“Better to be roughly right than exactly wrong.”

This sentence coined by John Maynard Keynes and later used by Warren Buffett could sum up the general idea underlying the practice of predictive costing. The art of building a predictive costing tool resides in the capacity to find the right balance between precision and speed, which is crucial to deliver accurate and timely forecasts to make the right decisions.

Too often, cost assessment is carried out improperly or uses models that rely on painstaking and sometimes obscure processes. As a result, companies find themselves asking legitimate questions:
- How can we use data from digital applications to improve efficiency?
- How can we transform the process to get accurate results as quickly as possible?
- How can we use the latest developments in data science to improve projections and ultimately the design of a new product?

These are some of the questions this paper will be addressing (1).

Companies that successfully implement predictive cost assessment as part of their project management strategy are at a clear competitive advantage. By integrating a projection of all costs associated with a future product or service early into the development phase, predictive costing sheds light on potential scenarios at a time when everything has yet to be decided. We are still too often confronted with companies that manage their projects with absolutely no concern for the financials, only to realise too late that their operating margin target is, regrettably, way out of reach.

A mistake that too many companies make is to consider cost forecasts an end in and of itself and to treat them as a final element.

But the point of introducing predictive costing early into the development process is actually to use the information provided by the data to bring down walls between departments and create a collective dynamic to explore scenarios and reconcile two strategies: the creative, even intuitive design thinking approach, and the more analytic design-to-cost method. This combination of practices provides the right framework for an iterative process that will eventually lead to optimal cost-value compromises for the organisation. Predictive costing is most effective when used as part of a flexible and collaborative project management strategy.

From our standpoint, this is only possible if the predictive costing tool was originally designed to yield results that fuel everyone’s curiosity and creativity, in addition to providing insight into the situation.

As a result, a good predictive costing tool is one that is understood and adopted by all employees, one that will act as a shared language between operational teams, especially during convergence phases.

(1) This article will rely on examples taken from the manufacturing industry, but the principles and solutions that apply to other sectors (services, construction, etc.) are virtually the same.
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The principle of predictive costing relies on forecasting costs on the basis of a set of available data. In actuality, it is often used in the early stages of a development project, to gain insight into possible financial scenarios and assess overall costs based on macroscopic elements.

The Various Calibration Levels for a Predictive Costing Tool:

- **Level 1**: linking cost drivers \(^{(1)}\) associated with a considered technology to costs.

  Example of a plastic part

  The cost of an injection-moulded plastic part can be determined from cost drivers associated with:
  - the technology: material, projected area, overall dimensions and average thickness of the part;
  - the industrial model: production volume and location, and number of manufacturing teams.

  Part's overall cost = function of (surface, material, dimensions, average thickness, production volume, country of production, number of teams).

- **Level 2**: linking a product's specifications \(^{(2)}\) with costs.

  Example of a shock damper

  Considering the primary function of a shock damper is to dampen shocks, and that its performance depends on two main criteria – stiffness and maximum load capacity –, then it is simply a question of building a predictive costing tool that integrates these two factors as input data. With a data set large enough, the method consists in using an algorithm – or various algorithms – to determine the causal relations between these criteria and the product's overall cost. This is the approach outlined below.

  The advantage of these models is to challenge the product's specifications, which we believe is the most effective strategy for early cost optimization.

  Shock absorber's overall cost = function of (stiffness, max. load capacity, production volume, country of production).

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\( ^{(1)} \) Cost driver: a factor that is expected to have a major impact on a product or service's overall cost.

\( ^{(2)} \) Specifications: a set of explicit requirements to be met by a product or service.
Ideally, level 2 tools should also integrate level 1, meaning the model should work as follows:

Specifications → Part’s cost drivers → Projected costs.

Using cost drivers as an intermediate provides the possibility to grasp the practical implications of the solution and understand how changes in specifications impact costs, thus creating a healthy dynamic: “Understand, question, optimize”.

The different types of predictive costing tools

Level 2 Predictive Costing

Product Specifications
- Technical features—example: corrosion resistance, UV resistance, shock resistance, etc.

Level 1 Predictive Costing

Technology’s Cost Drivers
- Solution’s description—example: technology, dimensions, material, surface treatment, etc.

