WHITEPAPER

Price Prediction Methodology

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The Science behind Lytica's Price Prediction Methodology for Electronic Components

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CONTENTS

INTRODUCTION

The pricing of electronic components is more an art than a science. It is strange then that predicting what you should pay for an electronic component is more of a science than an art.

If pricing was a science, there would be a formula for it and, if the variables were known, one could easily calculate a price. But there is none, at least none that I have ever found. As evidence, there are large marketing groups doing pricing. Negotiations exist to drive down prices and when companies merge, they discover that another company was paying a different price for the same component; sometimes the differences are surprising, particularly when they had been convinced they had the world's best price already. All of these are strong indicators that no formula exists.

I have been in Board meetings at several companies where the Board is shown sales and margin statistics by customer and reviewed margin by product. This would not be necessary or possible if pricing was not both fluid and situational.

I would argue that price is set by the buyer who must accept the prices offered by the seller to finalize a sale. It is the seller's job to position products and services so the buyer sees enough value to accept their offer. This is more of a dance (an art form) than a heuristic rule (a science). The buyer wants the lowest price possible for satisfying all the requirements with the purchase, whereas, the seller wants the highest price. Given the broad range of experience amongst buyers and sellers, one would expect to see a range of prices associated with the purchase of an electronic component.

There are many factors that could affect the price for the same item and related services. Competition is a well known one. Sole sourced parts are always more expensive than multi-source ones as competition sharpens pencils. Other factors (we have a list of about 60) include payment performance, inventory buffers, relationship style, future business potential and reputation. Some factors like supply chain depth, involve margin stacking as goods travel from manufacturer through distribution and possibly to contract manufacturers before reaching the buyer. In all cases, a range of prices emerges. When plotted as a histogram or distribution, this range of prices has a short tail on the lower price side of the mode and a long tail on the higher price side.

This asymmetrical distribution can be rationalized. On the lower priced side, there is a floor associated with the cost of making the component - below which, most companies will not sell. There is also a set of buyers who negotiate aggressively as this component is a key cost driver in their end-product. They focus concerted effort and their most experienced people on these devices to get a low price. On the higher price side, there are situations where the component is not a cost driver, the negotiators are less skilled or where non-procurement professionals, such as designers, commit to pricing too early in the sourcing cycle. Another relatively new situation leading to the high price tail is with companies where time to market imperatives and high end-product margin make component cost irrelevant to their business success. This is the case with several IoT companies. These companies pay the asking price. The result is a unique, asymmetrical price distribution for each component or set of like components.

Price is a variable that had not lent itself to analysis in a meaningful way. Prices are used in analysis of spending and product cost, but techniques to determine a fair market price for the electronic component itself were lacking. Attempts to derive a fair price often

involved modelling a price from the manufacturing process and materials costs. These cumbersome approaches use broad assumptions on costs, yields, intellectual property content value and margin. They ignored the myriad of other factors that enter price determination.

True pricing of electronic components is a secretive and private occurrence. Until Lytica's price benchmarking and prediction services, it was difficult to get a true understanding of how a price fit the marketplace. The adage "trust but verify" applied. However, there was no good means of verification. Assurances from staff, salespeople or comparisons with Internet-published pricing fail to meet any scientific standard of proof. Comparing common component prices from costed bills of materials from two separate EMS Companies will clearly show price differences and provide some insight; but do either of these prices represent fair market value for you?

As CPO at Nortel Networks, I had this problem. I was assured by salespeople and my own staff that I had the best prices. Consultants would tell me I had very good pricing but could do better in some areas. I would say good, what should I pay for this particular component? No one could tell me. I had this problem and I set out to solve it at Lytica.

