COTEC Portugal

THE IMPACT OF INDUSTRY 4.0 ON PORTUGUESE SMEs

i4.0 INDÚSTRIA 4.0

pi4.0 Plataforma Indústria 4.0

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00
EXECUTIVE SUMMARY
01
WHAT IS INDUSTRY 4.0?
02
INTERVIEW PROCESS
03
INSIGHTS
04
RECOMMENDATIONS



EXECUTIVE SUMMARY

This report describes the outcome from a set of interviews for COTEC on the impact of Industry 4.0 and its potential impact on Portuguese SME's.

Large companies have tended to exploit value from scale, allowing SME's to fill in the gap with more specialized or more customized services and products. The technology revolution enabled by information technology may impact this division of roles. Large companies could develop a capacity for greater customization, allowing them to leverage their greater access to capital and brand strength into the traditional domain of SME's.

This development is hardly certain, linear or inevitable and complications abound. Large companies suffer from strong path dependencies that may practically limit their adaptability. SME's may retain a greater advantage in customer intimacy allowed them to be more nimble. Countries where SME's are traditionally strong may have cultural advantages.

> *WE ARE AT A POINT IN THE HISTORY OF HUMANITY WHERE WE HAVE TO DO SOMETHING, BUT HOW DO WE CONNECT THE IDEAL AND THE TECHNOLOGY?*
>
> *WE WOULD LIKE TO UNDERSTAND*
> **HOW INDUSTRY 4.0 CAN IMPROVE THE QUALITY OF LIFE ON THE PLANET.**

Today Portugal finds itself in the mid-tier countries in terms of Industry 4.0 capability. The Northern European countries constitute the top-tier. By 2030 Portugal can realistically aspire to join the top-tier, but it will require a sustained effort involving 20,000 firms, retraining 200,000 employees and providing financing for hundreds of projects[1].

In order to assess the opportunities and risks around the advent of Industry 4.0 for SME's a series of interviews were conducted with companies and selected external stakeholders. Seven themes are extracted from the interviews, from which recommendations are drawn in the last section.

1 KPMG Portugal, Indústria 4.0, April 2019.



01

WHAT IS INDUSTRY 4.0?

Unsurprisingly there are many definitions for Industry 4.0. Unsurprising because any major societal change is accompanied by great uncertainties and it is inherently unclear which technologies and developments will prevail. Crypto-currencies were all the rage, until their energy drag became apparent to all. Autonomous cars were slated to become fully commercial by 2020, until it became clear that AI is not yet capable of handling the complexity of urban driving. But none of this discounts from the fact that the availability of vast amounts of data, combined with enormous progress in the capacity of algorithms to turn this data into something useful, can be justly characterized as putting society on the threshold of a major transition: **Industry 4.0**.

A quick recap of the previous three industrial revolutions: Industry 1.0 was the original industrial revolution, starting in the late 18th century and driven by the replacement of human power with steam. This led to an enormous growth in mechanical production, and enabled transportation on new scale through railways and steamships. The second revolution was made possible by electrification and more crucially by the idea of the division of labour, setting the stage for mass consumption. The new industry enabled by the IT revolution and the widespread adoption of the Internet was then coined industry 3.0.

> **THE BIGGEST ISSUE IS ALWAYS THE PEOPLE. THAT IS THE ISSUE.**

Industry 4.0 is constituted of a number of new or enhanced core capabilities, which express themselves through new technology areas that are listed below. The core capabilities are the following:

1. **MORE INTELLIGENCE IN THE BUSINESS PROCESSES:**

A far greater IT intensity makes business processes smarter and provides much greater capacity.

2. **MORE INTEGRATION IN BUSINESS PROCESSES:**

More data allows for greater integration within and crucially between processes.

3. **PROXIMITY TO THE CLIENT:**

While in the earlier revolutions the firm was essentially self-contained, Industry 4.0 is envisaged to provide an order of magnitude greater opportunities to integrate with customers (and suppliers).