Estimated Cost
- Financial details—example: cost of materials, process, specifications

In some cases, these tools are more accurate in predicting relative costs than absolute costs. But they also provide an answer to the question: “How much does adjusting specifications impact a product’s overall cost?”

Attitude change brought by the implementation of a predictive costing tool

A good predictive costing tool brings people together, encourages them to question things, yields new iterations and ultimately enables optimization!
Three Cost Forecasting Methods

Prior to developing a predictive costing tool, companies should conduct a preliminary study to identify needs and assess the organisation’s environment: what are the various customer profiles? What are their expectations? What is the project’s roadmap? How integrated is the company? Where do suppliers come in? What data is currently or expected to be available? Does reviewing past data make sense? What resources are available? Etc.

A good costing tool should offer a solution designed for specific needs and a specific environment (1). The goal is to find the right balance between accuracy, attention to detail and speed to deliver an efficient solution that sheds light on possible alternatives and leads an organisation to make the right choices.

(1) For instance, if you are redeveloping a product with a new technology, reviewing past data is of little interest. On the other hand, if you want a tool to help you shape your proposals for new contracts, then your solution should not focus on design to cost.
There are three general types of cost forecasting methods:

**Analogy**

Cost estimates are calculated on the basis of reference data, which can be adjusted macroscopically if necessary.

Example: calculating a new product’s overall cost on the basis of the old product’s cost, to which we apply x% for productivity or a provision of €y for an additional feature.

The goal here is to capitalize on experience, to derive profit from the company’s history. The information is recorded in a database for future reference.

**Parametric**

Costs are forecast using a specifically developed model that links specifications and/or physical properties with the product’s various costs.

Example: the cost is calculated using simple formulas, such as ratios applied to dimensional or functional aspects – for instance: €/mass, €/area, €/power –, or using more complex formulas that factor in several cost drivers.

The goal is to make the company’s experience intelligible, to make the data ‘talk’ by building predictive models capable of solving industry-specific challenges.

**Analytical**

The forecast is based on the assessed value of a hypothetical manufacturing model. It relies on a large set of technical and economic data: material prices, type of manufacturing machinery, cycle length, setup time, share of direct labour, of machine work, etc.

Example: the cost for a mechanical part is broken down into the cost of the raw cast element, machining, surface treatments, testing. Costing hypotheses are detailed for each factor: machinery type, operation time, % of rejected products, etc.

A comprehensive insight into the entire manufacturing process is a key condition for this approach to be effective.

As we will see below, the three methods are not necessarily in conflict with one another and can be used to complement one another. In fact, the parametric approach, which is the one most commonly used by companies for cost forecasting, often relies on data provided by previous projects (analogy) and/or, when available, costing data from analytical forecasts.
Recommended Uses

Predictive costing is a valuable tool during product development projects, especially during the early stages, when companies are trying to find the best DNA for a new product or service. There is no better time to optimize a product than during the early specification phase, as illustrated by the figure below.

Product Specification
Creating value – designing to cost
- Defining market expectations, categorizing and prioritizing customer needs.
- Positioning and performance levels in relation with expected prices.
- Translating customer needs into technical specifications.

Design
Identifying the best technical solutions
- Finding a technical answer to a given specified requirement or regulation.
- Dimensioning parts, standard vs specific, etc.
- Design choices, materials, tolerance, finishes, etc.

Procurement & Supply Chain
Picking the best partners
- Assessing the value of purchased parts, defining target prices.
- Co-designing key elements with suppliers.
- Assessing a wide range of suppliers.

Industrial Production
Optimizing the labour factor
- Design for Manufacturability
- VSM for manufacturing process, testing strategies.
- Make or buy decision for specific operations or series of operations.
- Optimizing the industrial and logistic model.
Flexible methods operate under the assumption that defining every specification and figuring out every detail of a new product before the development phase begins is counterproductive, because, more often than not, the result is a product that quotations from prospective suppliers reveal is too expensive. An unpleasant realization to make at a time when keeping on schedule is so crucial and it is usually considered too late to go back on earlier choices.

