL

DEAR READER

Welcome to the second issue of Prism 2022!

The global economic climate has changed almost beyond recognition over the last few years, thanks to an increasingly toxic combination of populism, the pandemic, war and the continuing existential threat of climate change. Globalization, which once seemed unstoppable, has been stalling and, in some areas, going into sharp reverse. For businesses, the focus of top management attention has shifted significantly towards securing resources and supplies.

In this climate, achieving business resilience has taken on a new importance. While only a few years ago, resilience was usually centered on how to manage operational risks and respond effectively to crises, today it's also about innovation – innovation along the entire value chain, from resources to customers, to find new ways of doing business that provide the sort of agility needed in a world where disruption is the norm. This is our theme for the current issue of Prism.

Our first three articles focus on different examples of innovation in managing resources. In our first article, we look at the endemic and increasingly critical problem of shortage of digital skills and capabilities. For years, outsourcing and offshoring have been the immediate response, but we make a case for a different, more strategic approach to address this core issue for today's businesses. Our second article examines the complex supply chains underpinning the creation of electric vehicle (EV) batteries. As battery materials become harder to secure, taking a holistic, end-to-end value chain view is more important than ever. Sticking with the theme of alternatives, our third piece looks at the rise of bio-based materials, and why a mix of consumer pull and technology push means their time may finally have come.

Many traditional players in established industries face growing challenges from start-ups and new, digital-savvy competitors – none more so than banks. Many have written off the chances of the large incumbents surviving in a fintech world, but we explain why there's still time for traditional players to strike back, providing they transform themselves rapidly.

Innovation is central to becoming more resilient, yet many large organizations are still struggling to replicate best practices across their different business units. Based on the latest research, our fifth piece explains the root causes of this innovation gap and proposes a range of solutions to bridge it.

Next, for something refreshingly different, we look at the potential for creative thinking to drive business innovation. Often misunderstood and neglected by senior managers, our last article busts common myths and shows how using some simple but powerful tactics can boost creative thinking in senior management.

Finally, we are delighted to bring you an exclusive interview with Antoine Hubert, the CEO of Ynsect, set to become one of the global leaders in the emerging insect-based food industry. Antoine shares some fascinating insights into his company and the opportunities for the future in this important area for biodiversity and sustainability.

We hope you enjoy the issue!

Rick Eagar
Chief Editor, Prism
Arthur D. Little

WINNING THE WAR FOR DIGITAL TALENT

– LOOKING BEYOND OUTSOURCING

AUTHORS

Michael Papadopoulos, Michael Majster, Olivier Pilot,
Alexey Pankov, Greg Smith

Businesses across the world are facing a shortage of professional talent and expertise in digital and IT skills and capabilities. For example, a 2021 survey suggested that 76 percent of IT decision-makers worldwide faced critical skills gaps in their departments, an increase of 145 percent since 2016[1].

Over the past decades, the standard response to dealing with this issue has always been "outsourcing". The huge revenue growth over the last 15 years of companies such as Tata Consultancy Services, Wipro, HCL, Infosys, Accenture, Capgemini and Atos underlines how prevalent the "just outsource and offshore" solution has become.

Yet, while outsourcing will always have a place as part of the solution to provision of digital skills and capabilities, it is no longer the panacea it used to be. This is because digital skills are now at the core of business operations. Approximately 90 percent of all operations in an average organization today are supported by software, and digital skills will become increasingly core with the further "softwarization" of products, services and experiences. Competence in digital channels, and in creating and managing omnichannel customer journeys, are crucial for both B2B and B2C businesses.

1. Skillsoft's Global Knowledge 2021 IT Skills and Salary Report

There is also rapid acceleration in adoption of disruptive technologies such as artificial intelligence (AI), machine learning (ML), the Internet of Things (IoT) and robotic process automation (RPA) – for example, a recent World Economic Forum survey indicated that some three-quarters of companies were adopting IoT, ML and big data analytics technologies[2]. These technologies require upgraded skills from staff to manage and gain value from them. There are also growing concerns about cybersecurity, for which overall "cyber-savviness" is becoming increasingly important.

All of this means digital skills are now one of the key determinants of competitiveness, value creation and business resilience. Therefore, from a strategic point of view, simply outsourcing digital and IT is becoming much less desirable – leaving aside the commercial implications of paying a third party to manage increasingly large parts of core operations.

In this article we look at some effective strategies businesses are adopting to address the digital skills gap as an alternative, or at least a complement, to outsourcing.

THE NATURE OF THE CHALLENGE

The demand for professional digital and IT capabilities has soared over the last decade, driven by the digitalization of businesses. This has led to a shortage in skills across a broad range of specialist digital domains, with the biggest shortage currently being in cybersecurity, followed by artificial intelligence/machine learning (AI/ML) and cloud architecture/planning. The results from a short survey across our global client base in late 2021 are shown in Figure 1.

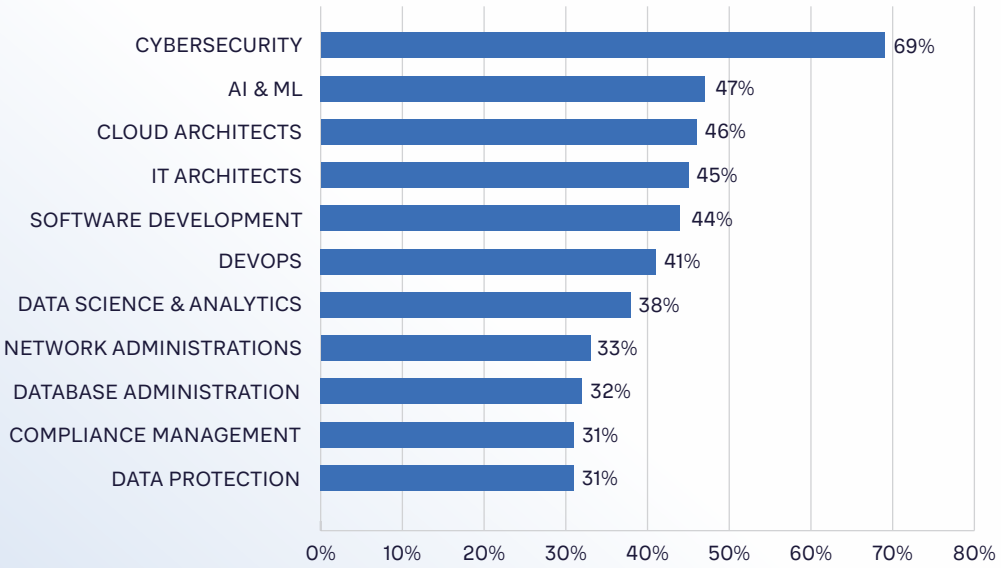


FIGURE 1: COMMON IT SKILLS FACING SHORTAGE (SOURCE: OPEN DATA SURVEY FROM ADL CLIENT RESPONSES)

2. Source: The Future of Jobs Report 2018, World Economic Forum

This is further backed by far wider surveys, such as the World Economic Forum 2020 reports. These show that skills gaps – either in local capability, leadership or failure to attract specialists – are perceived as the main barriers to digital transformations and new technology adoption.

FIGURE 2: BARRIERS TO ADOPTION OF NEW TECHNOLOGIES (SOURCE: FUTURE OF JOBS SURVEY 2020, WORLD ECONOMIC FORUM)

In general, businesses have been slow to recognize the strategic implications of this challenge. There are several reasons for this:

- Organizations have spent years establishing bureaucracies formed of management layers that are unable to create software solutions themselves; these are aimed instead at managing software creation by third parties, effectively offloading creation capability to externals. This made sense at the time because the targeted capabilities were, to a large extent, commoditized and non-differentiating. In this situation, an external software development arm was cheaper, more effective, and easier to manage than an internal one.
- The skills required to work with new digital technologies are increasingly hard to specify and gauge, and even harder to manage. Indeed, embedding these skills requires a more hands-on approach than in the past, because of the tight collaboration needed between the specialists and the rest of the organization to deliver software-enabled transformation. This means firms often fail to recognize capability gaps quickly enough, or think only about specialist skills, rather than the broader culture and operating model.

- As the market economy has continued to expand, firms have become accustomed to being limited by their capacity to find buyers for their products, rather by their capacity to produce those products. Generally, in the past the market has been able to meet demands for digital services. This is no longer necessarily the case, even with the growth of global IT outsourcing giants.

HOW TO ADDRESS THE SKILLS SHORTAGE EFFECTIVELY

To solve these problems, companies need to take a more strategic and comprehensive approach that goes beyond outsourcing. For example, Joseph Fuller, writing for Harvard Business School, argues: "Business leaders must champion an employer-led skills-development system, in which they bring the type of rigor and discipline to sourcing middle-skills talent that they historically applied to their materials supply chains." Indeed, skills shortages are not just confined to digital. Over the last few years, accelerated by the pandemic, record numbers of employees have quit their jobs as they reassessed the balances and trade-offs of their lives. This is the subject of the lead article in the May-June 2022 *Harvard Business Review*,* "Designing Work That People Love."

With this in mind, we see three complementary approaches for companies to take, which together effectively address both the supply and demand sides of the digital skills challenges: first, become better at engaging the right new resources externally; second, use the right approaches for skills transformation; and third, manage the digital and IT estate strategically to reduce skills demands.

1. BECOME BETTER AT ENGAGING THE RIGHT NEW RESOURCES EXTERNALLY

Being able to engage and retain the right resources is at the heart of the problem. There are three basic ways to make sure you have access to the right skilled resources in specialized areas such as software and data engineering:

- Making your company more attractive to the sort of people you want to recruit and retain
- Building strategic partnerships with IT service providers and the ecosystem
- Acquiring start-ups focused on the key skills you need

Looking at the first of these, it is key to create an environment that can be clearly seen as stimulating to data and IT engineers, allowing them to work on key strategic challenges while keeping a certain level of freedom and independence. The balancing act that all employers will have to find is how to deal with the above-mentioned engineers' preferences, while ensuring added value for the company.

* https://www.hbs.edu/managing-the-future-of-work/Documents/bridge-the-gap.pdf

This means defining a technology governance approach that is sufficiently open and architecturally decoupled from the legacy IT, while sharing some foundations that would ease the retrofit onto the operations. Companies such as TotalEnergies, Thales, SNCB and Air France have recently invested in large-scale digital factories that have created the "start-up" culture in a sidecar of the main company. Some of these have even become independent entities owned by the mothership.

In building strategic partnerships with external professional service providers, the key success factor is how best to infuse this external experience and knowledge into the client's employees, rather than just outsourcing. A number of tactics are effective in this process, such as co-locating in-house and partner teams, forming mixed internal/external scrum teams, and setting up internal organization maturity-led contract rewards. The worst thing companies can do is outsource their problem and try to forget about it – so many famous potential partnerships have failed over the years because the CIO was in this purely contractual mind-set.

THE KEY CHALLENGE FOR EMPLOYERS IS NOT TO DESTROY VALUE, WHICH CAN QUICKLY HAPPEN WHEN DEALING WITH HUMAN RESOURCES.

Finally, when acquiring start-ups, the main challenge involves maintaining the nimbleness of the acquired company by not going a bridge too far into the integration journey, which can easily kill its creativity and attractiveness. For example, we have recently seen a case in which a successful start-up was acquired by a global telco company that effectively killed it off through rebadging its team members and insisting they used the telco's standardized templates. The end result was that over 75 percent of the start-up's staff left within two years of the acquisition.

The key challenge for employers is not to destroy value, which can quickly happen when dealing with human resources. An important prerequisite for preserving value is for the chief information officer's and/or chief digital officer's ambitions and objectives to seamlessly contribute to the corporate strategy.

2. USE THE RIGHT APPROACHES FOR SKILLS TRANSFORMATION

In the past, big companies that needed to organize skills transformation were in the habit of sending large numbers of their employees to central training centers in fancy locations. However, in recent years, most companies have changed their approach, often as a consequence of the pandemic, growing consciousness of carbon footprints and social responsibility, and the realization that the return on investment was limited.

For one thing, massive transformation programs now tend to be located in hardcore digital hubs, such as Bengaluru, rather than sunny leisure locations. However, the companies that have most successfully pivoted towards digital have evolved their skill transformation programs to be segmented, specific and immersive:

- **Segmentation** is important because there is no one size fits all. Some employees will need to become power users, and some much less so. The level of desired target awareness needs to be the lead criterion when segmenting participants – from full stack engineer down to product owner.
- **Specificity** is important because the topic can be very broad. Data will lead you to AI, which will inevitably lead you to the cloud – and the technologies behind these will probably look different 18–24 months from now. That is why, more and more often, we are seeing the concept of developing one's "TQ" kicking in. TQ stands for technology quotient, analogous with intelligence quotient (IQ) and emotional quotient (EQ). TQ measures the ability of an individual to assimilate or adapt to technology changes by developing and employing strategies to successfully include technology in their work and life. A high TQ implies the right attitude, capabilities and decision-making strategies to fully leverage technology. For many employees, developing their TQ is a valuable objective to pursue in addition to specific technical competencies. Developing TQ has already become a mainstream objective in many organizations.
- **Immersivity** is important because digital can only be learned hands-on. While in the past this meant sitting behind a computer and fighting against a compiler to execute your code lines, today new techniques have evolved, enabled by gamification. In some companies, employees nowadays receive, as part of their welcome goodies such as a hoodie and a reusable water bottle, a virtual reality headset and access to the metaverse to attend a virtual classroom on their first working day[3].

3. MANAGE THE DIGITAL AND IT ESTATE STRATEGICALLY TO REDUCE SKILLS DEMANDS

From an architectural point of view, companies must focus more on ensuring that their IT and digital estate does not require unnecessary amounts of tech skills or unnecessarily skilled tech resources. Simplicity has to be front of mind when making decisions about the estate and its architecture. Companies need to become ruthless at eliminating overhead in terms of the quantity or quality of skills required to develop and evolve technology solutions, as well as to operate them.

3. At Accenture, 150,000 new hires will spend their first day of work in the metaverse – Fortune (ampproject.org)

Unfortunately, more often than not, companies have made the "digital transformation" years more difficult for themselves by allowing avoidable complexity to creep in, typically in the following areas:

- Unnecessarily customized solutions overlooking available commodity technology
- Unnecessarily complex architectures for custom solutions

In many cases, this has led to an explosion of the breadth of skills and technologies deployed in the tech estate. In order to reduce unnecessary complexity and help lower the volume and quality of tech skills required over time to develop and maintain the estate, there are eight things that companies should consider:

1. **Consider standardized and commoditized software solutions.** Buying off the shelf, or better, Software-as-a-Service (SaaS), literally allows you to delegate software development and maintenance to another entity for good, as long as the solutions are open enough to nicely integrate with the rest of the estate. Also, the less specific to you something is, the more widely available the skills are. Of course, you still need to follow the "buy for competitive parity" and "build for competitive advantage" rules, but it pays to think much harder about what competitive advantage really means for you before jumping to customize.

   AS A RULE OF THUMB, THE HIGHEST-POSSIBLE ABSTRACTION PLATFORM ON WHICH YOUR CUSTOM SOFTWARE USE CASE CAN RUN IS THE ONE YOU SHOULD CHOOSE.

2. **Use the simplest-possible solution architectures.** When a custom solution is indeed the right choice, technologists often want to try the latest technology and architectural concepts without any real justification for the case in point. However, these generally come with a cost in terms of complexity and availability of skills (for example, Big Data or microservices). Worse, these impacts are often felt most acutely and regretfully later on, when it comes to evolving and maintaining the solution.

3. **Use higher-level abstraction platforms for your use case.** From infrastructure to data management or application development, platforms exist for every layer that makes up digital assets to take care of and abstract lower-level considerations and allow companies to create custom products on top of them. This allows for simpler and speedier implementation, simpler required skill sets limited to technical layers above the platform, and lower

overall operational effort with minimal overhead. As a rule of thumb, the highest-possible abstraction platform on which your custom software use case can run is the one you should choose. In this category, you will find familiar concepts such as cloud infrastructure providers, cloud analytics and data platforms, low-code application or workflow development, and low-code analytics/dashboarding solutions (See Figure 3):

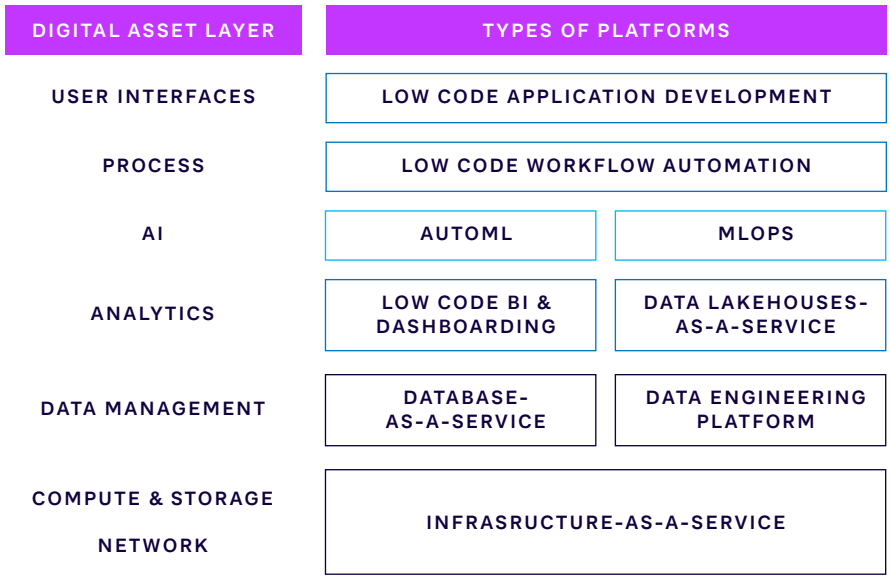


FIGURE 3: BUILD ON THE HIGHEST-POSSIBLE ABSTRACTION PLATFORMS

For example, building a digital asset on a low code application development platform requires less advanced technical skills that can be more easily learned or acquired. The lower layers, such as infrastructure and data management, will not need specialized resources to look after them. The key is to standardize the platforms at each layer and assess the highest platform level that can be used for each use case.