4. **CLOSING THE LOOP:**

Far from a one-way process, the interconnections that are possible allow for critical feedback loops, which are crucial for step-change improvements.

5. **SMART PRODUCTS AND SERVICES:**

Products and services are no longer static, and gain adaptive and evolutionary capacity.

6. **BUSINESS CONNECTIVITY:**

From a largely stand-alone entity, a firm becomes a node in a network, connected and co-dependent on other network nodes.

7. **INTIMATE HUMAN MACHINE COLLABORATION:**

The relationship between humans and machines is redefined. Technologies such as autonomous vehicles require rethinking the legal, regulatory and ethical frames to be reconsidered as new close relationships develop with machines.

For the purpose of this report, we chose to adopt the World Economic Forum (WEF) definition of the elements of Industry 4.0. WEF has coalesced a broad membership around the Centre for the Fourth Industrial Revolution [2], which aims to become a hub for multi-stakeholder collaboration to accelerate the benefits from extensive digitalization. It distinguishes the following technology areas:

2 https://www.weforum.org/centre-for-the-fourth-industrial-revolution

01 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Artificial Intelligence and Machine Learning (AI/ML) are the core enablers of Industry 4.0. It is the technology that converts data into useful applications. It is already familiar in homes and businesses, from Amazon book recommendations to robotised warehouse management.

Like most new technologies, it also presents new ethical dilemma's that will need to be addressed and resolved. Some are readily apparent such as the much debated choices that autonomous vehicles need to make when confronted with an obstacle, to fundamentally unforeseen consequences such as the influence of Facebook's algorithms on Russian meddling in the 2016 US elections, or on the Gilets Jaunes movement in France.

These developments will require new policies, standards and institutions to ensure delivery of AI/ML benefits to society.

02 AUTONOMOUS AND URBAN MOBILITY

Autonomous vehicles (AV) hold enormous potential: both incrementally by making driving safer and to reduce congestion through advanced driver assist function in individually owned cars. But also systemically: collectively owned, electric and light-weight vehicles have the potential to transform the design of cities, to dramatically reduce energy consumption and change social norms.
To realize the benefits of the later option will involve deep disruptions to a host of existing industries and societal practices.

03 BLOCKCHAIN AND DISTRIBUTED LEDGER TECHNOLOGY

As the early infatuation with crypto-currency fades, the quest for legitimate applications of Decentralized Ledger Technology (DLT) comes more clearly into view. Currency applications such as Bitcoin absorb vast amounts of energy and have an enormous carbon footprint, to the point that the energy cost can exceed the value of the monetary unit [3].

3 The Economist 09/07/2018 ***Why bitcoin uses so much energy?*** Accessed at https://www.economist.com/the-economist explains/2018/07/09/why-bitcoin-uses-so-much-energy

The Economist 07/02/2019 ***Will bitcoins price crash cut into its energy use?*** Accessed at https://www.economist.com/graphic-detail/2019/02/07/will-bitcoins-price-crash-cut-into-its-energy-use.

DLT is finding more societally relevant applications in low-volume high-value transactions such as oil trading, land registries or digital identity for refugee populations.

04 DATA POLICY

That *"data is the new oil"* [4] has become a much-used quip. Although the analogy quickly breaks down, as for example unlike oil data can be endlessly re-used, it aptly captures the centrality of data as a resource for Industry 4.0.

Applications like the Internet of Things (IOT), Autonomous Vehicles (AV) and Precision Medicine (PM) all require mining vast amounts of data. As developments progress, the ownership and potential abuse of data has come into focus. This has highlighted fundamentally different approaches between Europe which adopted its far reaching General Data Protection Regulation (GDPR) and the rest of the world that is either more permissive by choice or by oblivion.

