

# Advanced analytics for Industry 4.0

Data intelligence as an improvement lever  
for manufacturing business

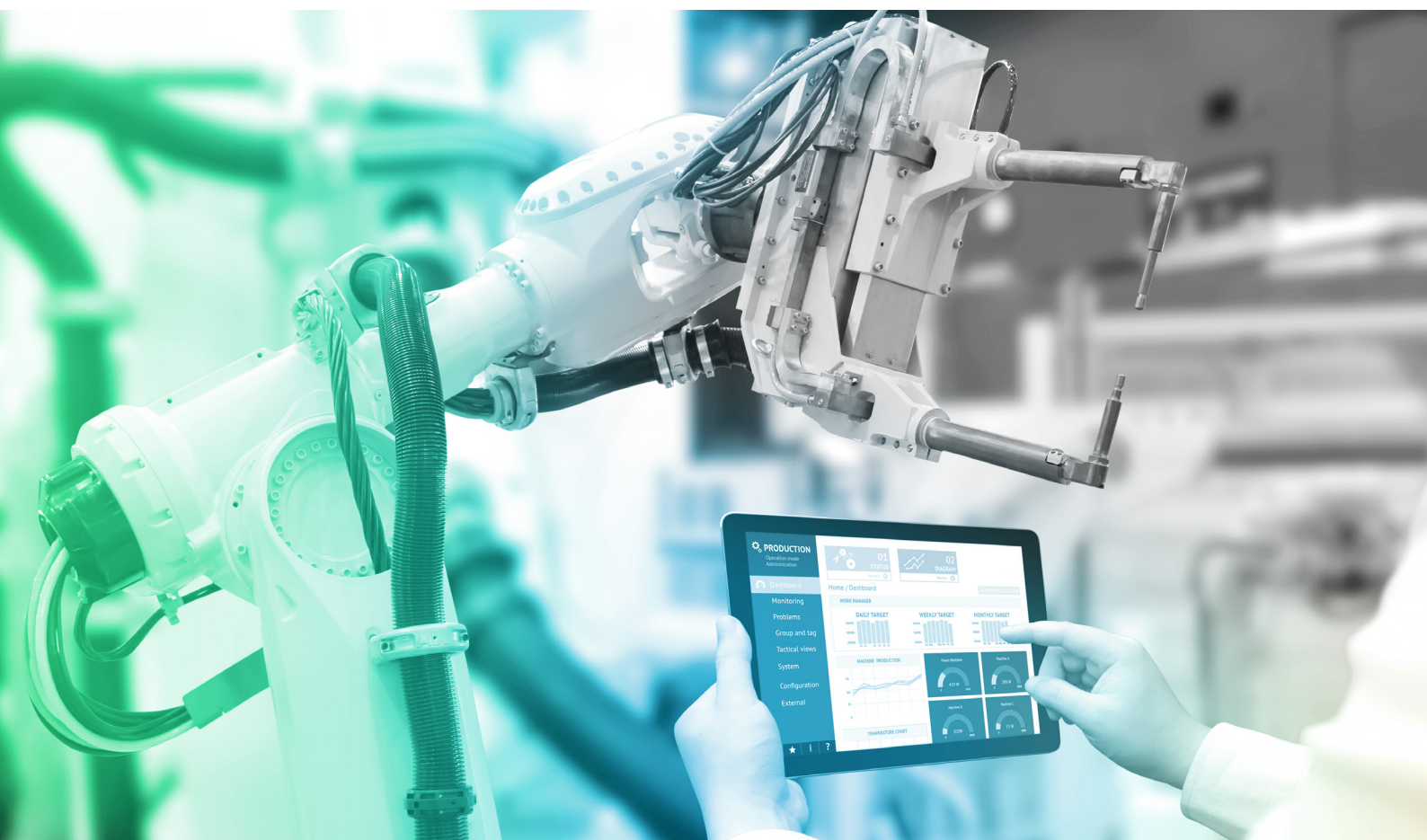
# Executive summary

"How could we have lived without 'this'?" is one of the most common questions that arises in any conversation. In many cases, "this" refers to sophisticated devices that make our life easier but were unavailable a few years ago.