AN ANALOGY

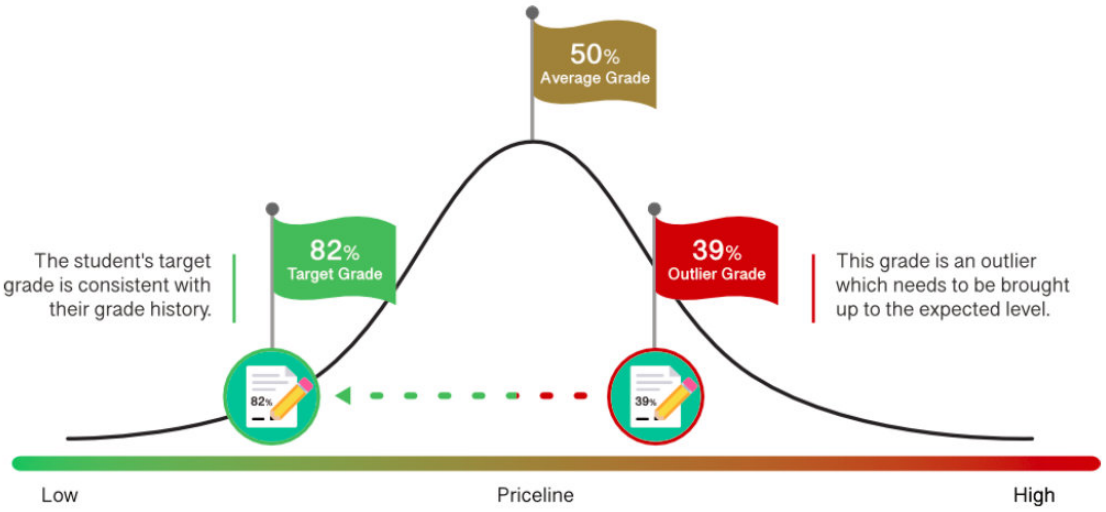
Before discussing the science behind Lytica's price prediction methodology, its worth considering how a student's grades are assigned and what grade differences mean.

A student's grade is a ranking - by percentage and relative positioning - of how well a student has mastered a subject. The grade could be considered a measure of the student's intellectual competitiveness in a subject; the higher the grade, the higher the competitiveness. The student's grade is a result of internal and external factors at play. Internal factors might include interest level in the subject, intelligence, amount of effort and time allocated to study or sleep. External factors might be the home environment, parental pressure, quality of teaching and more. All these factors interact in some complex way to deliver the student's score.

Let's assume there is an "A" student whose grades are routinely between 90% and 95% on test scores. What does it mean when that student gets a 50% grade? Clearly this grade is an outlier. Most of us would look for an assignable cause; was the student sick when the test was administered? Was there a severe problem at home or some other cause? One's

expectation would be that if the student rewrote the test, or took another test, their grade would return to the 90% to 95% level. We would expect that student to perform at their competitiveness level.

Students take many subjects and one should expect to see some variation in grades from subject to subject. We are all familiar with the concept of an average and the spread of grades about this mean. The student has a grade point average (GPA) made up of grades from each subject causing the spread. We could analyze each student's grades and discern information about the student. This is possible because the grading allows normalization across different subjects. We believe that a "B" in Math is not a good as an "A" in English but better than a "C" in Science. Knowing these scores, a parent, teacher or the student themselves could take action to push the lower scores up while maintaining or improving the higher ones. In a sense, they could take the best practices that delivered the "A" and apply those practices to the "B", "C" or worse subjects.



THE SCIENCE

Lytica's hypothesis is that a company's spending performance can be characterized using market price data and this characterization can help predict a company's appropriate pricing for electronic components. A second hypothesis is that individual Manufacturer Part Number (MPN) competitiveness levels can be applied to analyze the sourcing and procurement process using techniques from Statistical Process Control (SPC). Lytica's experience reveals that both hypotheses are correct.

Lytica's prediction methodology relies on three things.