4 The concept is usually credited to Clive Humby a British mathematician.

05 DIGITAL TRADE

Trade has already been profoundly transformed by digitalization. Cross-borders e-commerce continues to grow apace, platforms such as Alibaba have enabled the digitalization of entire supply chain across China and digital payment platforms have slashed transaction costs. Much value remains to be harvested through deeper integration of supply chains and sharing of design documents.

All this will require further standardisation and coordination. Deeper integration will also make companies more dependent on each other and potentially less nimble, requiring reframing of issues such as anti-trust and abuse of market power.

06 DRONES AND TOMORROW'S AIRSPACE

Drones have rapidly - if noisily - become ubiquitous. With applications ranging from chasing downhill skiers, through micro-managing crop yields, to taking out suspected terrorists a world away; unmanned aircraft are everywhere. Amazon air delivery or unmanned flying Uber's are the subject of speculation and experimentation. But also cases of airport shutdowns [5], terror attacks and thoughtless pranks have multiplied. These developments all require new smart regulation and policy.

5 In just the second half of 2018 Heathrow, Gatwick, Newark and Dubai airport have all been shutdown due to drone sightings.

07 FOURTH INDUSTRIAL REVOLUTION FOR THE EARTH

Coined as the Anthropocene, the current era has seen humans no longer being mere guests on their planet, but impacting the very Earth systems that support them at a global scale. Surging greenhouse gas concentrations and collapsing biodiversity are two visible and global consequences of this development. The viability of coastal cities, the mutation rates of bacteria, natural disasters, the oceans, food supply all constitute urgent and difficult challenges.

A new Industrial revolution such as 4.0 necessarily needs to keep these core challenges in its sights. Innovative data collection and analysis, micro-satellites, distributed sensor technology all have the potential to contribute to addressing the issues of the Anthropocene.

08 INTERNET OF THINGS, ROBOTICS AND SMART CITIES

Most devices today have some sort of Internet connection. Whether it is a refrigerator, a thermometer, a bicycle or a fitness tracker – they are all connected. These billions of devices, along with industrial sensors and robots are starting to coalesce into the Internet of Things (IoT). The next generation 5G networks will open expanded bandwidth for new applications, enabling all things smart: smart cities, smart grids, smart homes and smart offices.

This evolution comes with new challenges, in particular in the arena of cyber security, with the potential to cause harm at scale. Societal challenge may come from the tendency of technology to widen social gaps, grow inequality and reduce social mobility. Additional geopolitical cracks are widening as the developed nations wonder aloud whether to entrust Chinese companies to build their 5G networks.

09 PRECISION MEDICINE

Currently the most prevalent way of testing individual drugs is on male mice. Interference between combinations of drugs is overlooked as the permutations are endless and the cost of testing prohibitive.

The fourth industrial revolution has the potential to revolutionise this, as individual precision medicine becomes possible. This could also include the testing of pharmaceuticals on a software version of humans. Also there may be treatments based on an individual's genetic make-up in their unique environment. Immunotherapy for cancer is already delivers unhoped for improvement for selected patients.

Access to these costly approaches is rapidly becoming a societal challenge. Breakthroughs are possible in cost effectiveness, such as the rapid reduction in the cost of genetic sequencing or the increasing pressure on the pricing of pharmaceutical companies.

The challenges in these nine areas are not merely technological. Each poses new questions in the arenas of policy, regulation, ethics, social equity and international collaboration. But they also challenge the small and medium sized companies that are in the middle of this revolution, which is where we turn next.




02
INTERVIEW
PROCESS

02. INTERVIEW PROCESS

Between July and November 2018 a series of interviews were conducted with COTEC members from a broad array of industries and several other experts. The hour-long interviews were led by Roland Kupers (RKC) and supported by Joao Duarte (COTEC). Subject to Chatham House rules, the outcomes are summarised in section 3.