Recently, the manufacturing industry has embarked on a journey that will make us ask ourselves a similar question in a few decades: **How was it ever possible to manufacture and compete in the industrial market without using "analytics"?** Indeed, Advanced analytics has gained particular momentum in the manufacturing industry and has become **one of the most powerful tools for this type of companies.** A tool that will soon need to be part of the basic kit of every company seeking to achieve a competitive edge.

That is why **Minsait has already started developing a portfolio containing a set of advanced analytics solutions specific for the industrial sector.** An example of these solutions is our **Secuenciador 360°** product.

Advanced information processing has become an intrinsic feature for disruptive industrial companies





# Introducción

Of the many applications of Industry 4.0 (robotics, 3D printing, automation, synchronisation of supply chains in real time, etc.) advanced analytics has some of the best prospects in terms of applicability and impact.

A few years ago, it would have been unthinkable to regard complex algorithms and analytics (in general) as the fundamental pillar of digital transformation companies. Today, however, there are multiple opportunities for high-impact applications in different sectors, including manufacturing, thanks to the availability of a massive amount of data generated along the industry's value chain; storage capacities; the new analysis possibilities and data processing through more powerful and complex algorithms. Advanced analytics use has only been able to capture **20 to 30% of the potential** forecasted in 2011<sup>1</sup>, which means that there are still plenty of opportunities for the deployment of analytics in the industry. **Minsait** has the right balance of manufacturing and analytics expertise to provide **differential solutions** to manufacturers.

"Analytics" applications are generally divided into three groups: **descriptive**, **predictive** and **prescriptive** analytics. **Minsait's Smart Industry** solutions also include optimisation as an additional category, given its weight in the industry. These applications can take the form of different use cases depending on each stage of the industrial value chain (e.g. product design optimisation, planning optimisation, predictive maintenance, etc.)

Each one of the industries in the sector have different preferences when it comes to using analytics, but the sectors with greater **potential** to apply advanced analytics are: chemical industry, pharmaceutical and biotechnological industry, automotive industry, food and beverages industry, metallurgical industry, aeronautics industry, packaging and healthcare industry. Currently, our **Digital Solutions** unit is developing advanced analytics applications in the **key areas** of the different industries (e.g. planning optimisation, identification of anomalies using self-learning algorithms, predictive quality, identification of production defects and predictive-prescriptive maintenance).

The industry's **need** for advanced analytics **is evident**. Spain has a diversity of niche enterprises, but none of them can cover so many areas with the same expertise as Minsait. The **opportunities** created by industrial analysis are many and interesting for Minsait, because we can leverage from the backing of a technology giant such as Indra.



<sup>1</sup> McKinsey Global Institute. **The age of analytics: competing in a data-driven world**, [online], December 2016.

# 01 Advanced analytics applications

Advanced analytics has gained massive momentum in the industrial sector. Its evolution and conquest of the markets is unstoppable, along with its presence and importance as an essential tool.

Advanced analytics has gained massive momentum in the industrial sector. Its evolution and conquest of the markets is unstoppable, along with its presence and importance as an **essential tool**. The different applications of advanced analytics can be grouped into three main areas:

## 1.1 Descriptive analytics

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Its function is to **describe**, **diagnose** and **discover** what trends and patterns are occurring in a given process, thanks to the real-time study of historical data. The most significant descriptive analytics applications are:

- Real-time visualisation of data.
- Advanced visualisation of data (e.g. creation of benchmark tables offering flexibility in terms of variables, generation of ad hoc reports, etc.)
- Descriptive statistics of processes and detection through PCA (e.g. detection of production anomalies).