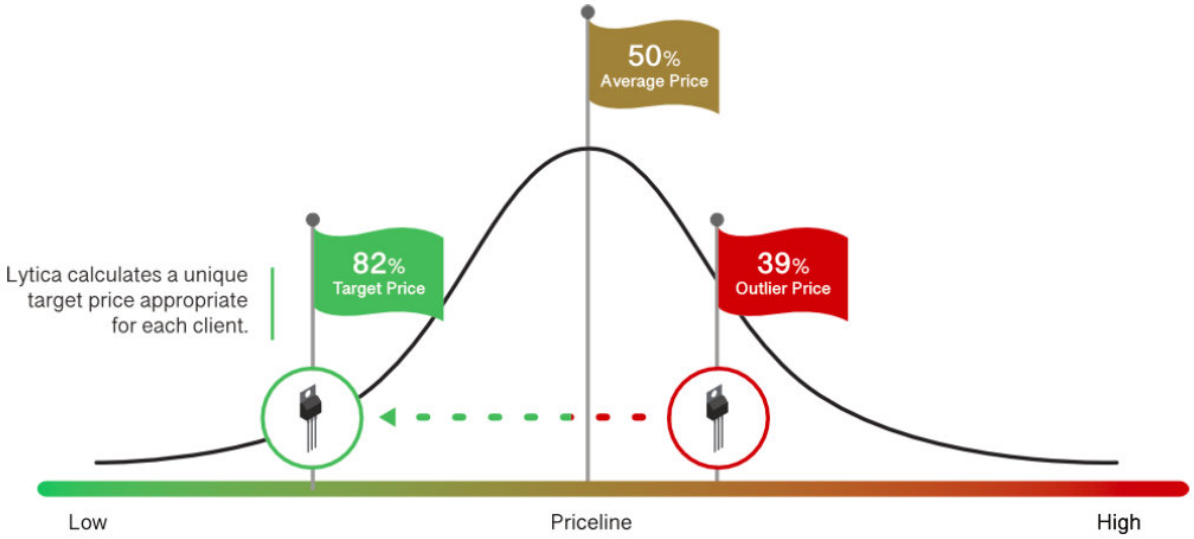
1. The first is a characterization or profiling of a client's spending, similar to determining a student's grade point average and the average obtained in each subject. We referred to this as intellectual competitiveness in the analogy and is termed competitiveness in Lytica's methodology. Competitiveness is a quantification of a client's spending profile and a normalization of their overall commodity and part-by-part performance. Competitiveness can also be determined at the MPN level and is available to aid in process analysis. Commodities or part types replace school subjects in the analogy.

2. The second is an assessment and identification of abnormal client price positioning within a distribution, like the 50% test score above. We refer to these abnormally priced components as outliers.

3. The third is repositioning outliers to prices consistent with the characterized competitiveness of the commodity. This is Lytica's prediction, based on data and positioned relative to performance levels already reached on similar parts by the customer. According to Lytica's customers, this inherent feature in our methodology – price prediction appropriate for them - has proven to be a powerful negotiating lever. . Customers are simply renegotiating a price that's right for them and that they are proven capable of achieving in the marketplace.

Central to all of this is a high-quality, comprehensive library of components with reference price distributions - from which individual component characterizations and predictions can be made. These distributions are models that best fit the data we obtain on each component. Each model is populated with real customer data and identified within specific time periods. This enables trend analysis of client and market data. This is useful to see if your price negotiations are keeping up with market trends, improving or falling behind.

The area under each distribution's curve represents 100%. If your price is marked on this distribution "X" axis (the price axis), the area to the right of your price, the high-priced side, will be less than 100% and represents the competitiveness value for your component. This is the same concept as used in probability calculations with a Gaussian curve; however, these pricing models are far from Gaussian.