The Three Main Cost Management Phases in a Development Project

During the exploratory phase, everything is still open for discussion, and it is that freedom that makes it possible to explore different scenarios, and challenge expectations and beliefs. Predictive costing is a crucial factor for the project’s convergence. In our experience, the capacity to involve all employees (marketing, R&D, sales, design, quality, production), as well as external stakeholders (technological partners, subcontractors, etc.), is one of the keys to a project’s success.

At a later stage, once the technical specifications have been approved or when the tooling phase begins, other – analytical – costing tools can be used. In that case, it becomes important to ensure the continuity of cost forecasts. The goal is to produce more accurate, but not necessarily different, forecasts for the same product. To achieve this interconnectedness and successfully link up costing tools together, it is a possibility that will need to be considered and planned during the solution’s development phase.
The Art of Making Data ‘Talk’, Two Approaches to Predictive Costing!

“It’s unbelievable how much you can learn from your own data!” This is something we regularly hear from our clients when they are presented with visual representations that highlight the relation between product specifications (cost drivers) and cost or their impact on a product’s final price. This approach provides a way to understand logical connections, as well as atypical factors, which are always interesting to investigate.

This is one of the applications made possible by the development of a machine learning-based predictive costing tool. Machine learning is a specific branch of artificial intelligence, which aims at giving computers the capacity to parse big data and learn from it without being explicitly programmed to that effect.

While the theory dates back to the 80s, machine learning technologies have become increasingly common in the last few years thanks a unique combination of factors:

- abundance of data generated by a rising number of digital applications;
- greater storage capacity and calculation performance with tools developed by big tech companies (the so-called GAFA – Google, Amazon, Facebook, Apple): cloud storage, distributed data stores, loop parallelization algorithms;
- emergence of easy-to-use software solutions, for instance: R, Python libraries.

The result is that companies are starting to entertain the possibility and wondering: How do you build this kind of tool? How do you actually implement predictive costing?

Fields of Artificial Intelligence

Artificial Intelligence

Methods for solving problems with a high degree of logical or algorithmic complexity, which imitate, substitute or complement human cognitive functions.

Machine Learning

Diverse techniques that let programmes learn without being explicitly programmed to do so.

Deep Learning

Sub-area of machine learning that uses cascades of non-linear neural layers to extract features, each layer operating on the output from the previous layer with a higher level of abstraction.

Artificial intelligence (AI) has experienced numerous waves of optimism starting as early as the 1950s. But the generalization of AI was only made possible by two sub-areas of the field: machine learning starting in the 80s, then deep learning in the 2010s.
The answer lies in three main steps, the first two making up the basic foundation to make a tool that is actually usable, while the third – and most important – step focuses on smart use.

**A- A Classic Three-Step Circular Method, Based on Analogy**

1- Delineating the Data Set to Collect

As explained above, the starting point of this approach is asking the following question: “What results are we expecting and to what end?”

When building predictive costing tools, one of the major challenges resides in the identification of ‘expected’ cost drivers. These can be determined with the help, for instance, of consulting experts. The model should then be enriched with financial parameters, such as purchase prices and internal costs.

2- Building the Technical and Financial Database

With this second step begins the fastidious task of collecting data scattered across many different software solutions: ERP systems, procurement applications, RFQ submissions, 3D and 2D drawings, Excel files from a variety of departments and, in some cases, stored safely in employees’ heads.

This data first needs to be collected, then properly cleaned and enriched. As surprising as it might sound, this process of collecting and processing data still takes up the major part of data scientists’ time – 53% according to the graph below.

**Breakdown of tasks performed by data scientists**

- **8%** Other
- **9%** Refining algorithms
- **10%** Mining data for patterns
- **53%** Collecting, labelling, cleaning and organising data
- **19%** Building and modelling data

*Source: CrowdFlower’s 2017 Data Scientist Report*
We are often confronted with the same recurring problems during our projects, for instance purchase prices listed without Incoterms (1), volume or manufacturing location, which renders the information useless, or makes it impossible to reach the level of precision required. In such cases, the data will need to be enriched with the right contextual information.