## 1.2 Predictive analytics

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Based on more advanced mathematical methods that include statistical analyses, data mining, predictive models, and machine learning, among others. Its function consists of **predicting events** that can occur in the future thanks to the development of a predictive model. The major applications of predictive analytics are:

- Prediction of anomalies and alerts.
- Demand estimation.
- Forecasting of process outcomes based on the values of variables (e.g. model for detecting product quality issues).

## 1.3 Prescriptive analytics

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Its function consists of **defining** the **actions** to take to obtain the best results in a process. It relies on predictive models, scenario simulations, localised rules and technical optimisation to be able to transform data and recommend the actions to take to obtain a desired result. This level of analytics is more complete and robust. It uses techniques such as complex event processing, neural networks, heuristic learning, and "machine learning", among others. This area also has huge growth potential (a 21% CAGR increase between 2016-2021)<sup>2</sup>. The most significant applications of prescriptive analytics are:

- Generation of scenarios to recommend actions.
- Identification of the best results in an autonomous way.
- Proactive updating of recommendations for action due to changing events.

<sup>2</sup> Gartner. **Market Opportunity Map: Analytics and Business Intelligence, Worldwide**, June 2017

# 1.4 Optimisation

Optimisation is one additional individual category within Minsait's industrial analytics offering given its relevance in manufacturing (in addition to the three typical areas of application of advanced analytics):

The search for, analysis and **definition of the configuration** under which products, machines, processes and systems **yield more**. The most significant applications of optimisation are:

- Process and scenario simulations.
- Analysis of the evolution and search for maximum and minimum key values.

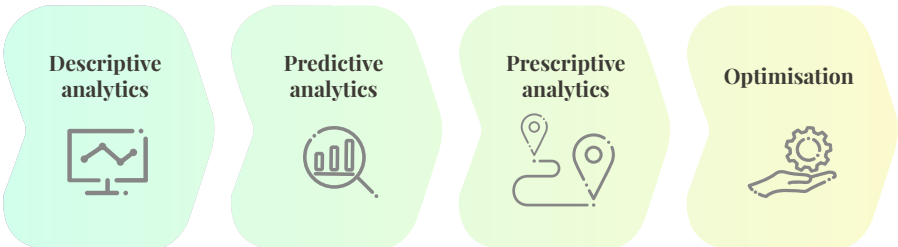


Illustration 1. Categories of advanced analytics applications.

The diversity and complexity of the industrial sector creates a wide range of potential advanced analytics applications. It helps a lot to position and differentiate all these applications over the industrial value chain so that we can truly understand their

potential. The following table<sup>3</sup> shows examples of advanced analytics **solutions** with a high impact on each of the industrial value chain stages (excluding supply chain processes such as supply chain and route optimisation):

	Design	Process/production engineering	Production	Quality	Maintenance
Description	<ul style="list-style-type: none"> <li>• Analysis of guarantees and user data to improve design</li> </ul>	<ul style="list-style-type: none"> <li>• Analytics of the existing lines for the design of new ones</li> </ul>	<ul style="list-style-type: none"> <li>• Basic analytics to improve production</li> <li>• Statistical Process Control (SPC)</li> </ul>	<ul style="list-style-type: none"> <li>• Analytics to investigate root causes</li> <li>• Identification of anomalies</li> </ul>	<ul style="list-style-type: none"> <li>• Analytics for reliability</li> <li>• Identification of anomalies</li> </ul>
Prediction and prescription	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>• Prescription of mitigation actions in response to production issues</li> </ul>	<ul style="list-style-type: none"> <li>• Predictive quality</li> <li>• Prescription of solutions to quality problems</li> </ul>	<ul style="list-style-type: none"> <li>• Predictive maintenance</li> <li>• Prescription of interventions</li> </ul>
Optimisation	<ul style="list-style-type: none"> <li>• Optimisation of the design through the combination of CAE and new algorithms</li> <li>• Computer Aided Engineering (CAE)</li> </ul>	<ul style="list-style-type: none"> <li>• Process optimisation (set point)</li> <li>• Optimisation during line design</li> <li>• Process simulation (capacity, business)</li> <li>• Computer Aided Engineering (CAE)</li> </ul>	<ul style="list-style-type: none"> <li>• Planning optimisation</li> </ul>	<ul style="list-style-type: none"> <li>• Process optimisation (set point)</li> <li>• Optimization during line design</li> <li>• Process simulation (physical characteristics) - CAE</li> </ul>	