4. **Consider sourcing externally.** Sourcing externally certainly has a place if it helps you drive one of the points listed above. In particular, sourcing externally is a good choice for building a non-differentiating technology asset based on a commoditized offering, building a platform that will make delivering future developments faster and simpler, or simplifying an estate or existing technology solution. It is also a valid choice to build a custom and differentiating asset using skill sets you do not yet fully possess (such as AI), as long as staff upskilling and interim managed services arrangements are part of the deal.

5. **Standardize.** Choosing established technology stacks, platforms and tools that should be used unless proven otherwise helps to rein in the array of talent required to maintain and evolve the estate. It also helps focus a company's resources on a few well-defined training and upskilling programs, while fostering in-house expertise and specialization. Reality has caught up with concepts such as "polyglot programming"[4], which was all about using the right language for the job, but in practice has often led to organizations ending up with far too many programming languages.

6. **Make your tech culture one of end-to-end efficiency.** Software asset development and operation is a relatively new discipline, and remarkable improvements have been made to improve efficiency and quality in software delivery over the last 20 years – for example, continuous delivery, automated testing, and DevOps[5]. Existing technical teams should be upskilled in these. More importantly, they should be made to adopt a culture of constant reflection around end-to-end software delivery efficiency gains that allows a finite set of resources to achieve more.

7. **Exploit the potential of AI where possible.** AI and ML can also help organizations address skills shortages, such as by automating tasks for skilled workers so they can be more productive, or by using AI-assisted learning or employee engagement. AI is applied to a wide variety of use cases today, in areas such as IT operations, security and threat detection. Public cloud providers and other third-party vendors offer a plethora of powerful tools that can help with cyber-security, application performance and general automation. Beyond IT operations, companies are applying AI and natural language processing to customer-facing fields such as marketing, sales and customer care in the form of chatbots to route or even fulfil requests, as well as social listening and sentiment analysis. We estimate that at least one-third of companies are already experimenting with AI in this space. However, AI adoption is one of the areas that itself is severely hampered by the skills shortage. In fact, more than costs, lack of tools, or project or data complexity, the skills gap remains the biggest barrier to AI adoption. Using high-level abstracted platforms such as auto ML services can go a long way in generating value from AI with lower technical skills. (See also point 3 above relating to platforms.)

AI IS APPLIED TO A WIDE VARIETY OF USE CASES TODAY, IN AREAS SUCH AS IT OPERATIONS, SECURITY AND THREAT DETECTION.

4. https://www.thoughtworks.com/en-gb/insights/articles/radar-hits-misses
5. DevOps is a combination of the terms "development" and "operations", meant to represent a collaborative or shared approach to the tasks performed by a company's application development and IT operations teams

8. **Empower your employees to self-manage.** Technology such as standardized low-code/no-code platforms[6] can effectively allow employees to self-manage using standardized technology platforms. This can alleviate the need for specialist IT skills, as well as help eliminate silos and create new functionality and capability. However, it also requires the right process environment to allow your workforce to act in an empowered way, while also keeping strong guard rails in place to keep things secure, performant and cost-effective.

Box 1 shows an example of these principles being applied in practice.

Box 1 - Addressing digital skills shortages through architecture simplification and training

A UK FTSE250 multinational software and information technology company attempted to transform its core business by moving a significant portion of its services to the public cloud. However, after months of failed starts due to lack of internal skills, inability to hire external talent, and lack of middle management willing to execute the transformation, the company decided on a strategic shift to its approach by focusing on simplifying the problem to reduce the need for additional skills. First, it undertook a major staff reskilling and retraining effort to both help the internal teams grow and empower them. This had an additional benefit of reducing staff attrition. Second, the company focused on simplifying its architecture by standardizing on commodity cloud services across its entire estate. Finally, it revamped its internal organization structure by creating a new team that would operate solely in the cloud to manage the transformation.

Of course, another difficulty and a common driver of complexity is the legacy IT and digital estate, especially when the guidance above has not been followed for many years. Often a huge amount of technical resources are required simply to keep things running. The guidance shown above must be followed not only for new initiatives, but also as much as possible for the legacy estate retrospectively. Failure to do so means as tech debt keeps piling up, interest payments in the form of tech resources overheads will keep gradually decreasing the available bandwidth to engage in new initiatives.

6. See also "Unleashing innovation using low code/no code – The age of the citizen developer" [Prism 1 2020]

INSIGHTS FOR THE EXECUTIVE

The digital skills shortage presents a tangible risk to every business and organization – especially since "software is eating the world" and every organization is now practically a technology company. The skills shortage is a risk to both business resilience and growth and innovation, as there is a near-constant drive for adoption of new technologies for organizations to compete and grow. Simply outsourcing is becoming undesirable as the sole solution as digital skills become increasingly core to maintaining competitive advantage and ensuring business resilience.

There are a few tactical moves to help with the digital skills shortage in the short term – such as constantly raising compensation – but those eventually become unsustainable. The real change needed is to transform the culture and practice around digital, diversifying and broadening the technical expertise of the workforce, nurturing a business sense among digital and IT resources, and enabling employees to focus on problem solving. Companies can not only address the skills shortage, but also create more business value, by managing digital resources more strategically. This involves focusing on a combination of measures around better accessing and retaining resources, improving skills transformation practices and, most importantly, managing the digital estate to reduce skills demand.

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ACHIEVING RESILIENCE AND SUSTAINABILITY FOR THE EV BATTERY SUPPLY CHAIN

AUTHORS

Patrick Dutz, Felix Hoffmann, Bernd Schreiber, Philipp Seidel, Alexander Krug, Rodrigo Navarro, Kai Oliver Zander, Shinichi Akayama

Batteries are a key enabler of the clean energy transition in mobility, which makes their supply chains vital at a time when the electric vehicle (EV) market is growing dramatically and billion-dollar investments have been announced in new EV battery gigafactories around the globe.

However, battery supply chains remain complex, global, and fragile, with many still evolving from scratch. Their resilience is impacted by a growing number of factors, from rising raw material costs to geopolitical disruption. Average battery pack prices have risen in 2022, the first increase since 2013. Environmental, social, and governance (ESG) concerns, greater regulation, and governments' desire to localize battery production add to pressure on already-stretched global supply chains. All of these factors lead to potential bottlenecks that affect production.

Given the importance of batteries to decarbonizing transport and achieving Net Zero targets, resilience in EV battery supply chains is a business, political, and societal imperative.

As this article explains, success requires new, more circular approaches across the wider battery value chain, built on greater transparency and an end-to-end view that will bring security of supply going forward.

THE CHALLENGES TO BATTERY SUPPLY CHAIN RESILIENCE

Batteries are central to current and future generations of EVs. Yet, the precious metals required for today's lithium ion (Li-on) batteries are scarce, and in many cases, current supplies will not meet predicted demand.

As can be seen in Figure 1, the battery supply chain is complex and typically distributed across multiple industrial sectors, geographies, and players.

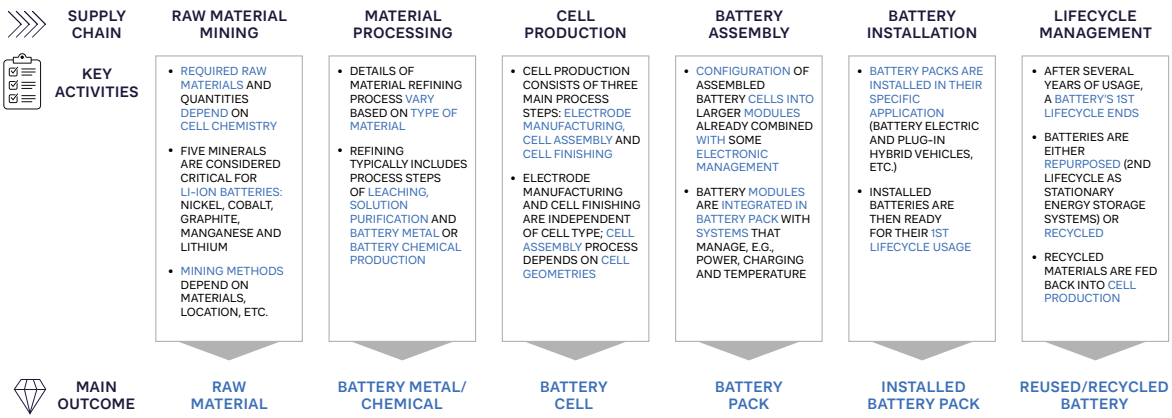

FIGURE 1: THE END-TO-END BATTERY SUPPLY CHAIN

It is also extremely volatile, impacted by a range of factors that challenge resilience, sustainability, and productivity:

1. INCREASING BUT UNPREDICTABLE BATTERY GROWTH

The vast majority (approximately 89 percent) of batteries will be destined for EVs, with a further 8 percent for the energy storage sector. Driven by a combination of rising consumer demand and government action, the EV market is growing dramatically and rapidly. As the world swaps fossil fuels for electric power, countries and players are scrambling to adjust.

To meet this need, global battery production is expected to increase 14-fold between 2018 and 2030, with a CAGR of 25 percent. An impressive number of new, multi-billion-dollar gigafactories have been announced across the globe, funded by a combination of new players, governments and traditional automotive companies. In Europe alone, battery production capacity is expected to reach more than 1,100 GWh by 2030 if all plans are fully realized.

However, the complexity of supply chains and scarcity of raw materials mean there are questions over whether consumer-driven demand for EV batteries can be met on the production side. As was demonstrated by the shortage of semiconductors disrupting production post-pandemic, the automotive supply chain has limited resilience around key components.

To further complicate supply chain planning, there is a wide range of views on how much demand will increase and whether it can be met. Forecasts for global EV battery demand in 2030 vary from 1.5 to 4 terawatt hours (TWh) of annual new installed capacity[1].

Scale will be vital to success, but moving from today's lower production volumes to achieve planned targets is not straightforward. As well as securing raw materials, scaling will require companies to quickly build expertise and invest in the right production tools if they are to operate efficiently and effectively. There are already indications that a lack of available production equipment may become a further bottleneck as multiple new gigafactories are built simultaneously.

2. RAW MATERIAL SCARCITY

Batteries rely on a global supply chain, bringing together a range of materials such as metals from Africa, lithium from Latin America/ Australia, nickel from Russia, and refined materials from China. In many cases, first-movers such as Chinese battery manufacturers have already secured vital supplies, leaving new players searching for sources. Raw material prices have risen dramatically – the average copper price has increased significantly from approximately $6.0k/mt in 2019 to approximately $9.3k/mt in 2021, while the average nickel price grew from roughly $13.9k/mt to about $18.5k/mt over the same time period. Prices have spiked even further in 2022 due to geopolitical uncertainty and sanctions.

RAW MATERIAL PRICES HAVE RISEN DRAMATICALLY – THE AVERAGE COPPER PRICE HAS INCREASED SIGNIFICANTLY FROM APPROXIMATELY $6.0K/MT IN 2019 TO APPROXIMATELY $9.3K/MT IN 2021.

Predicted demand outstrips current supply, particularly in regions such as the EU, which lack major local sources. For example, graphite, lithium, and cobalt are already on the European Commission's list of critical raw materials, flagged as potentially having high importance and supply risks. There is a danger that current fossil fuel dependencies in areas such as the EU could simply be replaced by new dependencies on imported minerals required for EV battery manufacture.

1. https://www.iea.org/data-and-statistics/charts/annual-ev-battery-demand-projections-by-region-and-scenario-2020-2030

3. VOLATILE MARKET DYNAMICS

Not only do battery manufacturers have to secure the right materials, but they must also ensure these are delivered on time and in sufficient volumes. Supply chain disruptions caused by the pandemic, the closure of the Suez Canal, and sanctions on Russia all highlight a lack of resilience that impacts production. Increasing tensions between China and the West are also leading European and US players to reduce their exposure to and reliance on the country. Growing protectionism around the world is likely to increase risks as governments potentially channel local resources to their own national champions.

THE SHIFT TO EVS CHANGES THE DYNAMICS OF THE AUTOMOTIVE MARKET, WITH BATTERIES MAKING UP A MUCH HIGHER PERCENTAGE OF A VEHICLE'S VALUE (40 PERCENT IN 2020, PREDICTED TO DROP TO APPROXIMATELY 27 PERCENT IN 2030).

The shift to EVs changes the dynamics of the automotive market, with batteries making up a much higher percentage of a vehicle's value (40 percent in 2020, predicted to drop to approximately 27 percent in 2030). This impacts the relationships between players, and how much value (and margin) they can derive from EVs.

On the technology side, future battery composition is not fixed. A raft of new chemistries are being introduced to meet demands for greater power and capacity and reduce cost by lowering reliance on scarcer materials, and at the same time increase sustainability. Players, whether manufacturers, OEMs, or recyclers, all need to be able to build plans that cope with this uncertainty.

4. GROWING REGULATORY OBLIGATIONS

Players in the value chain need to meet a growing number of existing local and international regulations for safely and responsibly extracting raw materials, and then producing, transporting, and disposing of batteries when they reach end of life.

Regulations are increasing as the market for li-ion batteries grows. For example, the proposed EU Regulatory Battery Framework will increase the percentages of recycled content required within new batteries and set stricter targets for recycling efficiencies. The aim is not only to drive a more circular battery economy, but also to reduce reliance on importing or mining scarce raw materials, which will further drive down the carbon footprint of EVs. Battery recycling also brings new, growing opportunities for players.

5. THE REQUIREMENT FOR SUSTAINABILITY

Many argue that while EVs themselves do not rely on fossil fuels, the supply chain that creates their batteries has major environmental and social impacts due to mining, refining and transport. Regulations such as the EU Battery Framework and the increased focus on measuring and reporting on ESG impacts are making the supply chain more transparent, as is the push to create a circular battery economy.

Achieving sustainability is a key requirement across the supply chain, as companies need to meet ESG criteria and invest in areas such as recycling to increase resilience. Certification must be in place to show that any new raw materials have been mined responsibly. Demonstrating sustainability is also vital to increase business resilience, as it impacts the ability to attract talent and investment and make sales.

EU LEGISLATION AND POLICIES RELATED TO BATTERY RECYCLING ARE EXPECTED TO IMPACT AND STRENGTHEN THE ENTIRE CHAIN

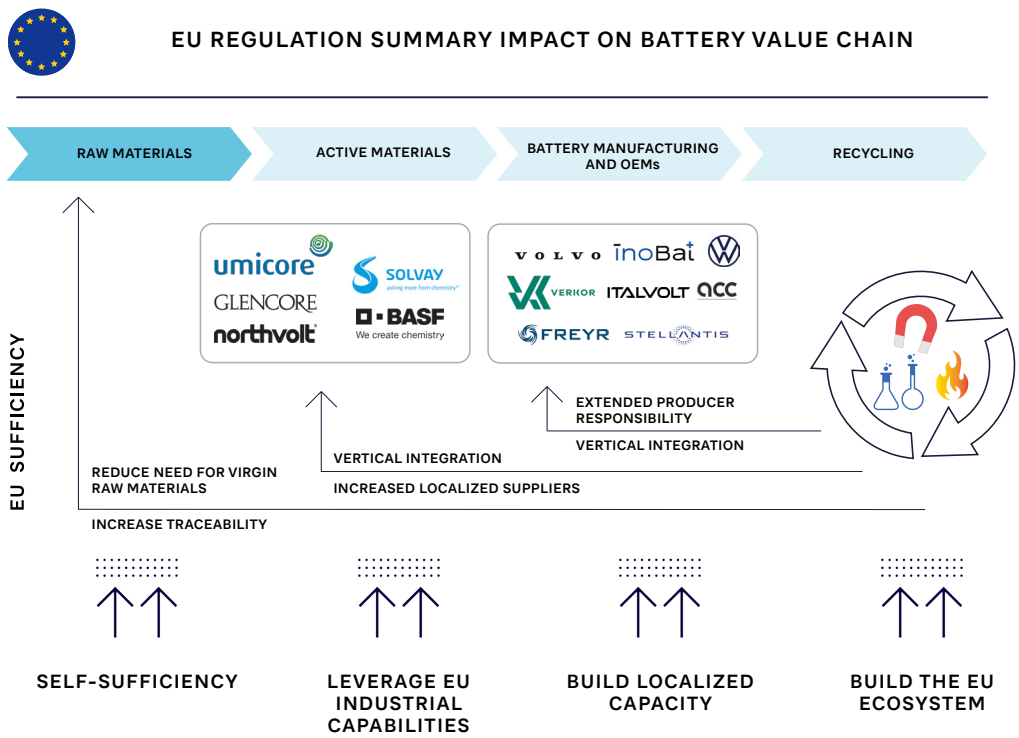

FIGURE 2: IMPACT OF EU LEGISLATION AND POLICIES ON BATTERY VALUE CHAIN

A TOOLKIT FOR BUILDING A RESILIENT BATTERY VALUE CHAIN

The lithium-ion battery value chain differs from other industrial value chains due to its specific challenges. Successfully building resilience into the value chain requires players to take an end-to-end perspective, from raw material sourcing to recycling – wherever they are within the supply chain. They need to understand the key upstream and downstream challenges and how they will impact their business to make plans that increase control. Unlike in many other sectors, the supply chain extends to critical materials, unstable global regions, and various industries, and faces unprecedented surges in demand. This requires a transparent, holistic understanding of supply chain risks, strong forecasting capabilities, and a nimble and innovative approach both upstream and downstream:

ENSURING TRANSPARENCY AND UNDERSTANDING

In such a complex and dynamic supply chain, taking a silo-based approach is simply not enough. For example, if you are a battery cell manufacturer, you need to understand and safeguard both material supply and the end-of-life needs of OEM customers, and research the requirements, constraints, opportunities, and technologies along the whole chain. You then need to use this to identify current and potential risks. More and more battery producers are engaging in upstream and downstream activities – for example, both BYD and Tesla are looking at acquiring lithium sources. Risks can change quickly in a volatile ecosystem, so this needs to be a constant exercise.

DEVELOPING THE RIGHT FORECASTING CAPABILITIES

While it is growing rapidly, the battery market is still immature. There are a range of competing predictions around future demand. Everything from potential battery technology changes to regulation can impact demand for particular raw materials and finished products. Developing strong forecasting across a range of scenarios is therefore vital to deciding where opportunities are strongest and how the right level of supplies can be safeguarded, such as through the right investments. Forecasting should focus not just on raw materials, but also other inputs. For example, the large number of planned gigafactories is leading to high demand for both skilled staff and the equipment used within them. Battery producers are already facing shortages in both areas. This needs to be planned for, along with wider automotive supply chain issues, such as the global shortage of semiconductors.