If organisations are often reluctant to engage in this long and painstaking process, it is generally due to the fact that they know little of the latest developments in the field of data science, which have made data collection significantly less time-consuming. For instance, we have developed for The Price Hub (2) a series of algorithms that allows the system to read and interpret notes on 2D drawings (title, reference, mass, materials, etc.) or extract key information from a 3D model (dimensions, surfaces, maximum wall thickness, etc.). The use of such algorithms is a very effective way to enrich data sets quickly, when performing the same task manually would require months in most cases.

3- Generating Value from the Database, Defining Charting and Statistical Rules

This last step is about making the data ‘talk’. The approach consists in using a mathematical model and graphical representations to produce cost forecasts. This is a modern application of machine learning, which is growing increasingly popular.

In some cases, incoherent results at this stage can force companies to loop back to step 1 so as to enrich the data with further contextual information. For instance, the fact that some ‘isolated’ elements cannot be reproduced using the algorithm is generally due to a missing specification, which was not initially identified as a cost driver. This usually means going back to step 1, but with newfound knowledge, yielding greater understanding!

How to Learn from Data?
The answer: charts, charts, charts!

Long before the recent development of neurosciences, which have established our brain’s preference for visual information, it was a well-known fact that “a good sketch is worth more than a long speech”.

So use graphic data representations to facilitate learning and unleash your intuition!

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(1) InCoTerms – short for ‘International Commercial Terms’ – are a series of terms used to assign responsibility for logistics and customs clearance between seller and buyer and clearly state each party’s obligations. On either end of the scope are EXW (Ex Works price) and DDP (Delivered Duty Paid), followed by the place of delivery.

(2) The Price Hub is a new platform targeted to industrial companies. It provides a comprehensive solution for producing cost forecasts, connecting buyers and subcontractors and transitioning to eRFQ processes with an updated panel: www.thepricehub.com
But how is it possible for an algorithm to learn?

Essentially, machine learning relies on a training-testing approach. The starting point is a data set consisting of known input data and expected results. This data is divided into two categories: learning data and testing data. By processing input data and expected results, some algorithms are capable of establishing logical correlations between input and output information.

Among those capable of doing so are logistic regressions, random forests (combination of decision trees) and support vector regressions. This is when the model is trained. It then becomes a question of testing the accuracy of the model using the testing data. Average deviation levels can be measured to assess the model’s accuracy. It is also possible to combine several models or even use techniques that explore a variety of variable settings for a given algorithm, in order to yield maximum accuracy.

Data organisation for machine learning

- **Data set**
  - Training data (learning)
  - Data earmarked for training the model
  - Testing data
  - Data earmarked for assessing the model
B- The ‘Mixed’ Method Based on Analytical Data

Though the approach that naturally comes to mind for building a predictive costing tool is usually the one outlined above – i.e. taking data on purchase prices and technical specifications, and connecting everything with a smart interface –, that particular approach does not always yield satisfactory results.

The difficulty is usually due to the variability in certain procurement factors, some of which are listed below:

- bargaining power, which can vary greatly from one supplier to another, depending on the product and commercial context;
- currency exchange rate fluctuations and raw material price volatility, which can generate sudden price changes;
- unclear cost definitions (tooling amortized in the product’s price, transport costs, etc.);
- volume effects, which are not always properly identified.

Other difficulties can also be induced by excessive variations in the production of a single product with no valid technical reason. For instance, this can be the case for companies that have decentralised manufacturing units, which do not operate on a common technical framework, or for companies using specifically developed designs showing a great degree of variability from one supplier to the next. But what appears to be a failure at first can actually be beneficial. That realization is an opportunity to draw up a new roadmap and shift the focus from examining a whole data set to concentrating on defining manufacturing best practices.

Lastly, there is one more case worth mentioning: technological breakthroughs. If you are considering the possibility of building a predictive model for additive manufacturing without any prior experience of the technology, you will need to rely on external data (from machine and material suppliers, for instance).

For all these reasons, it can be appropriate to build the technical and financial database using prices calculated analytically rather than actual purchase prices. The goal is simply to calculate the price of a significant sample of parts, enough to list the financial data needed for Step 2, as described on page 11.