The future is open but not empty. Industry 4.0 is open to multiple interpretations and its development is greatly uncertain. In order to accommodate this degree of uncertainty in an interview, the questions were woven around the classic set of questions originally developed for executive interviews for future scenario projects [6]:

6 These questions were first developed by Cees van der Heijden for the Shell scenario practice. See Wilkinson and Kupers, *The essence of scenarios, Learning from the Shell experience*, Amsterdam University Press 2014.

01

CLAIRVOYANT

If you could pose only three questions to a clairvoyant, somebody who could actually foretell the future what would they be?

GOOD SCENARIO

Imagine that the future is a good one, rolling out as you would like it to be, how would you, as the clairvoyant, answer your own three questions?

02

03

BAD SCENARIO

What about if the world develops in an undesirable direction?

INHERITANCES FROM THE PAST

What pivotal events can you identify in the past of this organisation, good or bad, that should remain in our memories as important lessons for the future?

04



IMPORTANT DECISIONS AHEAD

What major decisions with long-term implications does the organisation face at the moment, decisions that need to be tackled in the next few months?

CONSTRAINTS IN THE SYSTEM

What major constraints are you experiencing inside or outside of your organisation that limit you in what you can achieve in your business situation?





THE EPITAPH QUESTION

Please consider the situation in the future when you will have moved on from your current position, to the next job or to retirement. What do you hope to leave behind that people will associate with your period in office; what do you want to be remembered for?

The companies came from a wide array of sectors: pulp and paper industry, food, IT, automotive, footwear, automotive, pharmaceutical, industrial systems, robotics, office furniture and Ceramics. The interviewees were typically either the CEO or the marketing director.

There is an inevitable bias amongst interviewees. The Portuguese SME sector went through a drastic adjustment at the beginning of the millennium as its deepening integration into the European Union led to a shift in the positioning of the sector. Differentiation on labour cost became increasingly less meaningful as a source of differentiation, and the leading companies were those that could demonstrate a clear competitive advantage through innovation. So the companies that were interviewed by definition were those that had demonstrated a superior adaptive capacity, and been able to successfully navigate a deep industry transition.

While not always mentioned explicitly by the interviewees, this factor clearly played a role in their views on the challenges of Industry 4.0. Several alluded to the fact that they had adjusted before and that this made them confident that they would have the capacity to do so again. Others were required to rapidly shift their markets away from Europe and did so successfully in a short time period.

Another inevitable bias is the intrinsically optimist outlook of the entrepreneur – as an individual. By nature and necessity they overwhelmingly hold a 'glass-half-full' perspective of the world, display optimism and project a belief in the ability of their companies to meet new challenges.

The questions triggered rich discussions, from which seven themes emerged.

> "THIS IS BASICALLY AN ISSUE OF EDUCATING THE PEOPLE NOT CAPITAL INVESTMENT"

INSIGHTS

03

The interviews yielded these seven common themes:

IT IS ABOUT PEOPLE MORE THAN ABOUT TECHNOLOGY

01

"The biggest issue is always the people. That is the core", remarked one of the CEO's. This point was echoed time and time again by others. The soft skills are less of an issue – the problem is with the shortage of hard skills: people who know materials, algorithms, automation. *"There are staff members who don't have a smart phone, so you can't use WhatsApp to organise meetings".*

There is a generally perceived lack of skills – so training up own people will become essential, in addition to growing external skills programs. The bigger companies have greater ease to deal with these barriers – *"what they do well is train people".*

MANAGEMENT 101 MATTERS MORE THAN EVER

02

"There is a priority to get the basic management stuff in place, before getting to more elaborate." Practically it means things like breaking silo's between the bits of the organisation; sharing between the business units; knowledge management. Since everything speeds up with 4.0, it is ever more important to get the management basics right. One CEO pointed to a Portuguese culture of short-termism that might get in the way of creating a management capability to integrate the new processes.