Once battery players have built this end-to-end perspective, they can understand better how they can control factors to mitigate risks. Typical actions to achieve control cover a spectrum of models, from full vertical integration (as practiced by Tesla) to a looser, partnership-based approach (as done by many other OEMs). Electric vehicle manufacturer BMW, for example, set up a fully fledged battery-cell competence center not to bring production in-house, but to better understand technology and production processes.

STRONG VERTICAL INTEGRATION

One strategic answer to building resilience is vertical integration, a strategy adopted early by Tesla, when it was contrary to then-current industry practice. Pulling key parts of the battery and components value chain in-house gives a high degree of control and mitigates risk. In the case of Tesla, vertical integration includes:

- In-house battery production (and development)
- Significant internal software and semiconductor skills, including designing own chips. This allows greater flexibility and agility – for example, it makes it more straightforward to switch between different types of chip, mitigating availability risks
- Acquisition of suppliers – from those that provide production tooling down to raw material suppliers, and even mining licenses. For example, Tesla has purchased Grohmann Engineering (a specialist in manufacturing automation), ATS Automation Tooling Systems, and Hibar Systems

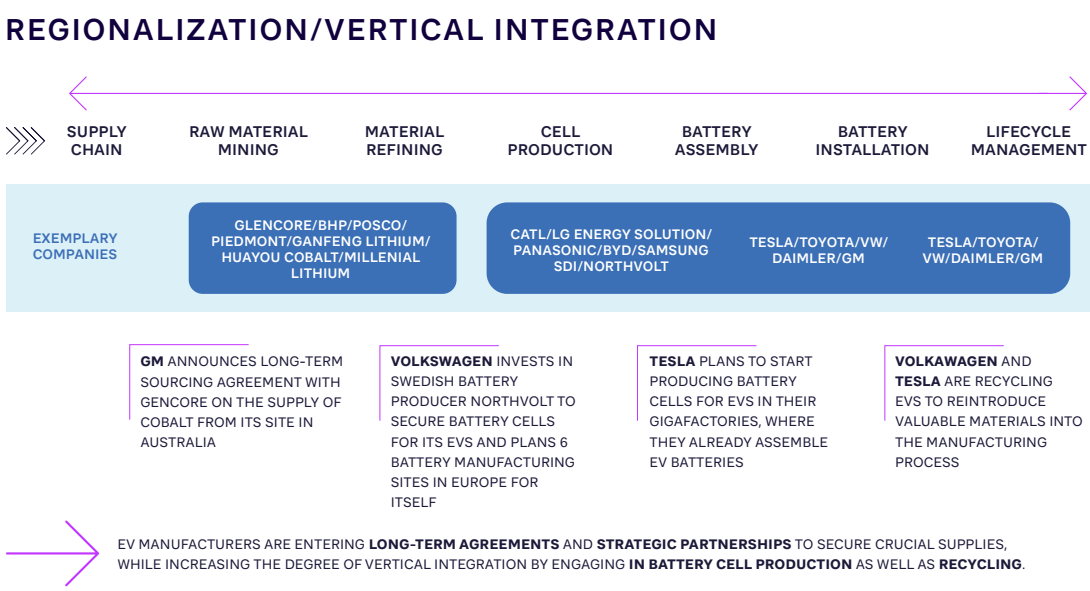

FIGURE 3: PARTNERSHIPS AND VERTICAL INTEGRATION ACROSS THE BATTERY SUPPLY CHAIN

However, full vertical integration is not possible for all players, and does have downsides. In a growing market, acquiring key suppliers or partners requires deep pockets, particularly as there is a shortage of available targets that have not already partnered or taken investment from other, competing players. Given the fast-changing nature of the EV ecosystem, there is also a significant risk that acquisitions will not deliver long-term value or will tie a player to a technology, process, or material that will be potentially superseded.

STRATEGIC PARTNERSHIPS AND ECOSYSTEMS

To avoid risks from straight vertical integration, many EV OEM and battery players enter strategic partnerships. Those provide new approaches to value creation, going beyond traditional buyer/seller relationships. They deliver resilience by minimizing key battery supply chain risks, but also provide access to IP, experience, and innovation. They include:

- Joint ventures and investments. For example, Volkswagen has invested in battery technology company QuantumScape and battery producer Northvolt to secure upstream and downstream battery knowledge
- Partnerships to guarantee supply of materials or capabilities. BMW has an agreement with Ganfeng to source sustainable lithium for batteries from Australia
- Experience exchange and cooperation in industry alliances between manufacturers and other players along the battery value chain, such as Eurobat and NAATBatt, to access knowledge and capabilities from complementary players
- Joint selling/production – working together to develop battery technologies at lower cost and higher performance. Example partnerships include Mercedes-Benz and ACC, General Motors and Posco, and Stellantis and LG. There are also joint ventures between upstream battery players such as BASF and Shanshan
- Cooperation – resource sharing without investment or creation of a separate legal entity. Examples of this include long-term strategic contracts (such as between Umicore and ACC) and the intent to establish a battery recycling cluster in Finland driven by BASF, Fortum and Nornickel

NEXT-LEVEL INTEGRATED BUSINESS PLANNING

Truly integrated business and supply chain planning is a key prerequisite of building resilience across the battery supply chain. Volatility and uncertainty require continuous synchronization of strategic, tactical and operational plans between all partners in the extended supply chain and the company's internal organizational units.

Adopting an integrated business and supply chain planning process allows battery companies along the value chain to fundamentally reduce the time it takes all players to react to changes in demand, adapting their supply and manufacturing capacities and priorities more quickly. Companies should look to increase capacity across the supply chain (such as for raw materials, refining and recycling). Unaligned decisions and priorities within functional silos and the supply ecosystem are avoided. For example:

- The CFO of a battery supply manufacturer clearly understands when to invest in new manufacturing capacity to avoid future delivery constraints, including a clear understanding of ramp-up processes and potential technology-induced capacity constraints.
- The production and materials manager is able to ensure that they have all labor and material requirements in place to meet demand, including machinery for specific processes.
- The maintenance team knows exactly what activities it needs to do and the optimal time to overhaul equipment.

It is key to align planning across all aspects of the organization (R&D, commercial, demand, production/supply and financial) and use this to create a joint strategic and operational plan. In the case of battery production, this must be extended beyond the borders of the individual organization. This provides a clear, real-time, end-to-end, aligned view that acts as a single source of truth for fast, agile, fact-based decision-making. Applying AI and automation on top of this process can then augment human capabilities, helping to mitigate risk in a complex, dynamic supply chain.

IT IS KEY TO ALIGN PLANNING ACROSS ALL ASPECTS OF THE ORGANIZATION (R&D, COMMERCIAL, DEMAND, PRODUCTION/SUPPLY AND FINANCIAL) AND USE THIS TO CREATE A JOINT STRATEGIC AND OPERATIONAL PLAN.

Against a background of fast-paced production ramp-ups and the resulting fight for all kinds of required resources, better planning will be even more decisive. It also enables battery companies to dynamically remodel their supply chains, such as by substituting suppliers or adding new, local sources of critical raw materials such as recycled batteries.

INSIGHTS FOR THE EXECUTIVE

The battery value chain is both extensive and complex, ranging from raw material producers all the way to recyclers, and impacting the thinking and planning of a wide range of companies. To ensure resilience, executives therefore need to:

- Build a strong understanding of current and future battery value chain characteristics, focused on the key risks
- Use this to evaluate potential concerns and identify opportunities for vertical integration
- Enable holistic, end-to-end SCM by creating and implementing specific tools and processes to improve transparency and steering across organizational borders
- Extend partnerships across the battery ecosystem to fill gaps, build capacity, and mitigate risk – and think beyond traditional structures of suppliers, OEMs, competitors, etc.
- Focus on securing a sustainable supply of the battery materials they need. This should be sustainable in two ways – meeting ESG criteria and being reliable, long-term, and able to scale with the business needs, such as by embracing circular supply chains
- Increase technical and process flexibility by optimizing R&D, procurement, and manufacturing. For example, build in agility to cope with emerging battery chemistries and the introduction of new materials, while creating redundant sourcing of key components
- Where possible, simplify and rebuild supply chains, substituting distant with local suppliers (such as close-by battery recyclers) to mitigate volatility and introduce diversification of sources

Achieving resilience will require continuous innovation across the full range of supply chain tactics, not only diversifying suppliers and vertical integration, but also adopting a holistic approach that takes the entire value chain into account.

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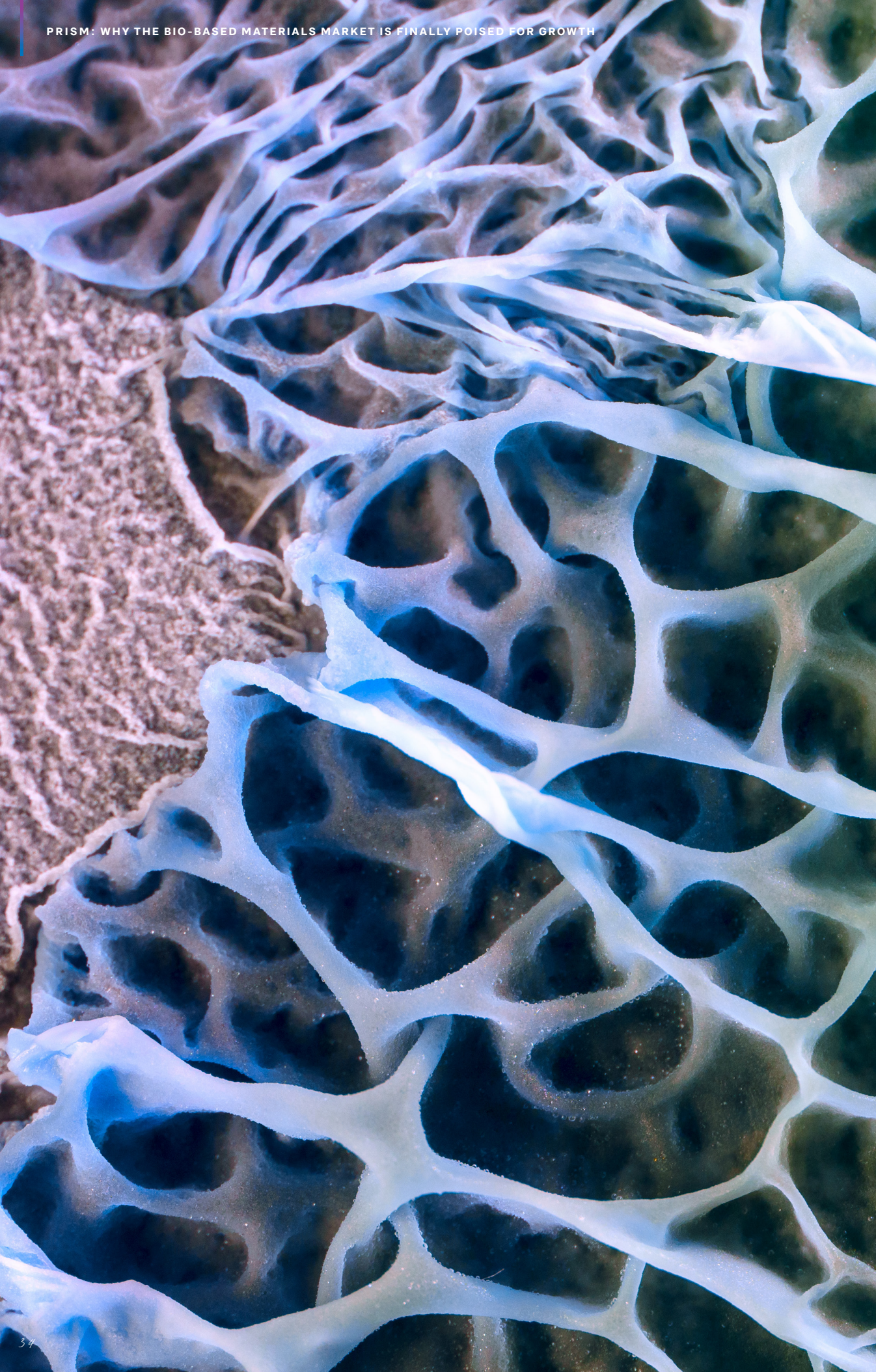

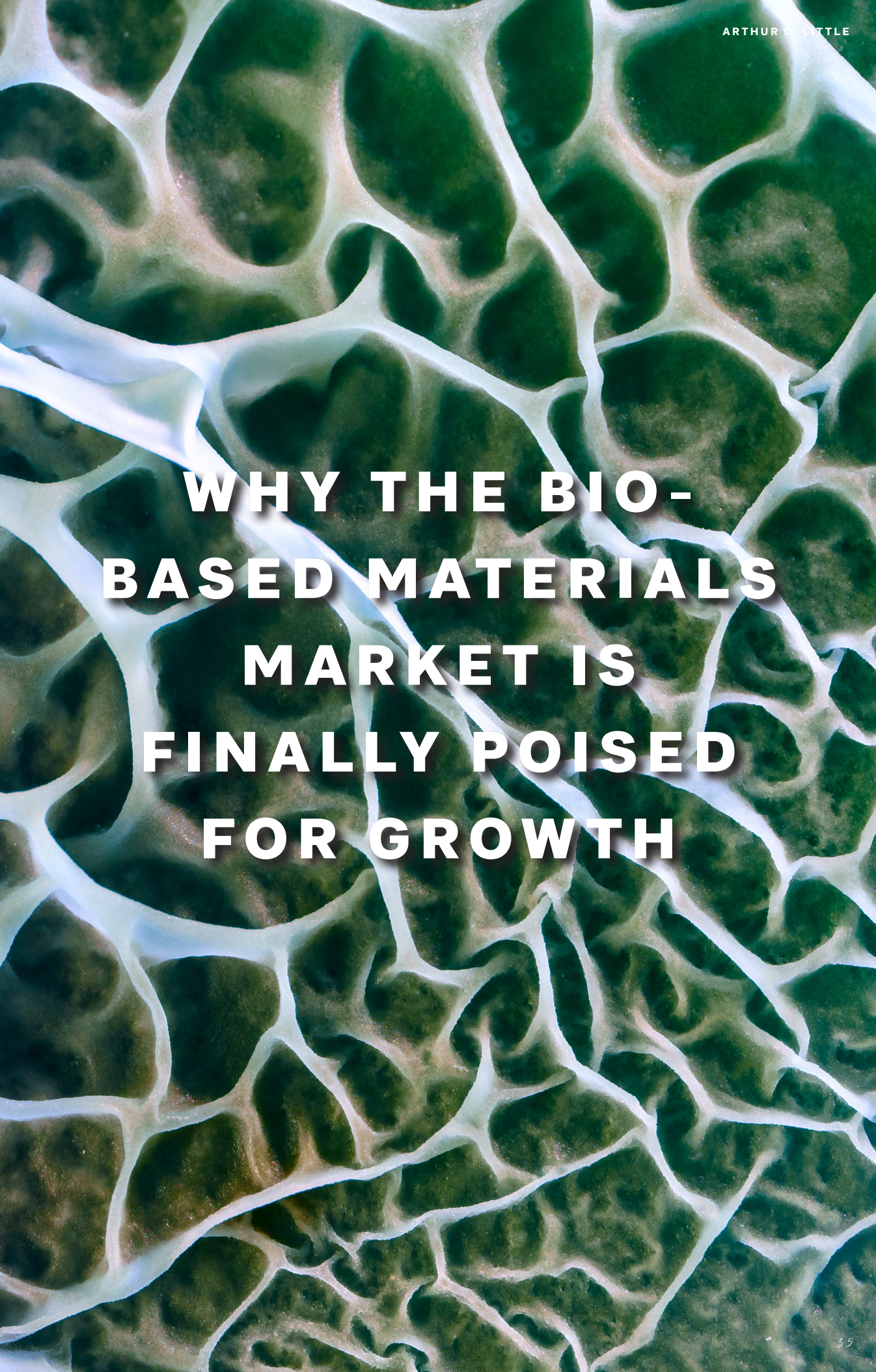

WHY THE BIO-BASED MATERIALS MARKET IS FINALLY POISED FOR GROWTH

AUTHORS

Trung Ghi, Philip Webster, Wendy Cheng, Passachon Srisaard, Shane Lim, Daniel Monzon, Michael Kolk

For decades, the market for bio-based materials[1] has been seen as promising without significantly taking off. Challenges in sourcing affordable and sustainable raw materials, achieving economies of scale, and securing sufficient end-market demand have all prevented the market from growing.

This is now changing rapidly, reinvigorating the market. Demand is growing, driven by increasingly environmentally conscious consumers and governments' Net Zero targets requiring consumer-focused product companies to achieve sustainability. Finally, technology breakthroughs are bringing down production costs for bio-based materials, while improving their performance to make them comparable or superior to fossil-based counterparts.

At the same time, the increasing volatility within the oil & gas sector is causing traditional petrochemical players to look beyond their fossil-based products for new and more resilient sources of future revenue and growth. All of this is driving interest and investment.

The market is now at an inflection point, with a growth rate that is both steadying and outstripping the wider materials industry. For example, bio-based plastics will see 17 percent CAGR growth between 2020 and 2030, compared to just 3.2 percent for conventional plastics. Several bioplastics will experience major capacity expansions in the next three years (CAGR), such as polyethylene furanoate (PEF) at 163 percent, polyhydroxyalkanoates (PHA) at 50 percent, and bio-polyamide (Bio-PA) at 38 percent.

The opportunities are there for both producers and consumer goods companies. How can players identify and successfully harness compelling areas for growth in the bio-based materials segment?

1. Bio-based materials are defined as chemicals and polymers derived partially or fully from bio-based feedstocks such as biomass, arable crops, and other organic matter.

THE TRENDS DRIVING CURRENT MARKET EXPANSION AND GROWTH

The upsurge of interest in the bio-based materials market is caused by a combination of both demand and supply factors:

1. DEMAND-SIDE PULL

Producers are seeing increasing consumer demand for bio-based alternatives in specific areas. These include premium items (such as in the fashion and automotive sectors), for which higher costs are less of a barrier to purchase, volumes are low, and companies want the increased brand recognition that comes from being a genuine sustainability market leader. Additionally, in some niches bio-based products are the only available or viable option, such as compostable cutlery and tableware for large-scale outdoor catering.