This method has many advantages, among which:

- The value of all products is calculated with the same method, thus shedding light on the deviations resulting from manufacturing differences.
- The possibility to format predictive costing tools to a known configuration, which can then serve as best practices. It is then the organisation’s responsibility to formulate this principle and apply a variation coefficient to the forecast reports. The deviation between the best practices identified by the analytical tool and the more realistic cost calculated in the forecast can later be used as an indicator of unexpected cost increases.
- Data input limited to standard parts matching corporate guidelines.
- The possibility to configure the tool for future developments.
- The capacity to quickly check purchase prices against the tool’s best practice forecasts and assess the degree of deviation.
An abundance of data on the one hand...

The digitization of content and corporate processes generates an ocean of data, especially with the introduction of ERP (Enterprise Resource Planning) and PLM (Product Lifecycle Management) software solutions in industrial companies of all sizes.

Maybe now this would be true in a matter of minutes? The trend is accelerating with the rise of data exchange in all industries. And in addition to structured data (laid out in fixed data tables), we are also seeing increasingly more unstructured data (images, signals, etc.), which lend this trend even more momentum.

In 2010, Google CEO Eric Schmidt wrote: "Every two days now we create as much information as we did from the dawn of civilization up until 2003".

... and the difficult task of collecting and deriving value on the other.

Data scattered across multiple systems.

Data is the essence of corporate memory. As information digitization increases, so does the risk of losing part of it. It has become too complicated to understand the information, figure out how to use it and how to manage it. As a result, it is increasingly important to organise and file data to prepare for the future. Our experience has taught us that taking part in this new economy means being able to derive value from data and its uses, and not solely from products as such.

As Nicholas Negroponte, Founder of the MIT (Massachusetts Institute of Technology) Media Lab put it as early as 1995:

"The information revolution is driven to a large extent by the shift from atoms to bits."

It is our belief that implementing a knowledge management strategy is simply taking the necessary precautions to ensure a healthy foundation for the next 30 years.

Keeping track of experiences, making the data 'talk', simply means admitting that there is always something to gain and learn from the past. This is not about doing things the way they have always been done, but quite simply about using experiences from your past and admitting it can be meaningful and significant.

In many companies, firefighting response driven by operational urgency and the lack of corporate resources hinder the learning process – leaving improvement opportunities untapped.

It is essential to get help from consultants during this step in order to build an efficient, digital-based database, with updated content and a user-friendly interface, that meets your organisation’s needs.

Turn your data into shared gold!
Predictive Costing at the Service of Design and Innovation

What does the word ‘innovation’ evoke in your mind?

During the last few decades, one of the areas that focused innovation efforts was finding applications for technologies. Innovating meant integrating new, sometimes moderately useful features and producing these so-called innovative products for short lifecycles. Today, the “do better with less” trend and the beginning of a shift from an economic model that was largely based on property to one based on usage herald new ways to look at innovation.

Let us take a look at the definition of the word on Wikipedia: an innovation is anything, produced or reproduced in large batches and successfully marketed or implemented for the first time, which has improved, changed, altered, transformed or revolutionized a field of activity, social practice or the life of a large number of individuals, generally in an unexpected or unconscious way.

According to this definition, an innovative product is one that provides a new cost-value couple. And in that regard, being simple and ingenious can prove very innovative, for instance the development of a new billboard in Peru that converts ambient moisture into drinkable water, or an incubator for premature infants sold in China and across Africa for just 1% of the price of traditional incubators sold in the West. These ingenious and economical solutions are also innovations!

In terms of how this might impact a project’s calendar, companies should determine a window when this research for the best cost-value compromise can be performed across a variety of integrated fields rather than as a series of siloed, linear processes.

This step, called “Design Thinking (1)” or “Design to Cost (2)”, requires taking a look at customer lifetime value in addition to cost factors.

