SQUARE ROOT COSTING:

Square root costing was developed to help companies quantify the costs of complexity and unlock the systemic cross-subsidizations distorting the view of profitability by product and customer.

REVEALING THE COST OF COMPLEXITY

SCOTT STALLBAUM

Most companies do not know where they make money. This is shocking, yet understandable given the challenges leaders face tracking and allocating costs. Calculating overall profitability is straightforward, but it is close to impossible to determine profitability at the product, SKU, or customer level.

Typical costing methods prove inadequate as continuous changes in product mix, processes, and organizational support structures render standard costing meaningless and activity-based costing exercises obsolete. In fact, countless times executives from various industries have told our consulting firm that they do not believe in the accuracy of their standard product costs.

However, without a robust costing tool, it is impossible to truly understand which SKUs are driving profits and which are losing money. This is a perilous situation to be in because in most organizations there are big winners and losers.

For example, Wilson Perumal & Company (WP&C) worked with a regional beverage distributor operating under the belief that its high-end products, which have very high price points and gross margins, were its primary profit drivers. However, the standard costs developed by the company's finance department inaccurately represented true costs. This eventually led to misinformed strategic decisions, such as an overinvestment in the sales force focused on small-volume, premium purchasers.

After using WP&C's proprietary Square Root Costing (SRC) methodology, the business found that fewer than 20 percent of SKUs were profitable and that all of those profitable products were actually the low-margin, high-volume products originally thought to be loss leaders.

Slower-moving, high-margin products added complexity to purchasing, sales, warehousing, and distribution, substantially

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increasing overall costs in hidden ways. Correctly allocating these costs to the company's high-end products showed that those products were, in fact, highly unprofitable. Massive cross-subsidizations disguised the true costs and profits of products, customers, and channels.

Until the development of SRC, there had been no feasible way to quickly and dynamically understand true SKU or customer profitability. WP&C developed SRC to help companies quantify the costs of complexity and unlock the systemic cross-subsidizations that distort the view of profitability by product, customer, and so on. It is rooted in a deep understanding of complexity and its impacts on operations and costs; therefore, it can move beyond the fixed and variable cost paradigm. SRC adds a third cost category to account for costs driven by complexity (e.g., changeover time or inventory management) and the unique behaviors of those costs.

This additional cost category accounts for non–value added (NVA) complexity costs that increase with volume but are not proportional to it — hence, the square root relationship after which this approach is named. Additionally, SRC employs the same top-down, allocation-based approach used in standard costing that is both fast and dynamic, giving it many advantages over activity-based costing.

What are complexity costs and how can you spot them?

In short, complexity costs in a business are driven by the number of products/services offered, facilities managed, and organizations operating. These costs can take many forms, but include NVA costs such as production downtime, schedule and order management, supervisory time, scrap, order processing time, etc. The impacts of these often overlooked costs show up in the form of growing, selling, general and administrative expenses, high inventory, frequent changeovers, bloated research and development, lost capacity, and reduced productivity, among others. It is important to understand that complexity costs do not directly add any value to the product in the eyes of the customer; therefore, they are synonymous with NVA costs. In order to spot complexity costs, it is vital to look at the portfolio through the lens of NVA efforts that drives variety. A helpful thought process to identify complexity costs is to imagine the difference in an operation, process, or organization that produces and sells a single product versus one producing and selling 1,000 products.

For example, manufacturing changeovers frequently go unnoticed and these costs are commonly spread evenly across all products. This makes lower volume products appear more profitable (and higher volume products appear less profitable) than they really are. However, changeovers are a complexity cost — if there were no product variety, there would be no downtime for changeovers. Additionally, production planning and scheduling look very different when there is a single product being made versus 1,000 products being made. The same holds true for many processes in front- and back-office functions like sales, finance, human resources, purchasing, and more.

Research affirmed by client experience shows that typically only 20 to 30 percent of products generate over 300 percent of total profit. The remaining 70 to 80 percent of products destroy 200 percent or more of total profit.

Square root costing is different

Traditionally, businesses used standard costs based on fixed and variable costs to make decisions regarding product rationalization, pricing, and new product development. Today, however, complexity has changed the game. While standard cost models accurately account for value-added costs like raw materials and direct labor, these models fail to truly account for the complexity costs created by a portfolio of many different SKUs. Standard cost models fail to associate NVA costs like changeovers, inventory management, and corporate overhead with specific SKUs. This is because standard costs are typically calculated at the gross margin level, and either ignore overhead or assume it is equally driven by all products.