Illustration 2. Mapping of analytics solutions by industrial value chain stages

<sup>3</sup> Not thorough

In addition to depending on the value chain stage, advanced analytics applications in the industrial field also depend on the **maturity of the organization** and the **amount of data available** for the analysis. The following table shows the relationship between these variables (maturity and data), the degree of penetration and the **impact** that advanced analytical solutions can have in the industry:

## Maturity levels of analytical solutions

	Basic	Medium	Advanced
Company characteristics			
Data available	<ul style="list-style-type: none"> <li>Few, semi-automatic data collection</li> </ul>	<ul style="list-style-type: none"> <li>Fully-automatic collection</li> </ul>	<ul style="list-style-type: none"> <li>Many, mapped and with historical and complete data bases</li> </ul>
Digital Maturity of the company	<ul style="list-style-type: none"> <li>Little experience in data use (handling of KPIs in a timely manner, simple calculations)</li> </ul>	<ul style="list-style-type: none"> <li>Usual use of KPIs</li> <li>Use of some analytics tools</li> </ul>	<ul style="list-style-type: none"> <li>Massive usage of KPIs to measure the effect of actions</li> <li>Use of some advanced digital tools</li> </ul>
Analytics applications			
Description	<ul style="list-style-type: none"> <li>Visualisation of KPIs</li> <li>Basic statistics packages for: <ul style="list-style-type: none"> <li>Quality improvements/continuous improvement/production</li> <li>Analysis of bad players (reliability)</li> <li>Analysis of guarantees</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Advanced statistics packages</li> <li>Statistical Process Control (SPC)</li> </ul>	<ul style="list-style-type: none"> <li>Identification of anomalies (maintenance / quality)</li> <li>Advanced SPC (Principal Component Analysis)</li> </ul>
Prediction and prescription	<ul style="list-style-type: none"> <li>Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>Predictive quality and maintenance</li> <li>Prescription of interventions: <ul style="list-style-type: none"> <li>Maintenance orders</li> <li>Set-point changes to improve quality</li> <li>Resolution of production issues</li> </ul> </li> </ul>
Optimisation	<ul style="list-style-type: none"> <li>Basic statistics: Design of Experiments (DOE) ANOVA analysis,...</li> </ul>	<ul style="list-style-type: none"> <li>Basic Computer Aided Engineering (CAE) level (CAD, FEM)</li> <li>Simulation of productive processes (Montecarlo, ...)</li> <li>Rules for Processes</li> </ul>	<ul style="list-style-type: none"> <li>Advanced algorithms for processes (heuristics, constraint programming, etc.)</li> <li>CAE + optimisation</li> <li>Advanced simulations (process + environment)</li> </ul>

Illustration 3. Examples of industrial analytics solutions according to their complexity

The absence of basic and average level applications for predictive and prescriptive analytics capabilities comes from by the intrinsic nature of these analytics applications. The

complexity of algorithms and IT systems that make up this kind of solutions demands an advanced degree of development for any type of initiative.

# 02 Manufacturing industry advanced analytics potential impact analysis

The manufacturing industry is one of the sectors that is generating more growth opportunities for advanced analytics applications, due to the versatility and the wide range of processes they can be applied to.

Another important lever in favour of implementing advanced analytics in the manufacturing industry is the **strong developments in hardware performance and widespread availability of technology**. This has enabled to make sense of massive intakes of sensor data and new sources of unstructured data (images, text, video, etc.). All these new functionalities fit perfectly in a sector with myriad needs.