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(1) Design thinking is a human-centered approach to innovation that draws from the designer’s toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success” – Tim Brown

(2) Design to Cost is a strategy that advocates a vision of integration and relies on the clear identification of actual customer needs to achieve cost savings. Concurrent engineering challenges the implicitly accepted distribution of roles, where employees working on product design are concerned with customer value, while cost management is left to those in charge of Supply Chain management. Design to Cost is a way to work on a product’s specifications, design and manufacturing process, in the broader sense of the term, to achieve savings on all direct costs.
Integration of predictive costing into design thinking strategy

The use of a predictive costing tool at this stage is crucial because:

- It helps designers acquire a better grasp of costs associated with technical features and allows them to weigh costs against customer lifetime value.
- This strategy of questioning the value of a specific feature against its cost automatically leads to researching better compromises.

The goal is not to design low-cost products, but rather to allocate resources where they generate value – a notion called ‘smart cost’.

The notion of ‘smart cost’ refers to the principle of allocating resources to features that will be most visible to customers.

The success of this strategy is dependent upon the company’s knowledge of market expectations, its capacity to anticipate them, to distinguish between must-have and nice-to-have features and to optimise the design accordingly. The age of blind cost cuts is over, replaced by a vision that integrates costs into a comprehensive strategy and encourages a collective attempt to optimize resource allocation.
6 Keys to Successfully Implement Predictive Costing

Building a predictive costing tool is a step that we consider crucial, but it is of course not enough to modify the organisation’s dynamics. Here are our six recommendations:

01 Establishing a diagnostic of your needs and possible applications for a costing tool
Before anything else, ask yourself: “Why? For whom? When? By whom? How? How much?”. Assess your organisation’s maturity and culture, make sure allocated resources match your ambitions. This is absolutely essential in order to achieve a comprehensive view of the project.

02 Integrating a convergence step into the project calendar
Make sure enough time has been allotted.

03 Defining economic expectations for each project phase and naming a supervisor to make the decisions
Cost management requires a specific framework and dedicated decision-makers, with the authority to make choices. This is usually the Programme Director, when there is one.

04 Building tools that bring people together and foster collaborative work
Tools must be simple – not simplistic –, transparent, comprehensible and educational. “Black Box” tools do not provide an effective way to bring about this kind of dynamic and are of little interest in our experience.

05 Decompartmentalizing and promoting collaborative work
Workshop sessions, joined by strategic stakeholders, are an absolute requisite to tap into all available knowledge and experience.

06 Creating a dedicated costing team, independent from operations if possible
A dedicated entity is an effective way to (i) guarantee the consistence of methods and processes being used and (ii) facilitate the capitalization on and promotion of the financial perspective. Relying on a team of independent professionals, with no links to other departments, will provide greater freedom, limiting the risk of conflicts of interest. These two conditions also consolidate the design-to-cost process.
In Conclusion

Implementing predictive costing is a challenging endeavour. In its most evolved form, it is the very foundation for properly understanding costs, because it underlines the most relevant interactions between product features and overall cost.

Some say that in the future, everything will generate data and learning how to derive value from it is the key to success in the long run. Perhaps it is true. But companies will still need to learn how to extract useful information from it, and in that regard nothing beats collective and collaborative work. In our experience, placing high hopes in a data scientist or a preconfigured tool running sophisticated algorithms without giving employees a chance to understand and become familiar with the tool is a mistake. This is why we recommend carrying a preliminary needs assessment, and seeking the expertise of data scientists, costing professionals and experts of parts or technologies in order to facilitate the development. This is precisely the approach offered both by our consulting firm IAC and online procurement platform The Price Hub. IAC provides its consulting services in the field of manufacturing and costing, its capacity to inspire organisational changes, while The Price Hub offers its expertise in implementing big data and digital projects.

With the help of well-designed forecasting tools, limitations due for instance to financial factors or a sustainable design strategy can become significant catalysts for innovation, as long as they are integrated and understood early enough into the development process.

Lastly, we recommend seeking the help of qualified professionals, preferably with extensive experience in leading project teams. Handling the financials of the project is best left to professionals with no ties to operations, in order to ensure the process remains unbiased, comprehensive, consistent, benevolent and accurate.

We are convinced that this is a unique moment in time to promote more ambitious and beneficial costing practices. Companies that will show their capacity to implement such practices as early and as well as possible will have the benefit of a long-term competitive advantage.

Making data ‘talk’ is an enlightening process, both fascinating and fulfilling!
What are you doing to achieve it?