Mass-market consumer goods companies are also dramatically increasing demand. Many have made bold commitments to switch to fully recycled or bio-based packaging as they have looked to differentiate and reduce their carbon footprint. This gives producers confidence in expanding capacity to service this growing need.

MANY HAVE MADE BOLD COMMITMENTS TO SWITCH TO FULLY RECYCLED OR BIO-BASED PACKAGING AS THEY HAVE LOOKED TO DIFFERENTIATE AND REDUCE THEIR CARBON FOOTPRINT.

Demand is also being stoked by new and planned regulations designed to increase sustainability and grow the circular economy. Many companies are aiming to get ahead of the curve and build resilience into their supply chains by mandating bio-based materials before they are compulsory. For example, in the automotive industry, companies such as Porsche are replacing composites with natural fibers (such as hemp) to enable recyclability while retaining the benefits of materials that are strong and lightweight. Producers that rely on manufacturing materials that are not easily recyclable will have to respond to this regulatory and consumer demand – by exiting the market entirely, developing breakthrough recycling technologies (which may not happen quickly enough), or switching to bio-based materials.

2. SUPPLY-SIDE PUSH

Many bio-based materials are now mature. For example, bio-polyamides (Bio-PA) are now cheaper than most natural fibers while delivering similar levels of quality and durability.

After decades of aborted attempts, capacity and material availability have finally expanded from pilot to commercial-scale activities in many areas as technology barriers have been overcome and investment has increased. Thanks to new finance, capacity for production of furan derivatives is expected to grow by 209 percent CAGR between 2022 and 2025, albeit from a low base[2]. Bio-based material companies such as Newlight Technologies ($107m Series F funding in 2022), RWDC Industries ($263m Series B funding in 2021) and Beijing Phabuilder Biotechnology ($37m Series A funding in 2022) have all attracted significant new investment. Many oil majors are investing heavily in bio-based materials to build future resilience into their portfolios. TotalEnergies Corbion has expanded polylactic acid (PLA) operations in Thailand, for example, using the byproducts of locally grown sugar cane.

THE OPPORTUNITIES AND CHALLENGES FOR UPSTREAM AND DOWNSTREAM PLAYERS

Understanding the market and seizing opportunities requires four key capabilities from businesses seeking to operate in the bio-based materials sector, as shown in Figure 1.

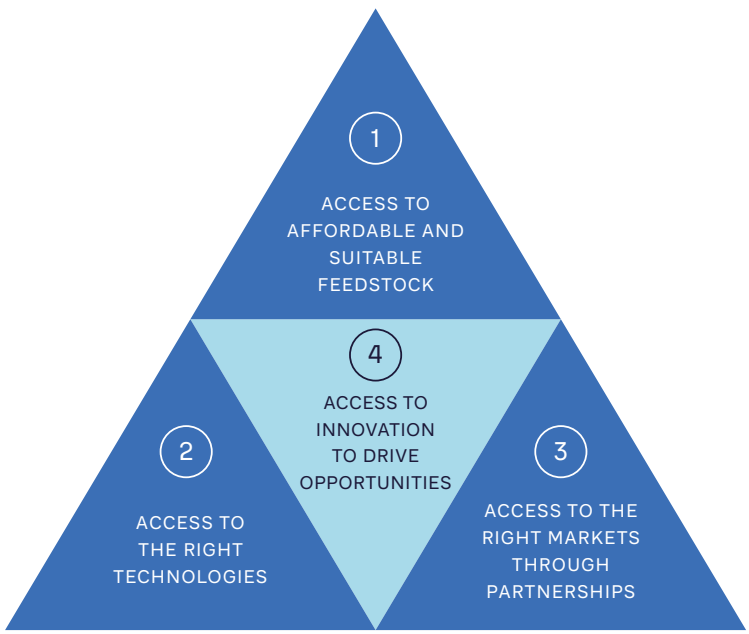

FIGURE 1: UNDERSTANDING THE REQUIRED CAPABILITIES

2: Source: Arthur D. Little/Nova Institute

1. ACCESS TO AFFORDABLE AND SUITABLE FEEDSTOCK

The cost of feedstock makes up 60–70 percent of the total production cost of bio-based materials. Therefore, reliable access to available, affordable feedstock of suitable quality and consistency is vital to maintain cost competitiveness against conventional, petroleum-based alternatives.

However, there are natural limits to the amount of biomass that can be created, based on the world's available land and the need to grow crops for food. This means producers must secure supplies against other players while regulators look to balance a finite supply against increasing demand. For example, the EU has tightened restrictions on the use of edible feedstocks in bio-based material production. Thailand only allows bio-based producers to use the byproducts of sugar cane processing, rather than the crop itself.

PRODUCERS MUST SECURE SUPPLIES AGAINST OTHER PLAYERS WHILE REGULATORS LOOK TO BALANCE A FINITE SUPPLY AGAINST INCREASING DEMAND.

Producers can build a resilient supply of feedstock in one of three ways:

1. Move production to regions where feedstock costs are lower, such as countries in Asia and Latin America. Arkema has expanded into India and Asian countries to gain access to castor beans, which are used as part of the production process of bio-polyamide. The textiles industry is increasingly adopting this practice.

2. Build partnerships to strengthen access to a consistent and high-quality source of feedstock, regardless of geography. HELM and Cargill have partnered to combine their respective strengths in chemicals and corn feedstock to open a $300m commercial facility in the US to produce bio-butanediol (Bio-BDO), a key intermediate for biopolymers. Long-term commitments are essential here.

3. Focus on or shift towards sustainably sourced feedstocks and greater recycling. Companies are increasingly relying on agricultural byproducts such as molasses, used kitchen oil, and palm oil waste as feedstocks. As well as increasing supply, this encourages greater recycling and supports the circular economy. LyondellBasell is using bio-naphtha produced from 100 percent waste materials from oil company Neste to create commercial biofuels (bio-polypropylene and bio-polyethylene) with verified renewable content. While bio-based materials and recycling are partly in competition, we ultimately will need both.

2. ACCESS TO THE RIGHT TECHNOLOGIES

Technological innovation is vital for achieving satisfactory production yields, building resilience by allowing a range of feedstocks to be used, and enabling overall cost-competitiveness.

There are three types of products for bio-based production – drop-in, dedicated novel, and non-dedicated novel (as shown in Figure 2). In many cases, novel routes are being explored to find ways to improve production costs and produce bio-based materials with new functionalities.

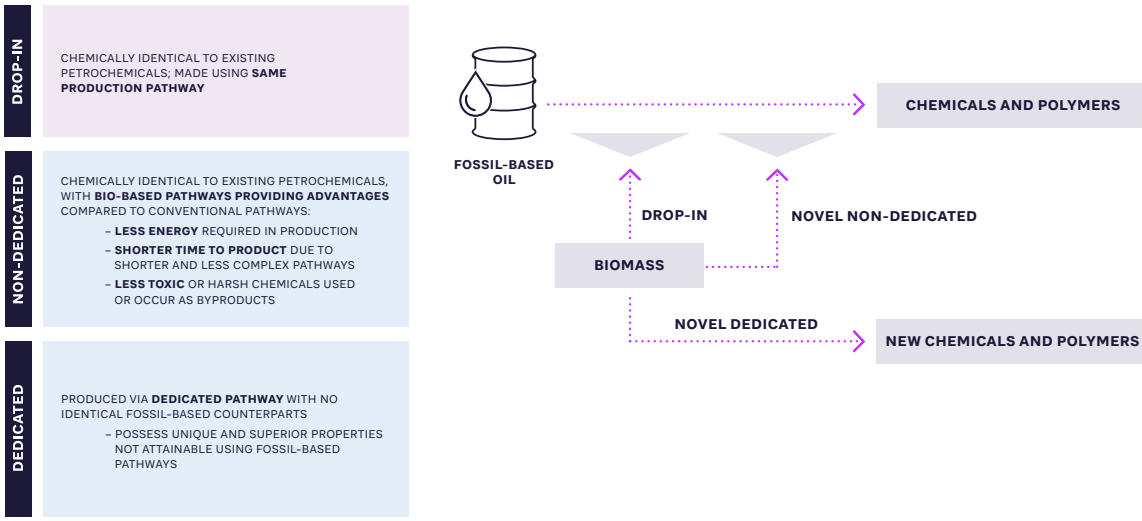

FIGURE 2: BIO-BASED PATHWAYS FOR PRODUCTION OF BIOPLASTICS

In particular, producers are looking to use technology to improve feedstock conversion (to lower costs) and improve production capacity, thus increasing economies of scale to cost-effectively meet demand. For example, despite having a range of uses, from food packaging to medical implants, PHA initially struggled as a technology. Significant improvements in production efficiency and scalability have increased fermentation yield to lower unit production cost while driving production growth.

Access to the right technology by developing it internally is capital intensive and has a highly uncertain outcome. Technology licensing is a common model, and removes the need to develop a new technology from scratch while mitigating M&A risks. Genomatica is emerging as a leading technology licensor, offering a wide range of bio-based materials production technologies that are being used by major players such as Novamont, Qore, BASF and DSM.

3. ACCESS TO THE RIGHT MARKETS THROUGH PARTNERSHIPS

There is growing demand from consumer product companies looking to differentiate, increase their own supply chain resilience, and meet current and future regulatory requirements.

This is increasingly led by luxury brands, for which price is less of a factor and purchasers expect sustainability and good business practices as a given. For example, both Burberry and Gucci have released products made from Econyl (nylon made from fishing nets, fabric scraps, and industrial plastic).

SUCCESS MAY REQUIRE MATERIALS PLAYERS TO MOVE BEYOND THEIR TRADITIONAL ECOSYSTEMS TO ENGAGE WITH END CUSTOMERS.

Matching supply with demand requires close partnerships to ensure bio-based materials meet exact customer needs. This can be achieved through co-development and close collaboration to explore new opportunities and create targeted solutions.

Building strong partnerships with end customers enables:

- Resilience of production and supply for both parties
- The ability to scale production to drive cost efficiencies, based on secure future sales. Dutch-based PEF producer Avantium has established a network of collaborators from multiple industries, including Lego and Carlsberg, to explore the use of PEF in different end products. Consequently, it has successfully achieved offtake commitments representing 50 percent of its upcoming commercial plant capacity, with additional capacity reservations of up to 67 percent
- The ability to improve processes to deliver economies of scale
- The ability for producers to position themselves as a premium or high-quality option, enhancing margins. Genomatica has established a partnership with high-end sportswear brand Lululemon Athletica to integrate bio-based nylons into Lululemon's sustainability product portfolio

Success may require materials players to move beyond their traditional ecosystems to engage with end customers. Origin Materials is collaborating with a network of global automotive manufacturers on raw materials standards, carbon neutrality, and other key sustainability topics in the automotive supply chain. This enables it to create a market for its own carbon-negative chemicals to be deployed in high-value mobility applications such as fabrics, plasticizers, seat foams, engineered polymers, tires, and hoses.

As well as building collaborative partnerships and ecosystems, producers will require new capabilities, such as around ensuring adherence to international quality standards and being able to certify the credentials of their bio-based materials and demonstrate that they are, in fact, predominantly bio-based.

4. ACCESS TO INNOVATION TO DRIVE OPPORTUNITIES

As the bio-based materials market expands and matures in many areas, continued innovation is vital. However, materials science has traditionally suffered from under-investment. Producers therefore need to build materials science capabilities that allow them to develop bio-based products such as polymers and plastics that are identical to or better than conventional alternatives. They also need to be able to provide unique solutions that cater to the specific demands of downstream industries, such as through embodied plastics.

AS THE BIO-BASED MATERIALS MARKET EXPANDS AND MATURES IN MANY AREAS, CONTINUED INNOVATION IS VITAL.

Feedstock innovation is also vital in, for example, combining bio-based feedstocks with recycled materials. For example, PTT MCC uses 50 percent bio-based materials when producing polybutylene succinate (PBS). This enables its end customers to meet their required sustainability standards.

KEY STRATEGIES FOR SUCCESS

Producers also need to understand and follow three key strategies when evaluating opportunities to add to their bio-based materials portfolio.

1. Take advantage of a positive and supportive regulatory environment

There is a growing global push for the use of sustainable, recyclable materials, based on environmental and Net Zero considerations. This is leading to legislation in two areas:

- Regulations that aim to increase demand. These can take the form of encouraging or mandating bio-based materials and/or discouraging the use of fossil fuel-based materials, such as through single-use plastic bans.

- Regulations that aim to increase supply. These could be financial and/or non-financial incentives, as have been deployed by the Thai Board of Investment, or bans and taxes on fossil fuel-based goods. The US REDUCE Act has doubled the import tax on fossil-based virgin plastic resins from $0.10 to $0.20 per pound, forcing suppliers to consider bio-based alternatives.

However, legislation is still maturing – for example, in the EU, labeling packaging as "bio-based" only requires 20 percent of the packaging material to be bio-based. This will change, as a current consultation is running around a new legislative framework.

To plan appropriately, producers need to build a deep understanding of the regulatory environment and, in particular, how changes will put pressure on their actual and potential customers to increase their use of bio-based products. Given the long-term time scales producers work to, this planning should be prioritized to position them effectively for the future.

2. Build and leverage the ability to create a technology advantage

Technology advantage is a key driver in the producer's direct control. It is critical to commercial viability and the wider adoption of bio-based materials in the absence of subsidies/regulations.

Producers should look at three areas to build advantage:

- **Feedstock advantage** to give flexibility. For example, Bluepha's fermentation technology allows it to use a wider range of biomass and waste feedstock in the production of PHA compared to rivals.
- **Process advantage** through fewer inputs and processes. Genomatica's Geno BDO technology delivers advantages over conventional processes, as it does not require succinic acid as an intermediate.
- **Properties advantage** to enable the wider use of bio-based materials. Roquette is working with personal care player Syntheon to expand the use of succinic acid, moving beyond its traditional role into high-value cosmetic segments.

By working together with downstream partners, producers can both develop technology advantages and secure complementary expertise to further refine their strengths.

3. Target markets with high growth potential

When identifying significant-size markets, those with high growth potential and little competition are ideal targets. While markets meeting all three criteria might be hard to come by, working in partnership with launch customers will help identify opportunities and provide early revenues, mitigating risk. For example, luxury fashion apparel brand Stella McCartney pioneered the world's first bio-based faux fur in partnership with DuPont Biomaterials in 2020.

However, high growth potential and a lack of competition does need to be balanced with other drivers (such as technology advantage), as shown in the case of succinic acid, an intermediate for polymer production. Despite significant growth in demand, only four players are currently operating within this space, due to struggles to scale up technology in a cost-effective manner and obtain cheap-enough feedstocks. While technology advancements are now being made, it is not yet clear whether they will lead to large-scale commercialization.

BUILDING A STRATEGY FOR SUCCESS

The path to achieving success in the bio-based materials market remains difficult. Market leaders need to align the four capabilities with the three key strategies, starting by securing the right feedstock and building a strong understanding of the product landscape, geography, and technology.

INSIGHTS FOR THE EXECUTIVE

Beyond identifying a clear winner, players should retain several key principles throughout their bio-based materials journey:

- **Act now to be ready for the future.** Suppliers should focus on value chains that are most at risk in the future and/or where a premium is already being paid now.
- **Disrupt the market as opposed to playing in the market.** Instead of following market trends, players should consistently identify ways to develop a unique proposition and create new market demands to remain relevant. Develop technologies with a protective moat to buy time in the short term to enhance and safeguard your competitive edge.
- **View bio-based materials as a future core business.** As opposed to seeing bio-based materials as a mere sustainability initiative, players should internalize the potential of bio-based materials as the successor of fossil-based resources.
- **Take a partnership approach.** Both producers and consumer goods companies should build early partnerships to explore and scale opportunities to reduce risk and build capabilities without over-investment.
- **Balance the bio-economy with the circular economy.** Beyond the use of bio-based feedstocks, players can consider expanding and integrating recycled materials into their product offering.
- **Build scale.** As with any process-based industry, you need to be able to grow production. Do you need partners, such as fossil-fuel players with experience of scaling operations?
- **Find a focus amidst the white noise.** While the opportunities within the bio-based materials space are vast, players should identify key technologies and markets to allocate resources to, rather than spreading themselves too thinly.