Lytica maintains two reference libraries; one based on exact component matching and the other based on form, fit and functional (FFF) equivalent component groups. The advantage of the FFF groups is that they contain more price points which improves statistical accuracy. The exact match groups - defined as exact by root matching where the MPN root excludes packaging characters - can be used to add validity to the FFF distribution equivalence. This is because clustering by MPN should not be apparent within a truly equivalent FFF distribution. Other exact match uses include SPC analysis of the purchasing process and disproving Vendor claims that Lytica's predictions don't apply to their component because the FFF match does not apply to their "special" part.

Creation of the models is made difficult because of two situations in addition to the raw complexity of curve fitting. The first situation is determining which price points are valid for inclusion in the distribution. The second is accurately recognizing the component's part number to enable matching.

The problem with valid price point determination arises from the many ways in which a price can be obtained and reported. The solution depends on rules that define what a valid price point is. In Lytica's database, a price point must be associated with a negotiation and a component's purchase. This definition automatically excludes pricing obtained from quotations and from all published or advertised pricing from distribution or aggregator websites. These are proposed prices, not transacted ones and are therefore excluded from the database. This definition leaves only real customer-supplied data representing their purchases in Lytica's reference library. Most of this data is correct; however, there is

always the possibility that someone is trying to game the system by providing erroneous numbers or perhaps made errors in file preparation. Algorithms have been created to test for price validity. The algorithms must be able to reject ridiculous or erroneous prices while allowing for shifts in the market pricing as might occur during a time of shortages.

Prices must also come from a distinct purchasing event. In many cases - particularly with EMS - we see the same price for a component used across many client's part numbers (CPNs) with different associated volumes. This is an outcome of their purchasing economies of scale and can result in a discrete negotiation being reflected 50 or more times within an EMS input file. Our best judgement tells us that this is likely one price point for our model, not 50. They most probably negotiated in bulk for the component (one transaction) and then assigned them to CPNs for internal use.

Manufacturing part number (MPN) spelling errors plague most input files. We have seen delimited and non-delimited concatenations of part numbers and manufacturer's names, letter and number substitutions within a part number such as a "5" and an "S", a "0" and a "O" or a "B" and an "8" as well as extra text attached to the MPN and unique wildcard characters from the client. Cleansing the input files to correct MPNs has been - and continues to be - the focus of Lytica's Artificial Intelligence (AI) program on data cleansing. This is a difficult problem to solve as there are billions of components with hundreds of valid MPN variations. We deploy a combination of techniques to ensure MPN spelling is correct. The predominant method uses our machine learning "Bill of Materials" (BoM) cleanser application. This application uses spell checking algorithms coupled with vast and accurate component reference sources. We supplement this with other approaches that narrow the scope of the problem. One such approach combines inputs from other clients using similar parts to define the range of possible spellings for the part under scrutiny. Another approach combines Parametric Induction to break down a Manufacturer's MPN code into parametric and attribute values and MPN deduction to determine a manufacturer's part numbers from an ordered list of parameters.

The science behind Lytica's methodology is straight forward in concept but difficult to implement. The creation of a vast, accurate and high-integrity priced component reference library, which has two aspects:

1. A critical mass of customers willing to try a different approach to negotiation and supply their private data to Lytica's library, and

2. High integrity component information using techniques like:
    - Machine reading of data-sheets
    - Information curation and normalization, and
    - Price modelling
    - Price prediction algorithm development and verification, and
    - Real-time data cleansing and supplementation. This cleansing includes spelling corrections along with proper manufacturer's names, market vertical and commodity assignments.

The solutions to overcome the difficulties above are dependent on the use of Artificial Intelligence technologies such as deep learning, machine learning, clustering and more.

APPLICATION OF COMPETITIVENESS TO CONTINUOUS IMPROVEMENT

Everyone involved with component pricing should know if their pricing is keeping up with market dynamics. In fact, they should want to know if their pricing is getting better with time. A change to a lower price does not necessarily represent an improvement. Managers should want to understand variations in their business process, the causes and where their organization's best practices exist. Adopting best practices across an organization is a sure way to improve. Adopting best practices is a foundation for improvement and pervades Lean, SPC, Just-in-time, Kaizen and many other techniques widely adopted today by the industry.