UNTIL THE DEVELOPMENT OF SRC, THERE HAD BEEN NO FEASIBLE WAY TO QUICKLY AND DYNAMICALLY UNDERSTAND TRUE SKU OR CUSTOMER PROFITABILITY.

However, as overhead typically accounts for a significant portion of overall costs

EXHIBIT 1 Exercise

	PRODUCT A	PRODUCT B	PRODUCT A	PRODUCT B	PRODUCT A	PRODUCT B
	BY VOLUME		BY SQRT OF VOLUME		EQUAL BY PRODUCT	
Total Cost ($)	$2.00	$98.00	$12.50	$87.50	$50.00	$50.00
Volume	1	49	1	49	1	49
Unit Cost ($/unit)	$2.00	$2.00	$12.50	$1.79	$50.00	$1.02

(between 25 to 50 percent, depending on the industry), it deserves a more careful accounting. SRC accurately captures the complexity-driven NVA costs that standard costs fail to consider.

Consider a manufacturing line producing 1,000 yellow pencils per day

In a bid to draw new consumers, management decides to diversify and produce 90 percent yellow pencils and 10 percent blue pencils. To do this, the line must stop production to change over between colors. Scheduling is now more important, and raw materials and finished goods inventories need to be coordinated.

Since the equipment has to be cleaned and recalibrated with every change, downtime occurs, and material scrap is produced each time a machine stops and starts production. Overall, the downtime associated with color complexity reduces capacity to 900 pencils per day.

Standard costing would spread the lost-time NVA costs across all products by volume, whereas the SRC approach would accurately assign the source of complexity — blue pencils — greater NVA costs.

Why SRC?

WP&C co-founder Andrei Perumal theorized the square root relationship between volume and complexity costs after a series of plant simulations. These models isolated the impact of individual variables, revealing that certain complexity costs (such as product setup times) demand variability, and inventory holding costs varied proportionally to the square root of volume.

In a manufacturing environment using optimal production scheduling for two items that are the same (i.e., same setup time, run rate, yield, etc.), average working inventory levels were proportional to the square root of each product's volume. If Product A had four times the demand of Product B, then Product A had two times the average cycle stock inventory.

For complexity costs, volume is the dominant driver of cost differences between products — or customers, regions, and so on. By accurately modeling these relationships, SRC can quickly and significantly improve the accuracy of costing exhibits. However, the true value of SRC comes from the insights it gives using the methodology's outputs, which allow companies to understand the actual drivers of product, SKU, and customer profitability.

SRC provides valuable information about the cost of delivering new SKUs to the market and can also provide insights into how a company can deliver the complexity required to meet customer demands in a more effective and profitable way.

The following example demonstrates how WP&C has helped various companies use SRC to inform strategic decisions and transform their businesses.

Situation

Say you have two products, A and B. Product A is one unit in volume, and Product B is 49 units in volume. You identified $100 in complexity-driven costs to allocate.

EXHIBIT 2 Economics of Proposed Dual-port Product

	CURRENT SALES		PROSPECTIVE DUAL PORT SALES	
	Model A	Model B	Dual Port ($5)	Dual Port ($10)
Annual Volume	105,000	7,800	112,800	112,800
Average Sales Price	$750	$842	$756	$756
Cost/Unit	$550	$912	$555	$560
OP/Unit	$200	**($70)**	$201	$196
Total Profit	**$20,454,000**		**$22,672,800**	**$22,108,800**

Application

Allocate the $100 in costs across the two products using each of the three methods (by volume, by square root of volume, and equal by product) to complete the table in Exhibit 1.

Square root of volume step-by-step calculation:

1. Calculate the square root of each product's volume (Product A: volume 1, square root = 1; Product B: volume 49, square root = 7).
2. Second, sum the total of the square roots (sum of square roots = Product A square root + Product B square root = 1 + 7 = 8).
3. Divide each individual square root by the sum of all of the square roots to determine the "burden" percentage (Product A: 1/8 = 12.5 percent; Product B: 7/8 = 87.5 percent).
4. Multiply the "burden" percentage by the total complexity costs (Product A = 12.5 percent × $100 = $12.50; Product B = 87.5 percent × $100 = $87.50).
5. Divide total cost allocated to each product by its actual volume (Product A = $12.50/1 = $12.50 per unit; Product B = $87.50/49 = $1.79 per unit).