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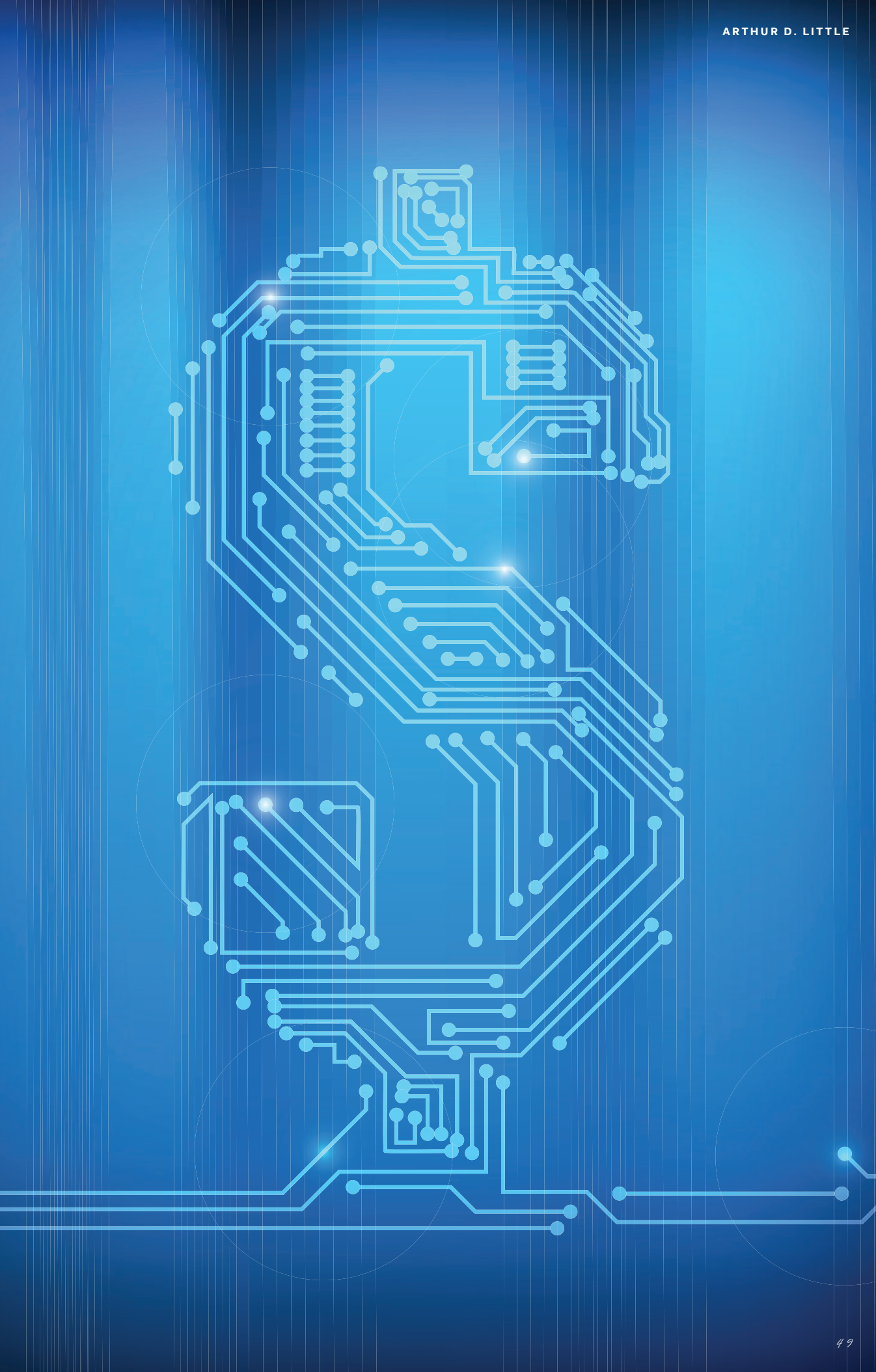
DISRUPTION

CAN BANKS STRIKE BACK?



AUTHORS

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"The universal banking model is inherently unstable and unworkable. No amount of restructuring, management change or regulation is ever likely to change that."

So said John Reed, the former Chairman and CEO of Citigroup, as far back as 2015, at a time when global banks across the world were starting to pare back their international operations in response to increasing regulation. The decline of the traditional global bank has only accelerated since then. The newly emerged digital native and "neobank" competitors are now in favor. Their state-of-the-art digital technology, lower-cost structure, lower capital requirements, and greater flexibility in introducing products render them nimbler and more adaptable to changing consumer demands. Moreover, they are free from the high labor and capital costs of maintaining and upgrading obsolete technology. Because of all this, fintech firms command a much higher stock market price than banks, which is often not much less than that of many major technology firms.

ALIBABA'S TECHNOLOGY CAN HANDLE 120,000 TRANSACTIONS EVERY SECOND AND REACH A DECISION TO GRANT A LOAN OR NOT WITHIN JUST THREE MINUTES.

To get a sense of the magnitude of the challenge banks face, we need look no further than Ant, the financial arm of Chinese marketplace Alibaba. Its technology can handle 120,000 transactions every second and reach a decision to grant a loan or not within just three minutes. This is the world's purest example of digital finance's tremendous potential, but the vivid signs of a banking revolution are everywhere – for instance, Europe's three largest "neobanks", Revolut, N26 and Monzo, have 23 million registered users between them, and that number continues to grow.

By contrast, the model of the traditional universal bank is dead, killed off by a changing marketplace and the emergence of a new breed of footloose financial players that command destructive technological power. Investors' decisions speak louder than words. Price-to-book ratios for retail banks remain consistently below 1 in all major markets. Venture capital investment in fintech has grown at 20% per year from 2011 to 2021. The number of fintechs companies nearly doubled from around 12,000 in 2018 to almost 21,000 in 2020.

So is it really game over for established banks? Fortunately, not yet. Despite all the funding that has gone their way, there has been no sweeping market takeover by fintechs. Becoming a bank is extremely costly, and there is still a lot of customer stickiness to the brands that they know. Also, fintechs are swimming with a lot of other sharks. For example, the market for payment companies is seriously overcrowded, with many players starved of capital and staring down empty balance sheets. Recent market corrections in fintech valuations (Robinhood being a case in point) and turbulences in the decentralized finance landscape show how fintechs will need to work hard to stay ahead.

There is, therefore, still some time. However, banks are notoriously slow-moving organizations and have a track record of being poor at anticipating change and failing to adapt. Banks do have a future, but they must accept that it's a different future. If bank leaders fail to make radical changes, they will perish. The time for those changes is now. Let's consider what they need to do.

PRIORITIES FOR LEGACY BANKS TO STRIKE BACK

To effect radical change, legacy banks need to consider six priorities to transform themselves into the sort of innovative, agile and forward-looking institutions required for a successful future (Figure 1).

FIGURE 1: SIX LEVERS TO TRANSFORM BANKS

1. PICK YOUR BATTLES AND EMBRACE THE ECOSYSTEM

The place to start is to recognize and acknowledge that things have changed, and it's no longer possible to be all things to all people. A legacy bank hoping to compete against fintechs and non-banks can no longer afford to dilute its resources by pursuing a "here and there, hedging your bets" strategy. Putting your eggs in different baskets may work for an investor, but not a legacy bank.

This means banks will usually need to move the dial by a factor of 10 rather than just readjust it and work in the margins. The best way to approach this is to make sure they develop a clear picture of the future – the point of arrival of the industry in three to five years' time – and decide what their role should be within that future. For example, the continuing rise of fintechs brings with it new ways of doing business, such as "triangular strategies" that allow them to leverage assets and channels banks don't have, and embedded finance, which, given the rise of e-commerce across many markets and channels, offers the opportunity for exponential growth. For instance, in the US, the size of the embedded finance market is forecast to equal that of Big Tech - in other words, approximately half the value of today's global banking market.

IF RETAIL BANKS ARE TO MAINTAIN ANY KIND OF POSITION IN THE MARKET, THEY WILL NEED TO TURN TO A BALANCE-SHEET-LIGHT MODEL.

As the traditional value chain is dissolved by these disruptors, it is being replaced by a much wider financial ecosystem consisting of many niches, which is creating a world where, at least for now, capital-intensive models still co-exist alongside those that are capital-light. In this hybrid business environment, the old-school British banking model, which has for so long underpinned financial services, is looking increasingly irrelevant and creaky. If retail banks are to maintain any kind of position in the market, they will need to turn to a balance-sheet-light model that revolves around selling third-party products rather than recycling deposits into new loans. For that, they will need a very different set of capabilities.

What is happening here to banks is, of course, part of a much bigger and wider economic shift in the marketplace. As Anne Bennett, CEO of the National Australian Bank, says: "The largest movie house owns no cinemas, the world's largest taxi company owns no taxis, and increasingly, large phone companies own no telco infrastructure. What, then, is the future asset for banks?" Her answer: "Experience."

Of course, the arrival point for every bank is different, but there should be a common factor between all – that this should be far away from where the bank is now. If it is not, the senior leadership team has not been thinking big enough. Without a clear strategy to follow, it is no exaggeration to say a bank could be heading for bankruptcy. And leaders need to be clear that this is much more than digitalization – digital is neither a strategy nor a business model in itself, but, rather, a means to enhance and implement a business model. In practice, banks will need to shed long-established activities, re-evaluate the levels of risk they are willing to accept, restructure systems and processes, and invest without quibble in the new technology that is needed.

2. PUT THE CUSTOMER AT THE FOREFRONT OF EVERYTHING

For the future, the customer should be everything. This means any digital transformation must be firmly and fundamentally anchored in the customer value it provides. Traditionally, banks have often focused on demographics and purchase histories to decide on customer priorities, but this will no longer be adequate to move towards the much higher level of customer focus needed in the new environment.

Instead, banks need to employ technology to acquire a much greater understanding of those they do business with, and then use this to personalize every interaction with them. For example, state-of-the-art "chatbots" and other computer-supported conversation tools are now a bare minimum. Data analytics and the use of AI to recognize each customer and then accurately predict the purpose of their conversations is of even more value. Becoming a seamless problem solver, offering "one-call resolution" to save customers time and effort, will go a long way towards winning their hearts and minds. Regaining customers' trust is essential to make the wheel turn in the traditional banks' favor.

Given that open banking means disruptive third parties can now access customer data held with another financial institution, banks have no choice but to focus on becoming high-level, data-first organizations themselves, so they can monetize their wealth of customer knowledge. Again, this comes down to investing in the right technology and top-notch analysis. This creates opportunities, but generally only for early movers, as they are the ones that tend to capture the market and hold onto their customers. Life is then harder for those that come afterwards.

3. INVEST IN TECHNOLOGY AND INNOVATION

Technology is the key enabler – from increasing productivity and cutting costs to reaching previously inaccessible market segments and enriching the customer experience. Unfortunately, technological obsolescence is rife in today's banking environment. Those not paying attention to approaching end-of-life hardware and software situations will find themselves in front of a funding abyss as they scramble to replace their old IT infrastructure with something more fit for purpose. The effective adoption and use of next-generation technology is the road to greater customer engagement, faster product development, better operational management, and improved compliance, efficiency, and growth. It will also enrich the customer experience through stellar, hyper-personalized service.

Shifting to new technology will obviously necessitate the writing off of old systems and software, but this is a price that must be accepted. Fortunately, the cost of IT continues to fall and the adoption of cloud-based services can dramatically cut infrastructure costs. Banks must also become technology agnostic by using architectures for front-, middle- and back-office processes that allow for easy integration with third-party solutions and facilitate migration away from legacy IT solutions.

The pace of technological change in the financial sector is rapid, with breakthrough technologies regularly appearing. This means banks need to become proactive in innovation management, continually identifying emerging technologies and then using them to lever advantage. Becoming a truly innovative organization calls for new capabilities and ways of working, including becoming agile in the same way as the best non-bank fintechs. This means creating quickly, running parallel improvement sprints, seeking fast feedback, doubling down on winners, and killing losers. It also means being prepared to embrace working with new ecosystem partners in different ways. For example, some financial institutions have been successful in incubating and scaling up new businesses externally through partners without compromising the wider organization, such as Openbank by Banco Santander. (Refer to ADL's Breakthrough Incubator model[1] for more on how this works.) A credible innovation strategy ensures that the products and services of tomorrow can be rapidly delivered.

THE PACE OF TECHNOLOGICAL CHANGE IN THE FINANCIAL SECTOR IS RAPID, WITH BREAKTHROUGH TECHNOLOGIES REGULARLY APPEARING.

1. "The Breakthrough Incubator: A proven approach | Arthur D. Little (adlittle.com)

Orange Bank is another example of what is possible. Orange Bank is able to bring out six to eight product innovations in a month, which is double what a legacy institution could deliver in a year, through taking a strategic approach to innovation and adopting modern innovation practices.

4. PUT IN PLACE THE RIGHT LEADERSHIP AND GOVERNANCE

Having the right person in charge is key to a legacy bank's survival and future success. Needed above all is a leader who understands how to be ambidextrous – able to deliver significant growth and productivity improvements in the short term, while simultaneously redesigning a bank's business model and moving it to the new point of arrival in the future. In most cases this means more emphasis on "Exploring" – innovating for the future – to better balance "Exploiting", which has typically been the main focus for legacy banks.

This is quite different from being merely "forward-looking", which involves doing little more than identifying a few industry trends and sketching out some possible options in response. The truly ambidextrous CEO must also be adept at peering through the blizzard of largely irrelevant information, slicing into the complexity of others' opinions, and be willing to back their decisions even when they are based on incomplete information. Some good examples of banks that have risen to the challenge in this way are BBVA, JP Morgan and Goldman Sachs.

Closely linked to this is the subject of governance. The board appoints the CEO, but do the board members have the right skills, capabilities and foresight to understand the radical nature of the transformation needed? Will they tend to prefer an experienced "status quo CEO" to one who is truly ambidextrous? Therefore, it may be necessary to refresh the board by bringing in a more diverse mix of open-minded individuals representing a range of gender, race and experience profiles. This should include a strong awareness of such things as artificial intelligence, machine learning, robotic process automation and augmented reality.

5. ALIGN VALUES AND CULTURE

Bankers often tend to feel uncomfortable when pursuing anything that does not have hard financial edges. However, competing effectively with fintechs and meeting the changing needs of customers mean it is now essential for legacy banks to address issues around organizational personality and culture.

In this, the leader's perceived values, attitudes and behaviors are key. A forward-looking ambidextrous leader can convince the organization that the old days of banking are gone, and that a different way of thinking is needed. This message needs to be pushed into every corner. Unfortunately, many bank executives do not yet understand the impact of something like digitization and how it impacts every aspect of the business, from core functions to organizational structure and culture.

A good example of this is RBS, which, despite the institution's massive resources, was incapable of creating a successful digital bank because it was hamstrung by old ways of thinking that were a mismatch with the new model. This can be contrasted with the likes of N26 and Tandem, which achieved great things with very limited resources because they had an aligned mind-set focused on speed and meeting their customers' needs in the best way possible. In addition, customer needs are changing. For example, just over half of Generation Z (those born between 1995 and 2010) say they trust their primary financial institution – a bank – most with their money.

ONE OF THE CHALLENGES FOR ALL BUT THE LARGEST LEGACY BANKS IS SETTING ASIDE THEIR CORPORATE EGO AND REALIZING THEY CAN NO LONGER GO IT ALONE.

Today, culture is often cited as the single best predictor of employee satisfaction, more so than compensation or work-life balance. However, the cultural values and day-to-day behaviors of banks are often out of sync with the types of individuals they need to recruit and retain, most significantly in terms of failure to be seen to respect employees adequately. Younger people in particular have different, and often stronger, beliefs and expectations regarding an organization's values and culture. For example, the need to truly embrace environmental, social, and corporate governance (ESG), which reflects a firm's collective consciousness beyond the purely commercial, is now a key priority for growing numbers of employees, consumers and investors.

6. SET ASIDE THE CORPORATE EGO

One of the challenges for all but the largest legacy banks is setting aside their corporate ego and realizing they can no longer go it alone. For those banks to deliver exceptional value to their customers – as they must – they have to be willing to work in partnership with fintechs, which have the digital knowledge and experience they need to access to make up for gaps in their offering.

Banks must be prepared to become part of a much wider ecosystem that is geared towards serving the broader needs of the customer. By doing so, they will be able to turn defense into attack and better protect their position. In such an environment, it isn't generally

possible for a financial brand to stand out as it did before. However, banks can, to some extent, mitigate this loss of visibility by ensuring they play a proactive role in shaping any platform they are part of. This means managing the process of developing the partner ecosystem strategically and purposefully, rather than, as is often the case, in a piecemeal and uncoordinated way.

There are some good examples of this in action. Santander, for instance, has launched "Trade Hub", a proprietary platform that encompasses non-financial services. For many financial institutions, this coming together with third parties to provide sector-specific solutions will be the only way to secure a long-term future.

Despite the challenges of transforming a legacy bank, it can certainly be done. DBS, Singapore's largest bank, is a great example of these six priorities in practice. (See Box 1.)

Box 1: How DBS transformed itself for a new future

In 2009, DBS, the largest bank in Singapore, set about transforming itself into the digital future. It realized that the radical change needed to create an ambidextrous business had to come from the top. This was driven by a CEO with an explorer mind-set – Piyush Gupta, whose mantra of "live more, bank less" has underpinned what is regarded as the most extensive transformation program of any bank. Today's reimagined DBS is characterized by simple, effortless service delivery. As Gupta explains, "I found that once you give people permission and some training, you unleash this tremendous energy to do things."

DBS has taken a leap into the digital future, drastically changing its business model through innovation. By adopting the cultural vision of a "27,000-person start-up", DBS has successfully repositioned itself, developing new products and services and delivering the type of growth and financial performance that has seen it go from a traditional regional player to being recognized as one of the world's most forwarding-thinking and innovative banks.

Creating a new "digital culture" was central to DBS's transformation. It was certainly the first bank in the world to develop a methodology for measuring digital value creation, which has led to the creation of a very successful digital banking model. For example, in India, DBS switched to a digital-only model with no physical presence. Its digital retail customers now generate twice the income, at a 20 percent lower cost-to-income ratio. This segment also generates a 9 percent greater ROE than DBS's traditional banking segment. Digital customers now make up more than 40 percent of the bank's customer base and generate about 70 percent of its profit.

INSIGHTS FOR THE EXECUTIVE - HOW TO START MAKING THE CHANGE

How do banks go about making the sort of radical transformation outlined above and become truly ambidextrous? The starting point is to make sure there is a shared sense of urgency and courage to embrace radical, disruptive change across the board and the executive. If you don't think you need to shift, everything else is irrelevant. As Winston Churchill famously said, "Those that fail to learn from history are doomed to repeat it."

A useful early step is to perform an honest stock-take of the bank's current position. An initial "pulse check" can give banks an idea of their current capabilities. They can then follow this up with a benchmark survey to see how those capabilities stack up against those of other banks. After this "ambidexterity audit", banks will have a much better idea of how to achieve a better balance between explore and exploit.

The most important early priority of all is to make sure that the bank has the right person to lead it to the ambidextrous future. This appointment needs to be an inspirational and entrepreneurial leader who understands the need for transformation and is willing to take risks and think differently – rather than merely maintaining the status quo.

Of course, it is all too easy to oversimplify the situation, and every institution will face differing circumstances and constraints. Deciding the strategy is one thing, but implementation is another entirely.

Nevertheless, timid board members who hide behind the excuse that transformation initiatives will disturb business as usual miss the point. In a brave new world of neobanks and digital fintechs, disrupting business as usual is precisely what needs to be done. If they feel they cannot, or prefer not to, participate in this, they should make room for organizations that are willing to do what is necessary.