Lytica's approach to understanding pricing is equivalent to factory process control solutions such as SPC for understanding process variation. Lytica's method is data driven, it involves normalization of information and benchmarking, it looks for events (prices) that are outside of the expected benchmarked range and flags them for investigation.

A reasonable first step to improvement is eliminating the price variation amongst components through renegotiation of the worst priced components or understanding the constraints to successful renegotiation. Later steps could look at the practices and business processes associated with your top performing commodities or components and applying them as improvements to the practices used with the underperforming ones.

Benchmarking and understanding where you currently are compared to others, is the starting point for any continuous improvement initiative. In the student analogy, the

student is compared to peers through grade normalization as well as seeing relative performance across subjects. With Lytica's competitiveness scores, the user can see the same. They can assess their results against market as well as doing comparisons between components, commodities, factories, or other definable grouping. Other groupings can include supplier and manufacturer assessments.

Lytica works with companies to assess the competitiveness of each component so that these factory SPC practices can be used to drive continuous improvement.

ACHIEVING THE SAVINGS

Lytica provides savings opportunity information from three actionable sources: Arbitrage, Duplication and Target Savings. The procurement team should act on these opportunities in this order.

ARBITRAGE SAVINGS

Arbitrage Savings opportunities arise when a company is paying different amounts for the same set of parts designated by the Client's Part Number (CPN). There are cases when a different price makes sense; however, if two factories are in the same country, it makes no sense. We have customers who have been able to establish the same lowest CPN price globally. It is recognized that suppliers will suggest - sometimes strongly - that their product is better and should cost more than other MPNs in your CPN, but remember, unless your engineers have made unfortunate alternatives choices - such as a 5% tolerance part for a 10% one - the value to you from all these MPNs is the same. You should not pay extra for this ethereal value that you don't need.

DUPLICATION SAVINGS

The Duplication Savings opportunity comes from two sources. One source is coding duplication where designers assigned two different CPNs to the same MPN. The other source is where a valid cross-reference to your application exists within your Bill of Materials and stands alone with a CPN not associated with the cross-referenced part.

Generally negotiating for the first source is straightforward whereas the second requires an approach like that outlined for Arbitrage. It may be necessary to go as far as quoting the alternative and putting forward a redesign business case to show the incumbent

supplier that you are serious about getting the savings before they move on pricing to keep the business. We have seen achieved cost reductions for customers on a component as much as 70%.

TARGET SAVINGS

Target Savings result from analysis using the science described in this paper to identify pricing outliers. Target prices are calculated after Arbitrage and Duplication have been accounted for. Our pricing guidance is to negotiate for the lowest price obtained from Arbitrage, Duplication or Target as different components will have different pricing opportunities.

Target Savings are often easily achieved once the outlier components and their price targets are pointed out to the supplier. At other times, strong negotiations using leverage tactics like that outlined for Duplication Savings are required. Suppliers will often claim that no customer is getting the price shown in our reports. This may be true as our predictions are statistically derived; however, someone is getting a better price and someone else a worse one for a form, fit and function equivalent device.

SUMMARY AND CONCLUSIONS

Lytica offers a science-based, data-driven solution for measuring market price competitiveness of electronic component spending, identifying outlier components that require renegotiation and market-based data to enable business process analysis of sourcing and purchasing practices.

Lytica's approach is unique but has been proven by our clients across the globe as an effective and efficient means for driving improvements in electronic component procurement.

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ABOUT LYTICA

We make electronic companies more competitive by being the most trusted source of electronic component market intelligence. Lytica brings visibility to supply chain risk and cost - *fast*, with the world's only comprehensive database of real customer pricing for electronic components. Lytica is trusted by the world's top OEMs and electronics manufacturers. We work with the best in the world - over 95% repeat customers. Are you paying a competitive price for your electronic components?

Find your best price today!

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