SUPPLY CHAIN INTEGRATION IS PROBLEMATIC

03

A much-discussed characteristic of Industry 4.0 is the promise of cost reduction and greater efficiency through much tighter supply chain integration. This raises two challenges. Firstly the need to integrate the company's processes internally first, which by itself requires substantial effort. This means to complete the Industry 3.0 transition before moving to 4.0: *"I would be happy to be 3.0 today."* A more structural second problem is that few customer relations are ready or stable enough to implement the level of potential integration. The necessary standards are not in place to be able to integrate flexibly with multiple customers, so it will initially need to be built on stable long-term relationships.

The automotive industry appears to offer the greatest opportunity for this, since the clients are highly concentrated and it is characterised by long-term partnerships with suppliers. But it is itself at huge risk of disruption; ubiquitous AV will change everything. E.g. will cars still need bumpers? Will it be the same or new companies? Deep integration requires selecting the right customers. With whom there is *"almost an open book agreement".* They would need to share stock, truck scheduling etc. *"This is virtually impossible for export, and even in Portugal there are only few."*

FEW SEE LARGE 4.0 INVESTMENT DECISIONS IN THE SHORT TERM

04

"This is basically an issue of educating the people, not capital investment". Most big short-term investment decisions that were mentioned by interviewees concerned buildings, integration programs – not specifically new Industry 4.0 technology. For example interviewees mentioned experimentation with additive manufacturing (3D printing), but mostly for niche or prototype application – manufacturing universally continuous through injection moulding; so no displacement of core process. *"It is really a continuous evolution, that you try to integrate over time. Not a discontinuous revolution."*

ENVIRONMENT AND CLIMATE CHANGE IS AN IMPORTANT THEME

05

"We are at a point in the history of humanity where we have to do something, but how do we connect the ideal and the technology? We would like to understand how industry 4.0 can improve the quality of life on the planet." A quarter of the interviewees mentioned climate change and environmental limits as either a defining or an essential theme.

Echoing the WEF Industry 4.0 theme, they pointed to shortages of materials, new energy, more material, climate disruption on customer demand, trade destabilisation. The pulp and paper industry underscored that they would soon be carbon free and be fully reutilizing materials. Others mentioned that the future of mining would be on the surface and not underground, as access to raw materials will be an increasing challenge.

The impact of the climate crisis goes well beyond foreseeable consequences, as consumer tastes may change or societal systems may become destabilised.

MULTIPLE TIME HORIZONS

06

As convenient as a concept like Industry 4.0 is, its impact varies enormously by industry and is spread out over time. In telecoms Industry 4.0 started in earnest more than two decades ago. Since its raw material is already fully digital, this made it much easier to make an early start. For the industries that manipulate molecules, Industry 4.0 challenges are mostly still ahead.

It is not obvious at first blush which industries will be most impacted- and timing varies greatly. Strikingly, a ceramics company reported extensive experimentation with super think porcelain and fast firing, pressure cutting complicated shapes for efficiency and saving material. While another company in advanced plastics reported that notwithstanding having 3D printers, traditional die-casting was foreseen to be the core process for years ahead.

All companies mentioned progressing (and struggling) with the integration of data between the various processes inside the company.



SME/MNC COMPETITIVE POSITION UNDER INDUSTRY 4.0

Q7

One of the core questions that COTEC posed for this project, was whether SME's would increasingly be at a competitive disadvantage to MNC's. The logic of the question is the following: the advantage of SME's traditionally lies in their greater adaptive and innovation capacities, enabled by shorter communication lines and more nimble cultures. The advantage of MNC's lies in greater scale, reach and efficiency, but at the price of higher overheads and more rigidity. If there are high barriers to Industry 4.0, MNC's may have greater capacity to implement the technologies – and at the same time it would give them the ability to match SME's in flexibility and adaptive capacity.

From the interviews it is not entirely decidable whether SME's will loose competitive advantage to MNC's – both may be disrupted by new companies altogether. In any case Portugal retains a highly flexible industrial ecosystem advantage [7]. The entrepreneurs are not fazed by the Industry 4.0 challenge ahead and confident of their ability to adapt and integrate new technologies. Strengthening the support systems to assist them in that transition is both necessary and prudent.