As we have said, establishing the bank's point of arrival in the future is vital. But this doesn't mean trying to plan every step along the way. We can be fairly sure that Jeff Bezos, when he began Amazon in his garage, had no idea where his company would be in 25 years, or the degree of disruption it would cause. Once banks have reinvented themselves, they need to do it again and again, through a constant cycle of deconstruction and reconfiguration, similar to the Buddhist notion of an endless cycle of rebirth. In the end, the winners will be the banks that can overcome the inertia that legacy institutions have traditionally been incapable of surmounting and transform themselves for good.

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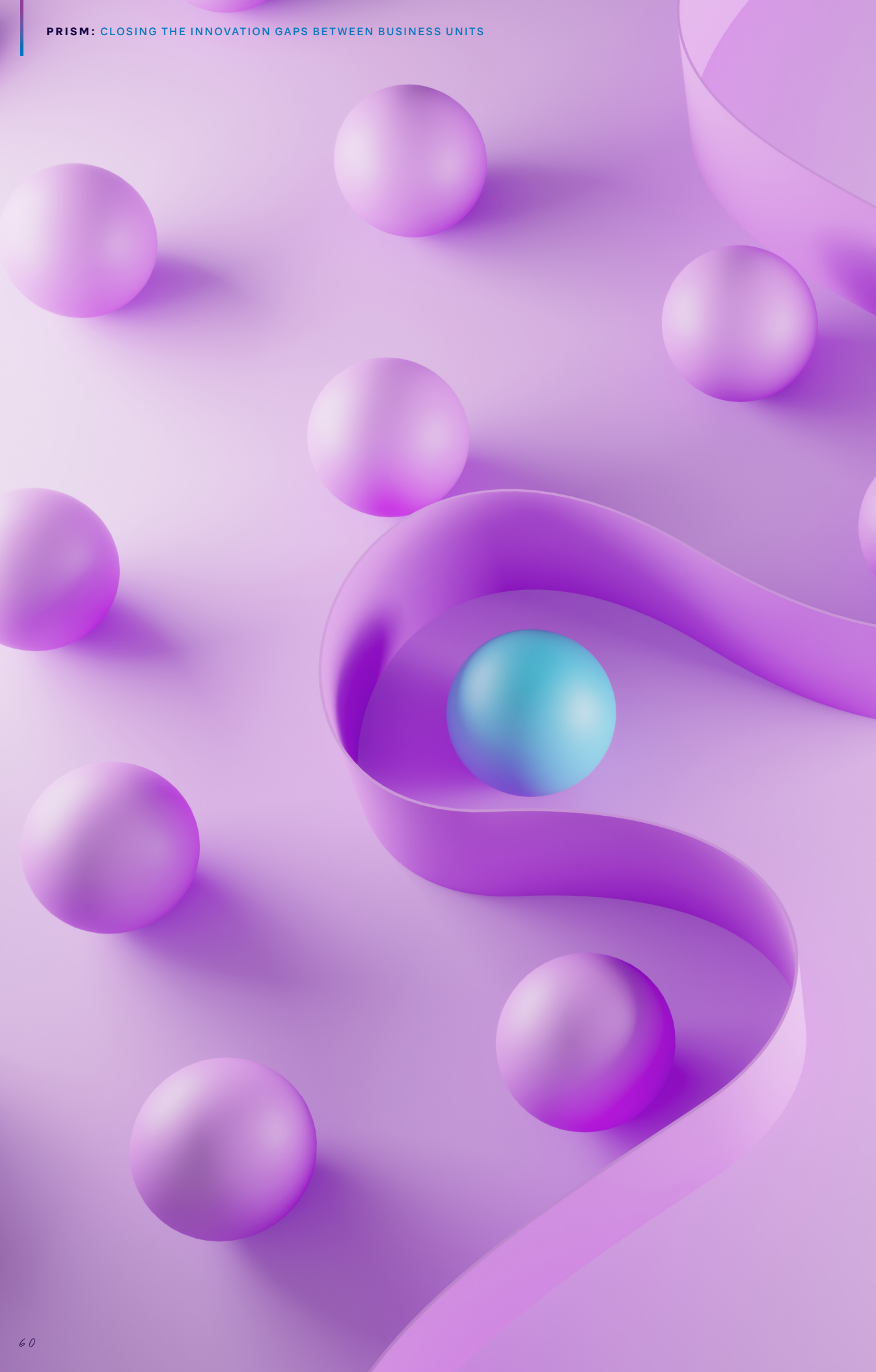

CLOSING THE INNOVATION GAPS BETWEEN BUSINESS UNITS

AUTHORS

Dr. Habib Hussein, Ben Thuriaux-Alemán, Dr. James Semple, Elis Wilkins, Professor Joe Tidd

If a business had two similar manufacturing sites that failed to share best practice processes, the chief operating officer would be seen as negligent. Yet, according to our latest research, the same thinking doesn't seem to apply to sharing innovation best practices, despite its importance for growth and competitiveness.

Why is this, and what can companies do to improve the situation? Based on new research, this article explores the reasons for failure to share best innovation practices between business units and sets out a strategic approach companies can take.

DEMONSTRATING THE INNOVATION GAPS

Embedding R&D and innovation centers into decentralized business units is a strategy widely used by large organizations to be more responsive to the needs of the local market and improve the relevance of innovation activities. Typically, such arrangements are complemented by some form of central coordination to ensure that longer-term and breakthrough innovation goals are not neglected in favor of short-term and incremental gains, and that there is some sharing of good practices.

ABOUT THE RESEARCH

Having run for over 20 years, ADL's Global Innovation Excellence Benchmark is an anonymous self-assessment best practice database, containing responses from over 500 companies to a series of detailed questions on innovation excellence. It measures two dimensions:

- Innovation success: "What has your innovation effort delivered in terms of business success?"
- Innovation management practices: "How sophisticated are your innovation management practices versus best practice?"

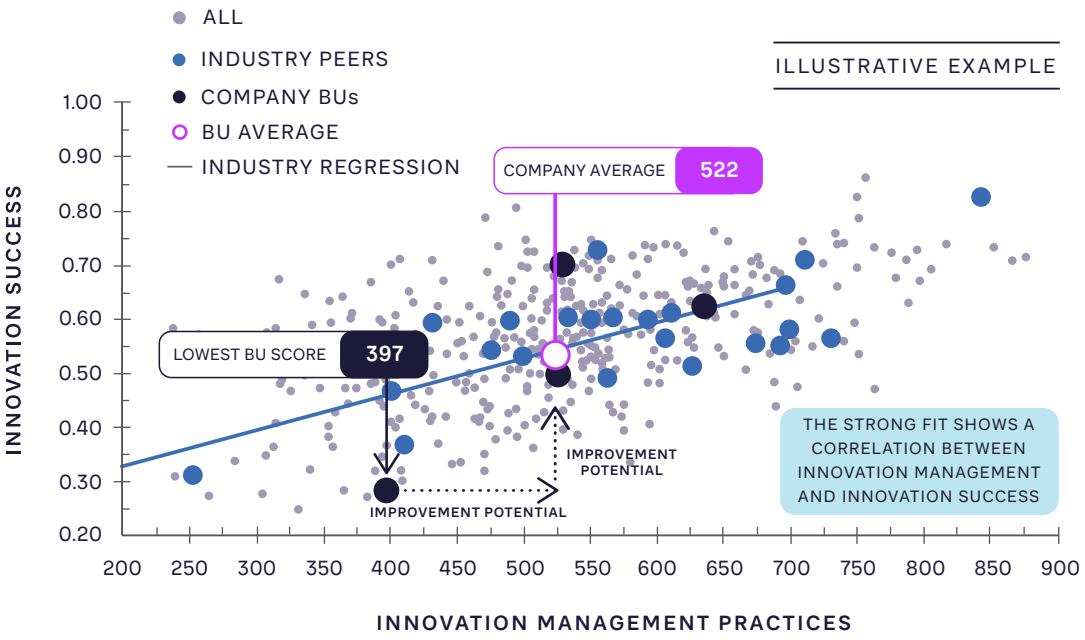

FIGURE 1: THE RELATIONSHIP BETWEEN INNOVATION MANAGEMENT PRACTICES AND INNOVATION SUCCESS IN THE CHEMICAL SECTOR

The dataset shows a strong correlation between excellence in innovation management practices and innovation success achieved, as shown in Figure 1. This holds across all industry groups.

For this research, the dataset was further analyzed to identify gaps between innovation management practices across different business units (BUs) in the same company, focusing on the 15 companies that provided this data.

To explore further the innovation gaps and their causes, a dedicated workshop was held with over 50 innovation executives from around the globe.

With this type of set-up, one might expect BUs within the same company to adopt similar innovation management practices. However, surprisingly, the data showed that this was not at all the case. The chemical sector provides a good illustration of the gap. (See Figure 2.)

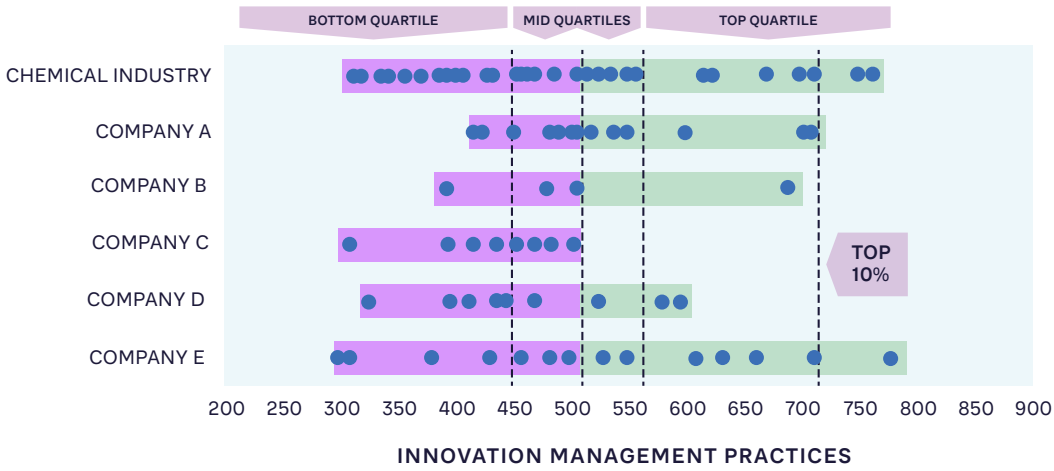

FIGURE 2: INDIVIDUAL BU INNOVATION MANAGEMENT PRACTICE SCORES ACROSS FIVE COMPANIES IN THE CHEMICAL SECTOR

Figure 2 shows that the range of individual BU innovation management excellence scores (the blue dots) is broad within each company. In fact, there is no statistically significant correlation between the performance of BUs within the same company versus BUs across different companies. The data showed similar trends across other industry sectors, so this is not something unique to the chemical sector. These gaps translate into multiple disadvantages, including lower overall innovation performance across the company, duplication of effort, and lack of transparency on innovation approaches across the company.

WE CALCULATED THAT IMPROVING THE PERFORMANCE OF THE WORST BU TO MATCH THE COMPANY AVERAGE IN EACH CASE WOULD LEAD TO 5 PERCENT GROWTH IN ANNUAL BU REVENUES, AS WELL AS IMPROVING MARGINS.

We calculated that improving the performance of the worst BU to match the company average in each case would lead to 5 percent growth in annual BU revenues, as well as improving margins. If improvements were made within all BUs, significantly higher revenue performances could be expected.

In our subsequent workshop comprising over 50 innovation executives and agents, 78 percent confirmed that standardizing best practices was a challenge and had a negative impact on innovation performance.

UNDERSTANDING THE ROOT CAUSES

Based on analysis, experience, and the views of innovation practitioners, failure to share innovation management best practices has three root causes:

INEFFECTIVE LEADERSHIP AND MISALIGNED INCENTIVES

Many BU organizational leaders are strongly incentivized on BU-specific goals and revenue targets, and this can make them uncomfortable with the uncertainty and risk associated with incorporating new innovation management practices from other parts of the organization. This is especially a problem if there is no organization-wide governance strategy for innovation management or senior management support for best practice sharing.

> *"I think the root cause of [not sharing] was that the business unit was so focused and incentivized on its own performance…."*
>
> **Head of Strategy at Corporate Innovation, global specialty chemicals company**

DIVERSITY OF NEEDS AND AIMS

BUs want autonomy over innovation and may see organizational best practices as inappropriate for their needs, targets and aims. There may also be variances in innovation clock cycles (i.e., the pace of innovation) and maturity levels between business units, particularly if they are located in multiple geographies or have different heritages, such as having been added by acquisition.

CULTURAL DIFFERENCES

Individual business units have built up their own cultures and may even compete against other parts of the same organization. Conflicts around power, politics and resources can lead to an insular "not invented here" mentality. This is particularly true if BUs have not been involved in creating innovation management practices. Central management may be seen as out of touch, and sometimes shared language of innovation is lacking across the organization.

> *"The dominant barrier that leads to a lot of variability across the organization is around politics and the friction of connecting, particularly on a global level."*
>
> **Head of R&D at global CPG**

INSIGHTS FOR THE EXECUTIVE – HOW TO BRIDGE THE GAPS

These challenges can be overcome, but require a strategic approach, with senior management backing and focusing on three levers:

1. ENSURE STRONG LEADERSHIP BACKED BY THE RIGHT INCENTIVES

Senior management should first recognize the size of the innovation gaps, and then take an active role in closing them by emphasizing the strategic importance of innovation management best practice to the entire organization and building trust between the BUs. This should be supported by incentives, such as providing access to additional innovation funding for BUs that deploy best practices and meet innovation targets.

Companies then need to create a balanced cross-business unit innovation portfolio with clear plans and protected budgets for short, medium, and long-term innovation targets. Management should set clear expectations for innovation portfolio transparency, including dashboards with board-level monitoring and KPIs.

A good example of this is provided by global materials technology group Umicore. Recognizing that it lacked the data to effectively manage innovation, Umicore established an Innovation Excellence Board to set and monitor innovation results, processes, and insights, and to ensure coaching at all levels to foster adoption and collaboration. (See Figure 3.)

What you cannot measure, you cannot manage....
Umicore's expectation was that innovation should be everywhere in the company. To achieve this, it recognized that innovation excellence had to become part of the company's culture. To foster its inclusion in company culture, innovation excellence therefore needed to be part of the company's innovation governance model.

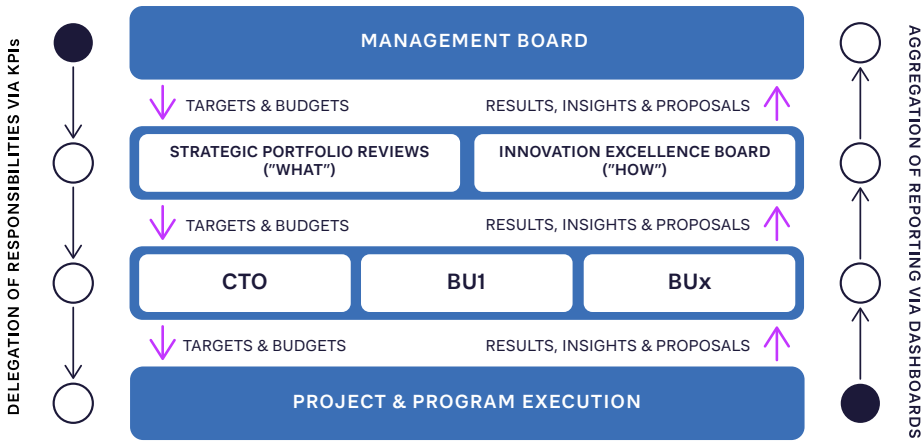

FIGURE 3: GOVERNANCE OF INNOVATION MANAGEMENT AT UMICORE

2. ENGAGE BU STAKEHOLDERS TO ENABLE CHANGE

BU stakeholders should be engaged, involved, and listened to, in order to create a sense of ownership around "new" innovation best practices. It is vital to build opportunities for collaboration at all levels by breaking down silos and enabling cross-pollination of ideas through meet-ups, communities and other knowledge-sharing forums. Bringing in influential innovation project leaders from outside can sometimes be effective.

> *"Most teams focus on solving their problems independently, resulting in islands of success rather than cloning of success. The need is to create the right culture, supported by creative incentivization models that focus on discovering and cloning success, rather than just solving problems in the silos."*
>
> **Senior Director Data Sciences, Supply Chain, Innovation at Walmart Global Tech India**

CASE STUDIES – ENGAGEMENT IN ACTION

After identifying differences that prevented the company from reviewing and prioritizing its portfolio, a global catalyst manufacturer developed a common framework for portfolio prioritization and managing innovation across BUs. It hit a roadblock as one BU argued it should not have to provide input data on project resources. However, the shared solution removed reporting bureaucracy, making project managers' lives easier – this incentive overcame the BU objections. Transparency across the portfolio highlighted immediate improvement opportunities.

Schaeffler, an integrated automotive and industrial supplier, has started to implement "excitement packages" to secure buy-in for innovation initiatives, especially in the early "fuzzy front end" of the innovation process. Recognizing that different stakeholders have different needs and expectations, the innovation function includes decision-makers early by "speaking the same language" in addressing their main needs for information. For example, by using a variety of tools and approaches, such as financial scenarios showing the dollar impact of innovation, providing physical prototypes or capability demonstrators to technically oriented decision-makers, or presenting storylines and visualizations to get emotional buy-in, the full opportunity space and potential of an innovation idea can be more easily communicated, understood and assessed.*

3. BUILD A COLLABORATIVE, INNOVATION-LED STRUCTURE AND CULTURE

As with any successful change initiative, building a cross-BU culture of collaboration requires both top-down and bottom-up approaches to bring teams together. It begins by clearly setting out the overall innovation vision, mission, and objectives for the organization, and understanding what targets the innovation and R&D teams will need to deliver. While objectives, constraints and KPIs will differ across BUs, a common understanding needs to be built about what innovation success looks like, supported by a common language. Involving BUs from the outset is important. A common assessment and benchmarking framework ensure that a credible overall picture can be built to overcome siloed perceptions.

A COMMON ASSESSMENT AND BENCHMARKING FRAMEWORK ENSURE THAT A CREDIBLE OVERALL PICTURE CAN BE BUILT TO OVERCOME SILOED PERCEPTIONS.