The various types of industries have different appetites for the different types solutions due to their idiosyncrasies. The attractiveness of each the applications largely depends on **data availability** in the industrial environment and on the **critical business factors** found in each of the sectors.

1. Achieving a sufficiently large "data lake" is essential to assuring the performance and impact of the analytical solution. Through asset sensorisation, we are now able to expand (or create) the historical data required by predictive/prescriptive or visualisation type solutions.
2. In the same way, it is important to know the criticality of the different areas that affect each sector (e.g., the scope of quality control will not be as relevant for a pharmaceutical company as for a raw-materials company such as a timber or mining company).

Carrying out an analysis of the most important sectors within the industrial area and its potential adoption of advanced analytical solutions is vital to define the **strategy** for the solutions **offering**. The following graph shows the data availability and the different critical areas in some of these industrial sectors:

## Sectoral analysis of capacities in industrial analytics

	Data Availability				Critical business factors	More attractive applications
	Engineering	Production	Assets	Quality / guarantees		
Automotive (OEM)	⊕⊕⊕	⊕⊕⊕	⊕	⊕⊕⊕	<ul style="list-style-type: none"> <li>Cost management (60-80% suppliers)</li> <li>Product design</li> </ul>	<ul style="list-style-type: none"> <li>Optimisation of design and production lines</li> <li>Analysis of guarantees / user data</li> </ul>
Automotive (suppliers)	⊕⊕	⊕⊕⊕	⊕	⊕	<ul style="list-style-type: none"> <li>Cost management</li> <li>Optimisation of resources and processes</li> </ul>	<ul style="list-style-type: none"> <li>Monitoring and control over production</li> <li>Advanced planners</li> <li>Process optimization</li> </ul>
Aeronautics and Defence	⊕⊕⊕	⊕⊕	⊕	⊕⊕⊕	<ul style="list-style-type: none"> <li>Product design</li> <li>Production / quality control / guarantees</li> </ul>	<ul style="list-style-type: none"> <li>Design optimization</li> <li>Process simulation (physical cases)</li> </ul>
Medical devices	⊕⊕	⊕	⊕	⊕⊕⊕	<ul style="list-style-type: none"> <li>Product design</li> <li>Production / quality control / guarantees</li> </ul>	<ul style="list-style-type: none"> <li>Design optimization</li> </ul>
Chemical companies	⊕	⊕⊕⊕	⊕⊕⊕	⊕⊕	<ul style="list-style-type: none"> <li>Production costs</li> <li>Quality</li> </ul>	<ul style="list-style-type: none"> <li>Mt. and predictive quality</li> <li>Identification of anomalies</li> <li>Process optimization</li> </ul>
Consumer packadge goods	⊕	⊕⊕	⊕⊕	⊕⊕	<ul style="list-style-type: none"> <li>Production costs</li> </ul>	<ul style="list-style-type: none"> <li>Advanced planners</li> <li>Monitoring and control over production</li> </ul>
Food and Beverages	⊕	⊕⊕	⊕⊕	⊕⊕	<ul style="list-style-type: none"> <li>Production costs</li> <li>Food quality and safety</li> </ul>	<ul style="list-style-type: none"> <li>Monitoring and control over production</li> <li>Advanced Planning.</li> <li>Mt. and predictive quality</li> </ul>
Pharma/ biotechnology	⊕⊕⊕	⊕	⊕⊕⊕	⊕⊕⊕	<ul style="list-style-type: none"> <li>Product quality and safety</li> <li>Maximise capacity</li> </ul>	<ul style="list-style-type: none"> <li>Predictive quality</li> <li>Process optimisation</li> </ul>
Metalworks	⊕	⊕⊕	⊕⊕⊕	⊕⊕⊕	<ul style="list-style-type: none"> <li>Production costs</li> </ul>	<ul style="list-style-type: none"> <li>Maintenance and quality prediction</li> <li>Monitoring and control over production</li> </ul>