7 COTEC in collaboration with EY, A new business innovation architecture for Portugal.

RECOMMENDATIONS

04

This section lists the recommendations that can be distilled from the interviews with entrepreneurs. It also connects those recommendations to the eleven initiatives identified in COTEC's Industry 4.0 Fase II report.

01	Evaluation of Digital Maturity
02	Industry 4.0 Experience
03	Innovation Stimulus
04	Sectorial and Digital Training and Development
05	Learning Factories
06	Experimentation and Apprenticeships
07	Digital Connectivity
08	Industry 4.0 Coaching
09	Innovation Risk Management
10	Access to Finance
11	Financing and Transformation

01

ADDRESSING THE CAPABILITIES GAP IS THE HIGHEST PRIORITY

1 4

Unsurprisingly, a continuing focus on providing support for SME's to develop their staff remains crucially important. It is equally clear that this doesn't mean exclusively focussing on knowledge about Industry 4.0 technologies, but also the important and well-trodden elements of management and staff development.

The interviewees demonstrated a clear awareness of the gaps in key internal capabilities. Filling these gaps should be their first priority.

02

PLATFORMS THAT ENABLE COLLABORATION

5 6

Innovation happens within ecosystems and only to a lesser degree within a firm. Continuing to build and nurture innovation ecosystems that support SME's will be essential both to support existing SME's and to nurture the birth of new companies.

03

MORE ATTENTION ON THE IMPACT OF CLIMATE CHANGE

For SME's climate change is substantial opportunity. New products and services will be required, consumer tastes will change and enormous capital will be mobilised. In the emerging framing of "Ecological Civilisation" in China and the "New Green Deal" in the US, it is clear that effective climate policy will touch every part of the economy. A proportion of companies is acutely

aware of this – more are not. Given Portugal's strong reputation in this respect, it would seem like a big opportunity. A COTEC climate change opportunity initiative could be helpful to catalyse focus and innovation.

04 8 9 ARE COMPANIES UNDERESTIMATING THE CHALLENGE?

The question posed in the previous section whether SME's underestimate the challenge of Industry 4.0 remains elusive. One way to deepen our understanding of this question would be through a collaborative future project, collectively designing a set of scenarios of how developments may play out in Portugal. This would require the involvement of diverse participants from industry, government and civil society.

05 ETHICS, STANDARDS AND REGULATIONS

An advanced vision on interconnection standards is what enabled Europe to take an early lead in the mobile communication revolution. An enormous public-private investment and partnership in defining common standards, enable interconnections between companies and products to take-off more rapidly than anywhere else. The success of industry 4.0 will equally depend on good interconnection standards for example in the collaboration across supply chains. This is not something the private sector can do on its own, and it requires very active support and leadership from governments.

Although little mention was made in the interviews of the role and importance of ethical assurance and regulation, these are themes that appear consistently in each of the WEF elements of Industry 4.0. As such they certainly are worthy of COTEC attention and coordination.

> "IT IS REALLY A CONTINUOUS EVOLUTION, THAT YOU TRY TO INTEGRATE OVER TIME. NOT A DISCONTINUOUS REVOLUTION."

UNIVERSITY OF PORTO	NAVIGATOR	FRULACT
DSTELECOM	ERT	POLISPORT
BOLFLEX	SIMOLDES AÇOS	CELOPLÁS
BLUEPHARMA	VIEIRA LOPES, LDA.	EFACEC POWER SOLUTIONS
INTROSYS	MOVECHO	MOTA CERAMIC SOLUTIONS
ERNESTO MORGADO		

INTERVIEWED ENTITIES


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i4.0 INDÚSTRIA 4.0
Pi4.0 Plataforma Indústria 4.0
COMPETE 2020
PORTUGAL 2020
Roland Kupers Consult