*source: Panel discussion on how to boost innovation and profit through business unit cohesion, EIRMA CTO forum, Wageningen, Netherlands, 2022

Identification of "soft" levers and understanding the "unwritten rules of the game" that shape the norms and behaviors in each BU is important to remove barriers to sharing. Using an iterative and participative process, trust can be built, and a common prioritized set of initiatives can be identified that has buy-in from both BUs and corporate.

> *"I think that one key area that we tried to change was to ensure that the ownership for driving innovation was in the business unit, as well as in the technology organization. We also put in place structures that fostered a close dialogue between our technical experts and market experts to build a joint vision for the future."*
>
> **Lorraine Phillips, experienced senior director from a supermajor oil and gas company**

For many large companies, poor sharing of innovation management best practices is limiting their performance, leaving innovation value on the table. Adopting the right leadership approaches and focusing on BU engagement, trust, and collaboration can make a big difference.

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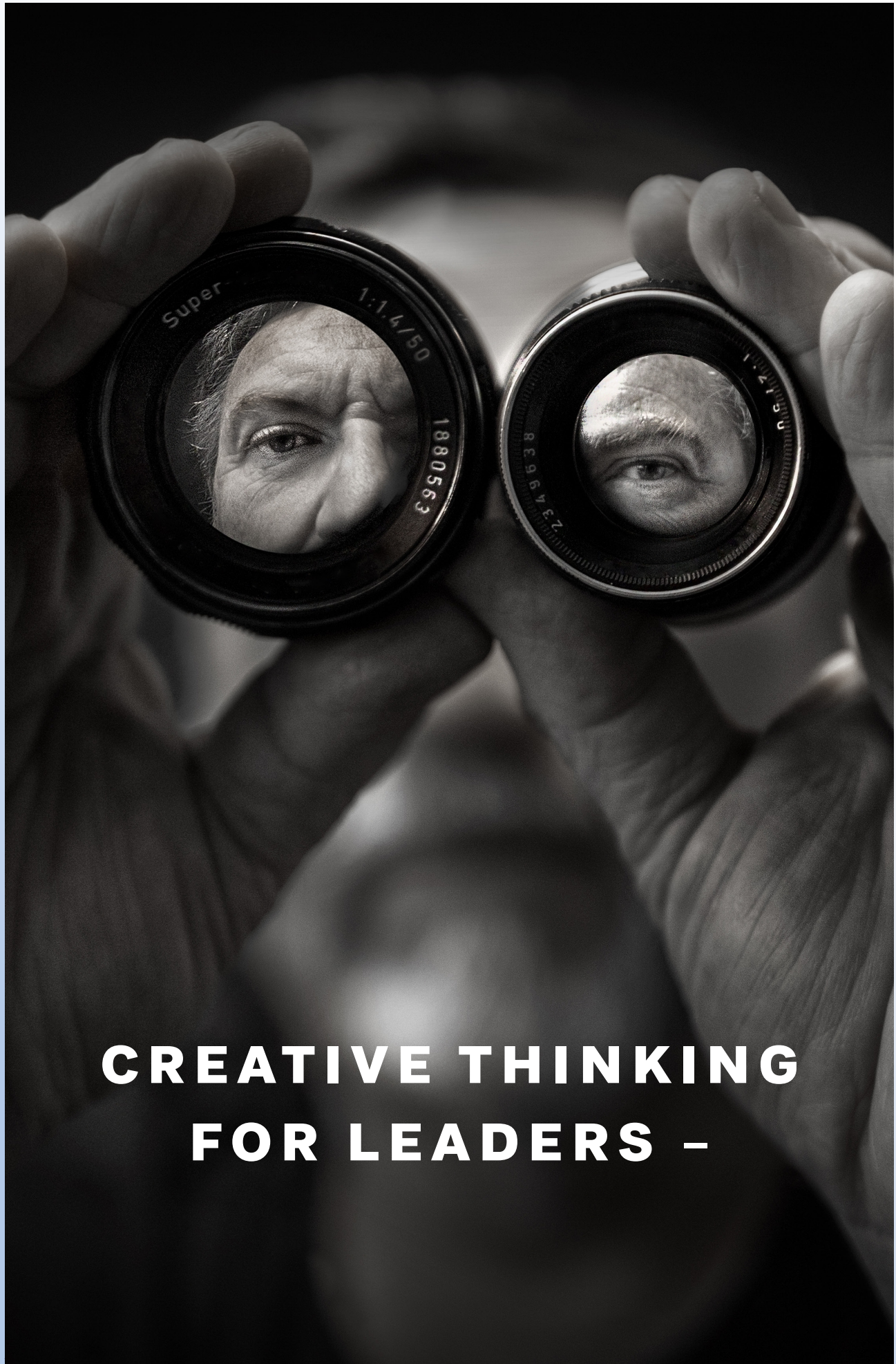

CREATIVE THINKING FOR LEADERS –

CHANGING YOUR PERSPECTIVE

AUTHORS

Albert Meige, Rémi Larrousse

There is still a fashionable prejudice that large corporations don't know how to do rapid radical innovation, and that start-ups are now taking the place of the research and innovation departments within big firms because the "liner is too big to turn". This is misguided. As we saw during the COVID-19 crisis, some large companies can deliver incredible innovations very quickly. Existing products were rapidly hacked to fight the virus. For example, sporting goods retailer Decathlon transformed its diving mask into a respirator.

Pharmaceutical giants such as Pfizer and AstraZeneca reinvented the vaccine development cycle. Some companies made their industrial capacities available to produce essential equipment, such as Faurecia producing facemasks and LVMH hydroalcoholic gel. In most cases, decisions were taken at the highest level in just a few days. Large companies know how to innovate and move fast – when the platform is burning.

Yet, in normal times, innovation can still be a big challenge. One reason is that, faced with a complicated business or technical problem under non-crisis conditions, smart people and smart companies generally love to follow the Cartesian approach: i) break it down into sub-problems, ii) solve each of the sub-problems, and iii) combine the sub-solutions to obtain the solution to the initial problem. In practice, this doesn't necessarily work because it presupposes that the interdependencies between the sub-problems are negligible.

The other common approach, beloved of our own consulting world, is the "assumption-driven" approach, whereby based on experience and expertise, one tries to imagine the right solution, and then seeks out the facts or data that will support it. It works relatively well in many cases, but there is one big drawback – the imagined solutions are biased by our expertise and mental models.

In this article, we bust some common myths about what creative thinking means for business executives, and explain how it can and should be implemented pragmatically as an integral part of the business management process.

THE CHALLENGES FACED BY TODAY'S BUSINESS EXECUTIVES

Niels Bohr, the Nobel laureate in physics and father of the atomic model, said, "Prediction is very difficult, especially if it's about the future!" This is an ironic but very true statement. Anticipating the future has never been easy, but most people would accept that it has become increasingly difficult in today's business world due to the rapid pace of change, the blurring of boundaries between traditional sectors, and the sheer volume of available intelligence. Executives face a triple challenge, as shown in Figure 1[1].

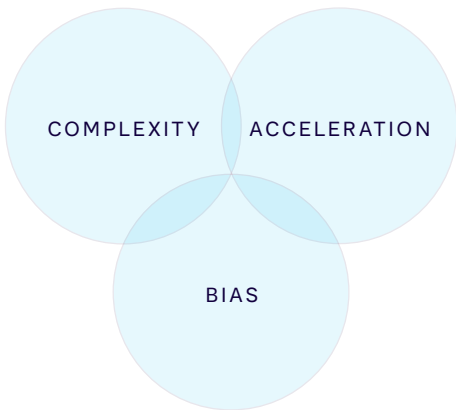

FIGURE 1: THE CHALLENGES FOR EXECUTIVES

1. See also our article published on HBR France: www.hbrfrance.fr/chroniques-experts/2021/10/40194-le-triple-defi-des-p-dg-dans-un-monde-complexe/

First, executives need to deal with additional complexity, resulting especially from convergence between technologies and sectors. For example, if we consider the future of food[2], executives have to look beyond the agri-food sector towards pharma, logistics and e-commerce, and beyond food manufacturing technology towards life sciences, gene editing, smart materials and digital technologies.

Second, executives need to be able to move faster. New, disruptive technologies are accelerating how quickly they improve performance and penetrate the market once they have reached maturity. Gene editing is a good example of how new technologies can follow an exponential growth curve following a breakthrough.

Third, executives need to cope with cognitive biases that prevent them from thinking freely and differently, one of the prerequisites for innovation. These cognitive biases arise from the fact that the brain creates mental models of reality based on what has always worked in the past. The more one knows an industrial sector or company, the less likely one is to detect anomalies or disruptions that often arrive sideways and unexpectedly out of the "fog".

Creative thinking is essential to cope with these challenges. It helps identify fresh opportunities arising from convergence in a way that purely linear analytic reasoning cannot. It helps with thinking laterally to detect weak signals and new disruptive technologies early enough to avoid being left behind. In particular, it helps overcome cognitive bias by generating fresh perspectives.

More often than not, executives have achieved leadership positions because they are good at guiding their organizations to deliver high performance. However, the most successful ones have also succeeded in becoming "ambidextrous"[3], combining "business as usual" with creative capabilities to explore new territories and detect anomalies. It is among these anomalies that the seeds of tomorrow's business are to be found.

CREATIVE THINKING IS NOT WHAT YOU THINK IT IS

One of the key barriers preventing business leaders from properly embracing creative thinking is that it is misunderstood. Here are five common myths that leaders should be aware of:

- **Myth 1 – Creative thinking is the opposite of analytical thinking:** The left brain is often considered to be analytical, rational, and logical, while the right brain is related to creativity and imagination. However, this distinction between the two hemispheres of the brain is a myth, and many researchers have dismantled this idea[4] and the way it has spread in our society.[5] Creative thinking is not the opposite of analytical thinking; rather, both are complementary and

2. See also Appetite for disruption – Making the most of the future of food [Prism S2 2021]
3. See also Ambidextrous organizations – Build sustainable competitive advantage, Arthur D. Little 2017
4. Nielsen, Zielinski, Ferguson, Lainhart, Anderson. An Evaluation of the Left-Brain vs. Right-Brain Hypothesis with Resting State Functional Connectivity Magnetic Resonance Imaging. *PLoS* ONE, 2013
5. Elena Pasquinelli, *My brain, this hero – myths and realities*, Paris, Le Pommier, 2015

mutually reinforcing. For some neuroscientists, such as Beau Lotto[6], creativity is better considered a supercharged version of analytical thinking.

- **Myth 2 – Creative thinking involves having a "Eureka!" moment:** This myth of sudden enlightenment is often found in the autobiographies of famous inventors and researchers, and contributes to the image of the solitary genius struck by an intuitive flash. In reality, any idea is rarely born "good." When we look at all the experiments and drafts inventors and composers go through, we can see all the erasure marks and rewrites that show that an idea has progressed slowly.

- **Myth 3 – Creative thinking is about brainstorming and gimmicky workshops:** The creativity training industry, with its endless tools and jargon that deliver questionable results, has given the concept of creative thinking a bad name. Research has shown that brainstorming is not an efficient way to deliver solutions to complex problems.[7] In reality, creative thinking is most often simply a matter of conducting the right thought experiment to see a situation from a new perspective and changing the framing of the problem you are trying to solve.

- **Myth 4 – Creative thinking is synonymous with free thinking:** We all have in mind the "thinking out of the box" paradigm. Once again, this image is false. In reality, it is usually not the existence of a "box" that is constraining creative thinking. Indeed, often the best creative thinking can arise by adding an "artificial box". We often hear in companies, "There's not enough budget to be creative," or, "There are too many regulatory constraints that limit our options." However, constraints are often what makes creativity possible. Constraints, used in conjunction with creative thinking, can help to produce more offbeat or disruptive ideas, for example, due to the need to side-step a constraint.

- **Myth 5 – Creative thinking is the responsibility of the innovation department:** In reality, creative thinking is both distinct from and complementary to the innovation process. Creative thinking is a cognitive approach that involves changing the way you look at a problem, and therefore can be applied to any aspect of the business, from innovation through to strategy, marketing, finance, or management accounting. Creative thinking is not just for creatives.

6. Beau Lotto, *Deviate: The Science of Seeing Differently*, Hachette Books, 2017
7. Nicholas W. Kohn, Steven M. Smith, *Collaborative fixation: Effects of others' ideas on brainstorming*, Applied Cognitive Psychology, 2011

Based on this, we offer a definition that is useful in a business context:

> ***Creative thinking is the ability to change our perspective on a problem in an intentional way in order to identify original or unexpected solutions.***

Each underlined part of the definition is important:

Changing perspectives: Here lies the core mechanism of creative thinking – the ability to perceive a problem from different angles and different perspectives. Changing perspectives helps to redefine the problem and find original or unexpected solutions, and ultimately aids in reframing the problem entirely to change the nature of the solutions.

A CREATIVE SOLUTION DOES NOT ALWAYS NEED TO BE BASED ON A NEW IDEA. IT COULD BE AN OLD IDEA APPLIED IN A NEW WAY.

Making the process intentional (instead of accidental): We know that a number of discoveries or inventions were made by chance or luck. However, Louis Pasteur said, "Chance favors the prepared mind." The question is, therefore, how to prepare the mind. Creative thinking can rely on certain tactics that can be used to systematically shift our perspectives.

Original or unexpected solutions: In this definition, the emphasis is on solutions rather than ideas. This is important because a creative solution does not always need to be based on a new idea. It could be an old idea applied in a new way. For example, the electronic cigarette industry that grew up in the 2000s was based on idea originally patented in 1963.

INSIGHTS FOR THE EXECUTIVE – HOW LEADERS CAN IMPROVE THEIR CREATIVE THINKING

How should executives go about improving their creative thinking? A good starting point is to ensure leadership properly buys into the idea that it is an integral part of reasoning and decision-making – and applies to everyone. For example, we often hear our clients say, "I'm not creative, and neither are my teams!" or, "Please, not too many ideas! Otherwise, we won't know what to do with them." This is the wrong mental model. Of course, effective rational thinking relies heavily on analytical processes, but also requires a healthy dose of creativity. Otherwise, it's just thinking halfway.

There have been many methods and tools developed over the last few decades to help drive creative thinking, such as Kaizen, brainstorming, Six Thinking Hats, TRIZ, and the concept/knowledge (C/K) theory. Ultimately, the most important thing is not the school or the method, but rather, the underlying creative tactics that can be used for problem-solving, tackling strategic challenges, or decision-making.

We can illustrate this with a simple example. Several years ago, we collaborated with a company that was developing a cordless iron. The question the teams were asking themselves was: "Who can design a small, inexpensive battery powerful enough to store the energy necessary for the creation of water vapor?" At the time, this type of battery did not exist, and no laboratory was able to design it. The key creative step was to change the perspective, reframe the question and look for substitutes. It was not the battery itself that interested us, but the effect of steam. So, we reframed the question: "Is there a substitute for water vapor that shares the same properties, but with less energy consumption?" This is what led the teams to identify water atomization technologies. In seeking a substitute for steam, the insoluble problem of energy storage became a solvable problem around lowering energy consumption.

In this example, no special tools were used. While we would agree that such tools can sometimes be effective, they can also be time-consuming, costly, and viewed with skepticism, especially by time-hardened, battle-weary executives.

Instead, our experience has shown that using the following six tactics in a culture that recognizes creative thinking as part of the normal decision-making process will go a long way towards helping analytical, linear-thinking executives to become more ambidextrous.

1. Pay attention to surprises and anomalies

Many scientific discoveries, such as penicillin and Velcro, are the result of accidents. Often there is a tendency to set aside anomalous information as an exception that might distract us from our main goals. The challenge is to pay attention to these surprises and anomalies and be prepared to take time to explore them, pull the thread of the ideas they raise, and develop them: In other words, to be conscious of the value of serendipity and the combination of chance and sagacity, and exploit it where we can.

2. Draw analogies from different fields

Drawing parallels between things that seem unrelated can help to approach a problem with a different lens. For example, in 2019, governments decided to ban plastic straws and single-use plastic. This posed a challenge within the food industry, which was not geared up to produce paper straws in large quantities. The solution came, perhaps surprisingly, from the cigarette industry, which knew a lot about small paper tubes. Teams should be encouraged to ask where else similar problems can be found, and how similar problems were resolved under other conditions.

3. Apply substitution and subtraction tactics

The substitution tactic involves finding possible substitutions that could transform the question being asked or provide an easier-to-implement solution. It can be applied systematically by considering different words, verbs, objectives and so on in the question being asked, and different processes, ingredients, forces, stakeholders, places and so on in the solutions being considered. Substitution is one of the TRIZ method principles, and is often underestimated in its effectiveness.

The subtraction tactic involves thinking systematically about which parts of the problem we could make disappear, what could be made smaller/lower/shorter/lighter, and how we could do it. Subtraction is also frequently underutilized, but can be a useful tool.

4. Ask three types of creative questions

This tactic encourages teams to reframe the problem and avoid jumping too quickly to the solution by thinking in terms of three types of questions:

- **Curiosity questions**, often starting with why, what and who (for example, what business we are really in and who our real clients are)
- **What-if questions**, for example, what if our business did not exist, or we made our product free?
- **Future questions**, for example, what could make us disappear, or make us irreplaceable, in five years?

5. Adopt the point of view of someone else

Putting oneself in the place of others is helpful to shift perspectives and detect unexpected and original solutions. For example, teams can be asked to consider a range of outside viewpoints, not only clients or end users (which is one of the central aspects of design thinking), but also others such as competitors, mentors, strangers, or even relatives. We also find it very effective to adopt the point of view of famous real or fictive people, such as Sherlock Holmes, Wonder Woman or Elon Musk. How would they see the problem, and how would they view possible solutions?

6. Play with semantics and visual sketches

Normally, issues, challenges, and problems are first defined by words put together to create sentences. Therefore, the ability to play with the meaning of words, to use one word rather than another, plays a key role in reframing a question to expand the field of possibilities. Similarly, visual "sketch-noting" or visual representation are useful tools to foster our creative thinking. For example, teams can be encouraged to represent the problem in three different ways in the form of a drawing.

MOST, IF NOT ALL, EXECUTIVES ARE ALREADY AWARE THAT CREATIVE THINKING IS AN ESSENTIAL COMPONENT OF EFFECTIVE BUSINESS LEADERSHIP.