Illustration 4. Sectoral analysis of capacities in industrial analytics

With a market potential analysis of the different sectors, it is possible to determine the solutions with **higher forecasts** within each industry sector:

- **Chemical industry (and energy):** maintenance and predictive quality, identification of anomalies, process optimisation.
- **Pharma/biotechnology:** predictive quality, process optimisation.
- **Automotive (suppliers):** production visualisation and control, advanced planners, process optimisation.
- **Food and Beverages:** production visualisation and control, maintenance and predictive quality.

- **Metalworks:** production monitoring and control, maintenance and predictive quality.

Some sectors are more likely to adapt these solutions on a larger scale. The main candidates to develop a greater speed of implementation in the following years are the automotive, chemical, and pharmaceutical and biotechnological sectors. This is mainly due to having **critical business areas impacted by analytical solutions**.



## 03 Minsait's Capabilities

Minsait is in a privileged position thanks to its wide coverage in data analysis capabilities, algorithms, and technological and strategic consulting through leading multidisciplinary teams.

In addition, Minsait has a specific set of **characteristics** that make it the perfect candidate for becoming the company of reference for analytical solutions in the industry:

- Possibility of implementing advanced analytics solutions using its **proprietary IoT platform** (Sofia2), connecting the physical and the digital worlds.
- Capabilities to define specialised data strategies for each type of business and sector.
- Expert approach in **cybersecurity** for in-cloud data processing.
- **Unique suite of 4.0 products** with specific applications (maintenance and predictive quality, 360° production programmer) capable of scaling easily to different industrial sectors in a short amount of time.
- **Open ecosystem** policy that encourages collaboration with the best external experts in each subject (optimisation, neural networks, etc.), and which increases solution speed and quality whilst increasing knowledge and internal capacities.



## 3.1 Secuenciador 360°

Many of these capabilities were used in the joint development of the **Secuenciador 360°** product alongside a high-profile client. During the development of the product, the path taken started by looking for an area that showed a high potential impact from applying an advanced analytics solution: a preliminary diagnostic at the client's plant revealed an area with complicated, manual and inefficient programming that generated unnecessary stocks, inefficient energy consumption and potential savings in other areas. After studying several possible solutions the proposal was to automatically generate the weekly program for the area, using advanced algorithms with a double objective: **meet deliveries and optimise costs**. The proposal ended up being one of the priority initiatives and is currently finalising its development.

A phased approach was proposed in the beginning of the project:

1. Understanding of the problem working side by side with the client.
2. Pilot testing of an algorithm to perform a value test using exact algorithms of mixed linear and integer programming (in collaboration with Indra's Energy sector advanced analytics specialists and licensed CPLEX tools).
3. Develop an adapted algorithm based on the pilot one using open source solvers.
4. Develop and test Planificador 360° on the Sofia2 platform.

During the development of the algorithm using open source solvers, the development team found out that the problem was too complicated to be solved using the integer linear programming algorithm used in the pilot with reasonable processing times. In response to this unforeseen situation, the team decided to change the original plan and take a **two-way path**, putting into practice two of Minsait's best capabilities:

- Internally develop a simpler algorithm based on sequencing rules to meet the deliveries and optimise consumption (and use of machines) in a simpler way.
- Launch the development of a meta-heuristic algorithm that can—on an open source solver—perform a more complex and complete optimisation (maximum deliveries, cost optimisation of: energy, use, labour, stocks...) with more reasonable processing times.

*Secuenciador 360°* is developed over Sofia2 and will be able to incorporating different types of algorithms to carry out the planning of any section and, while at the same time, increase **Minsait's internal knowledge** of planning algorithms.



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Minsait is the Indra business unit that responds to the challenges which digital transformation poses for companies and institutions. Indra is one of the leading global consulting and technology companies and the technology partner for the key businesses of its clients around the world.



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