To conclude, most, if not all, executives are already aware that creative thinking is an essential component of effective business leadership. However, not all leaders are fully aware of the extent to which their own and their company's cognitive biases constrain their thinking. The most successful companies focus on the principles behind creative thinking, such as finding analogies, substitutions, alternative constraints, and different perspectives, and applying them to every aspect of the business. Being ambidextrous – being future ready as well as delivering business as usual – is one of the most important attributes of today's leaders.

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HOW INSECTS CAN HELP REINVENT THE FOOD CHAIN

AN INTERVIEW WITH ANTOINE HUBERT

ANTOINE HUBERT
CEO AND CHAIRMAN OF ŸNSECT

Ÿnsect is a rapidly growing agri-food company based in France, set to become one of the global leaders in transforming insects into high-performance natural ingredients for pets, fish, plants, and human beings. Antoine co-founded the company in 2011. In this interview with Arnaud Jouron, Partner at Arthur D. Little, Antoine shares some fascinating insights into the company and the exciting opportunities for the future in the insect-based food industry.

FIRST OF ALL, COULD YOU TELL US HOW THE ORIGINAL BUSINESS IDEA CAME ABOUT?

As long as I can remember, I have always been deeply interested in topics related to agriculture and environment, which motivated me to study agronomical engineering later on. When studying abroad in New Zealand, I had learned how insects were contributing to soil preservation, in addition to other interesting applications in bio-engineering, thanks to their physiological properties.

Back in France, I started to work as an environmental consultant, and alongside this, I started an association to promote the topic of soil preservation with the other future founders of Ÿnsect – Alexis Angot, Jean-Gabriel Levon and Fabrice Berro – who shared the same interest. In particular, we wanted to highlight how worms were contributing to soil preservation and how we could use them to recycle organic waste to close the food cycle, notably in cities.

Quite soon we had transformed a small organization into a think tank, working with large labs to measure the impact of urban agriculture in terms of nitrogen and carbon dioxide. Besides this, we looked into what sort of food transformations were possible with insects, highlighting the environmental (e.g., fewer GHG emissions), health (e.g., protein rate, nutrients) and economic benefits of edible insects and their potential impact on food and feed security. Then we decided we needed to take an active role. Becoming a for-profit organization while retaining a central aim of positive impact seemed to be the best way, which gave birth to Ÿnsect.

IN THE FUTURE THERE WILL BE LESS DEMAND FOR ANIMAL-BASED PROTEIN AND MORE FOR PLANTS AND MUSHROOMS, BUT ALSO INSECTS.

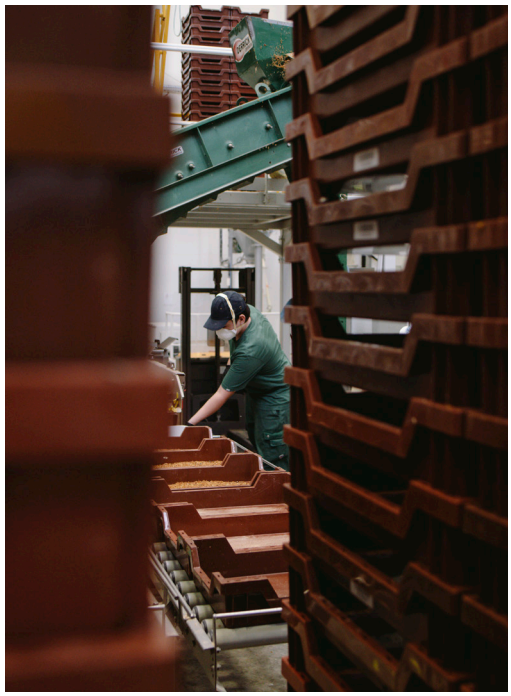
The overarching idea of it is essentially that insects have a far greater role to play in our society than just producing honey and silk. They are at the base of all food chains and have an immense amount of biodiversity. They should be further integrated into our food cycle to make what I would call "smart food" more effective.

COULD YOU SAY MORE ABOUT THIS CONCEPT OF SMART FOOD?

Well, let's do an analogy with the concept of smart grid. In the energy sector, there aren't any winner-takes-all solutions, but rather, a set of different options that are more or less adapted to certain environments. The diversity of the mix is needed to balance the strengths and weaknesses of each option. The same goes with agriculture – the choice of what to farm will have to vary in terms of its fit to each area, climate conditions and local demand. For food, we could expect that in the future there will be less demand for animal-based protein and more for plants and mushrooms, but also insects. In this context, the aim of Ÿnsect is to help make a diversified "smart food" chain a reality by being the global leader of insect-based products while addressing multiple markets.

WHAT ARE THE ENVIRONMENTAL BENEFITS OF CONSUMING INSECT-BASED PRODUCTS?

The use of insects provides real benefits for our planet's biodiversity and climate. We have performed end-to-end analyses on our production cycle that support this, and found that there are significant net reductions in GHG emissions as a result of the growth and mortality of animals fed with insect feed. There are also benefits from carbon sequestration through the use of frass (insect droppings) fertilizer.



THE USE OF INSECTS PROVIDES REAL BENEFITS FOR OUR PLANET'S BIODIVERSITY AND CLIMATE.

In addition, Ÿnsect as a company is working to reduce its own environmental impact. Our current footprint is much lower than that of traditional animal proteins, in terms of both carbon emissions (30 to 50 times less emissions) and water use (20 times less water used than for beef and 50 times less than for pork), while for our energy consumption, we have set ourselves a target of 100 percent green electricity use within three years. Our aim is to go even further thanks to our new farm designs, which will have improved efficiency. It's also important to remind ourselves that environmental improvements are also economic improvements – reducing raw material and energy needs allows us to address clients for which sustainability is becoming increasingly key.

HOW DID THE COMPANY GROW AND DEVELOP?

We started as a deep tech company aiming for scale-up. The overall idea was clear, but we needed to study the potential end markets, define the industrial process, and obviously choose which type of insect would be the most appropriate. In fact, we tested flies, butterflies and beetles, comparing them in terms of physiological properties, scalability and client benefits, before focusing on the Tenebrio Molitor mealworm after our first fundraising in 2015. These funds helped us to run several pilots, some in partnership with universities. We then launched an industrial demonstrator and, after just two years, we were reassured of the viability of our concept despite some areas of remaining uncertainty. Launching this first facility was critical in our development. With new Series B and Series

C funding in 2019, we were able to finance our first full-scale farm, located in Amiens. Operations started in the beginning of 2022. The challenge now is to ramp up quickly in order to produce at full capacity.

WHAT MAKES ŸNSECT DIFFERENT FROM OTHER ACTORS IN THE FIELD?

I see several differentiating factors, but the main ones would be our production process, our local production philosophy and the quality of our products. First of all, our production process comprises two independent steps, allowing us to have one harmonized and optimized platform capable of addressing multiple end markets. The first step consists of breeding the larvae using the vertical farming method that we have developed and scaled up. We took the traditional systems used to grow mushrooms and applied the principles of Industry 4.0 to it – the details of this are interesting, but we might come back to that later. Then the larvae are harvested to produce what we call CFL (Clean Fresh Larvae), which is the initial input of all the end products. This CFL is transformed into different finished lines with the appropriate mix to address each market. Most of our competitors do not have this capacity, as they tend to be specific to only one product in one market. In the end, this means any industrial optimization can be shared across the plants, giving us a tremendous advantage in terms of efficiency.

WITH OUR PRODUCTS WE HAVE OBSERVED LOWER MORTALITY RATES IN ANIMALS AND GREATER GROWTH IN PLANTS, THESE BEING MAJOR FACTORS THAT CLIENTS TAKE INTO ACCOUNT WHEN SELECTING PRODUCTS.

The second key differentiating factor compared to other alternative proteins (e.g., soy), would be that our products are more local, which is increasingly important both to our clients and to the end customers. The limited surface area required by our farms due to the verticalization concept, the controlled environment in which the larvae are bred, and the fact that our process requires less energy and water than other proteins allow us to be more flexible when choosing the location of our plant. It gives us the possibility to be close to our markets in different geographies and climates. Because we span the entire value chain from biomass supplier to distribution channel, we can, for example, replace chemical fertilizers that come from Russia, palm oil coming from SE Asia, or soy coming from South America.

Finally, there is a point to be made about quality here as well. With our products we have observed lower mortality rates in animals and greater growth in plants, these being major factors that clients take into account when selecting products. This puts us in a good position to place our products in a more premium category.

CAN WE GO BACK TO VERTICAL FARMING AGAIN? YOU MENTIONED THAT YOU WANTED TO GIVE MORE DETAILS ABOUT THE CONCEPT

Yes, that's right. So, as I said, the basic system is quite simple, and has traditionally been used to grow many things, such as mushrooms, insects and plants. The key component that we have added to it is to make it completely automated, with in-built sensors and software that provide us with valuable real-time data. This means better control, process optimization, biosecurity and traceability. We have been constantly exploring and testing different ways of applying technologies from Industry 4.0 to make the most of our data-based approach.

HOW DO YOU SEE THE NEXT 10 YEARS COMPARED TO THE LAST, AND WHAT MARKETS WILL YOU BE PURSUING?

We used the first 10 years to lay the foundations, not only for Ÿnsect, but also for the industry, by conceptualizing, building and refining an entire ecosystem surrounding insect farming. The aim for the next 10 years will be to accelerate our expansion to the rest of the world. The ecosystem is still very European at the moment.

This, of course, involves developing new sites internationally in order to produce locally, being close to our raw materials and clients. It also means exploring new applications that we have probably not even envisaged yet, which will allow us to unlock new markets. For example, we have only scratched the surface of the possibilities that insects have in the health market. On this topic, we have conducted pre-clinical trials that indicate that our larvae may have cholesterol-relieving properties. This would definitely help us to accelerate people's acceptance of insect-based products. I think our biggest challenge in the coming years will be to significantly increase the acceptance of mealworm-based products in order to rapidly develop our sales in the animal-feed, human-food and fertilizers markets. The launch of our Amiens farm will be a massive support for this expansion.

Within the animal feed markets, pet food is a top priority, as this is a growing and resilient market that is very well adapted to the quality of our products (e.g., protein contents, palatability), and also provides attractive prices and potentially high margins. To address livestock feed, which is a far deeper market, we need to continue to improve the efficiency and performance of our farms to be more competitive in a market that has large volumes yet lower expected margins. Aquafeed is also a high-priority market, as it has a strong appetite for insect protein given its benefits in terms of accelerated growth and lower mortality.

With regard to human food, we truly believe that this will be the biggest market in the long term. Whether that happens in the next five or 50 years will depend on our ability to deliver on marketing and communications, as well as build up international partnerships to help cross the chasm of popular acceptance – today it's still limited to "early adopters".

Finally, we plan to address the fertilizer market with our "Ynfrass" product, which we would like to use for more than just feeding plants. This is part of an ongoing R&D program to establish the effects on the growth and health of plants that use insect fertilizer, and the results are already quite promising.

DID YOU SEE ANY RELUNCTANCE FROM STAKEHOLDERS TO BE CONVINCED THAT INSECT PRODUCTS COULD BE SUCCESSFUL?

I think there are two elements here: one is client acceptance, and the other is regulatory approval. Regarding client acceptance, it is clear that this is evolving for the better. At the time of our last fundraising in 2020, we felt confident that there was a demand for animal and plant feed already thanks to our sales teams, who worked side by side with clients such as pet food companies. Having focused first on quality, we can now focus on improving our technology and processes to become more competitive on price. As for regulatory approval, we have had to put in place an ecosystem that supports the approval of our products, putting regulators in touch with relevant scientists, universities, clients and suppliers. This approach has paid off, with our mealworm products recently gaining approval for human consumption from the European Sanitary Agency.

LOOKING FORWARD, ARE THERE ANY ELEMENTS THAT RISK SLOWING DOWN GROWTH?

Much of our expected growth rests on our ability to execute the planned expansion. For us to be successful, it is critical that we continue to have access to local talent and capital. This is especially demanding, given the fact that our industry does not exist in almost all the countries where we plan to expand, and that some roles are difficult to source, such as the technical ones. Thus, we need to think carefully about our recruitment strategy and how we want to continuously train our new joiners in order to develop the required skills. With regard to funding – be it capital, borrowing or subsidization, we need to acquire a deep understanding of the local ecosystems surrounding our potential suppliers and clients, as well as a perspective on local and national authorities.

HOW WOULD YOU COMPARE THE GROWTH PHASES OF ŸNSECT IN TERMS OF DIFFICULTY?

We might have the impression that the new phases are more difficult than the previous ones, but they are, in fact, just different. The issues, people involved, knowledge, and available resources are simply not the same. For example, the first funds we had to raise as a young company of 10 people with a narrow focus on innovation were not simpler to get than the large funds we raised afterwards. We were in a cutting-edge field and we had to build a totally new industry. In fact, we had to identify and clearly define the potential markets to understand who the clients were and develop products to address them accordingly. We also had to move fast from principles to a detailed industrial design and our first full-scale operational plant. On top of that, we had to convince the regulatory bodies and investors to support the industry. In reality, the moments where things went wrong allowed us to clarify how we should do things differently. It also forced us to be very flexible and think on our feet, growing and adapting as we went along.

HOW DO YOU SEE THE AGRICULTURE SECTOR EVOLVING IN THE NEXT 10 YEARS, AND WHAT MAJOR INNOVATIONS DO YOU SEE FOR YOUR INDUSTRY?

I think agriculture will be more diverse, driven by consumers who are demanding a wide range of products. This diversification is currently reflected by low-tech systems such as permaculture, local-loop food sourcing, urban farming, and so forth. These are allowing consumers to eat more fresh fruit and vegetables, while reducing the carbon footprint that results from importing these from further afield. However, this is insufficient in the long run. We need to see a step change in the use of technology. Greater use of technology would help to optimize the use of water, fertilizer, feed, etc., and ensure that it is applied exactly when and where it is needed.

Also, I think we will see less monoculture on a massive scale and more diversity even on a regional level. New pairings of livestock and plants will be explored, and will unlock a broader range of products. Rather than seeing farmers raising large vertebrates, we might see hybrid systems playing off the benefits of insects, algae,

mushrooms and plants, taking into account the particularities of the local environment. These are some of the ways to respond to this simultaneous demand for greater diversity and sustainability.

This can also be applied to fishing. Rather than focusing on the two or three popular species that will invariably be overfished and destabilizing the ecosystem, we could fish the 150 species that are available to us while respecting the quotas. The same stands for the use of algae, mushrooms and insects, which have fallen out of use or never been consumed. If people are provided with indications for how to cook these, the demand will eventually follow. This initial spark requires the help of influencers, as I think there is a real audience, especially with the younger generations.

HOW WOULD YOU DESCRIBE THE CULTURE AT ŸNSECT?

It's difficult to define one culture. Our culture is constantly evolving, and although it is still based on our initial values as founders, it has also been enriched by those that have since joined us. This becomes truer when you consider that more than half of our employees have joined us in the last year and a half. We are always looking for balance, and we favor a culture consensus. We share a deep sense of solidarity as a team, considering that our successes are always collective, and we extend this solidarity to our ecosphere by being committed ecologically, economically, and socially. Adaptability is also part of our DNA since our environments and knowledge are by nature constantly changing, forcing us to continuously evolve. Another core value would be authenticity, being sincere in everything we do with a strong commitment and belief. We have ensured that we take an active role in conserving these core values by reasserting them at regular events and ensuring that they are effective within our day-to-day operations as a team, as well as with our clients, shareholders, and environment in a broad sense.

I THINK AGRICULTURE WILL BE MORE DIVERSE, DRIVEN BY CONSUMERS WHO ARE DEMANDING A WIDE RANGE OF PRODUCTS.

LOOKING BACK, WHAT ADVICE WOULD YOU GIVE YOURSELF 10 YEARS AGO, WHEN YOU STARTED YOUR JOURNEY WITH ŸNSECT?

Firstly, the key is to recruit well and to avoid letting one's ego get in the way of hiring the best talent. We were clear on this from day one. What we could have done better, however, was anticipate where and how soon we would need to recruit in order to keep up the momentum on key projects. This is especially the case with top management roles and the ones requiring a high degree of expertise, as these take six to nine months to recruit – time that is then lost for the company. Secondly, I think we could have made more of an effort in internalizing some core capabilities early on and highlighted its importance from the start to our investors. Indeed, at the beginning, we had to outsource some of our core research and site management, which, in the long run, was not always the most appropriate choice in terms of cost and operability.

AND FINALLY, WHAT DO YOU THINK ARE THE ELEMENTS THAT MAKE UP A GOOD LEADER?

There is not a simple answer here, and the theories on this are numerous. I think that, as a CEO, one must have a holistic vision of the aims and challenges of a company and assess them in their correct context. To do this, you need to ensure that you surround yourself with people who know more than you, and you need to feel safe putting your trust in their hands. It is also important to be able to grasp things quickly, to connect the dots between people and topics and apply one's curiosity to question any subject – even if naively. The leader has the responsibility to ensure that teams are onboarded with energy and enthusiasm. Ultimately, the role of a CEO can be likened to that of an explorer. They must know how to provide a course for the company while remaining flexible in the face of changing circumstances.

Antoine Hubert is the Chairman and CEO of Ÿnsect, the global leader in insect-based protein and fertilizer, which was founded in 2011 and raised nearly $400M. Ÿnsect is also the only aggrotech company that is part of the French lαbel Next 40.

Besides his role at Ÿnsect, Antoine leads the cooperative insect industry association and the International Platform of Insects for Food and Feed (IPIFF), and is a Board Member of the Protéines France consortium and LFD (La Ferme Digitale). Prior to co-founding Ÿnsect, Antoine worked on scientific projects in environmental risk assessment, biomass and plastics recycling. He is an agronomy engineering graduate from Agrocampus Ouest and AgroParisTech. Together with Alexis Angot, he co-founded NPO Worgamic and the company OrgaNeo.

In 2021, Antoine was recognized as one of the Meaningful Business MB100s, an award celebrating leaders who combine profit and purpose to help achieve the United Nations Global Goals. In the same year, he was named first in the ranking Choiseul 100, and has been selected as part of the French American Foundation's Young Leader promotion.

In February 2022, Antoine published his first book, "For Planet, People & Profit: An Insect Farmer's Manifesto", which highlighted the possibility of combining ecology and economy, while calling for committed entrepreneurship.

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