Case 1: Diagnosing product profitability to inform new product development

A $5 billion HVAC manufacturer (HVAC Co) had maintained profitability over recent years as its portfolio of products continued to grow. With pending technology and regulatory changes, management expected the number of SKUs to triple while volumes grew at a slower rate. This growth would result in higher production and sales costs to support a more variable portfolio and impact existing scale. HVAC Co needed to understand how this added complexity would impact the business and how to best manage it moving forward.

WP&C used SRC to analyze the impact of complexity in HVAC Co's furnace offerings. Two furnaces, Model A and Model B, were identical apart from the location of the flow port. Model A's port was on top of the unit to comply with construction standards in the Midwest, while Model B's port was on the bottom of the unit to support the Southeast market. Model A sold 13 times the volume of Model B.

HVAC Co assumed the costs to sell these nearly identical products would be similar, but our SRC analysis revealed the real costs associated with bringing the slower-selling Model B to market (e.g., manufacturing, selling, distribution, marketing, other overhead, etc.) was $912, compared to only $550 for Model A.

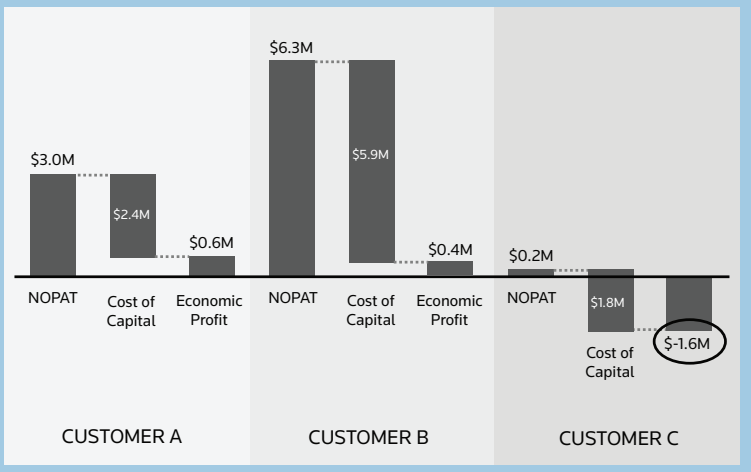
At this true cost, Model B was losing money, but HVAC Co had to keep offering that format to serve its Southeastern market. A solution was needed to deliver the added complexity of Model B in a more efficient way.

With an understanding of HVAC Co's operations and customers, we recommended the development of a dual-port product. Reengineering a furnace to have both a top

EXHIBIT 3 Additional Cost/Unit Impact on Profit

ADDITIONAL COST/UNIT	POTENTIAL PROFIT INCREASE
$5	$2.2M
$10	$1.7M
$15	$1.1M
$20	$0.5M
$25	$0.1M

EXHIBIT 4 Economic Profit by Customer Type



NOPAT = net operating profit after taxes

and bottom port location would reduce the number of furnace SKUs by half, driving down inventory costs, reducing changeovers, and lowering supply chain costs.

Analysis showed that if the less costly Model A could be reengineered as a dual-port product for an additional unit cost of $25 or less (the difference between Model A's unit cost of $550 and the weighted average unit cost of Models A and B, $575), it would be profitable to transition to the dual-port design (Exhibit 2).

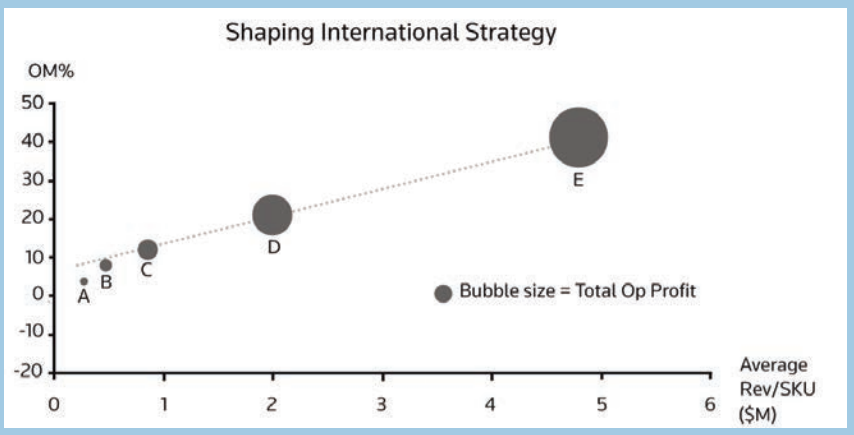
Model A and Model B's sales volumes would combine and represent the sales of a new dual-port product. The unit cost to bring this dual product to market would be Model A's current unit cost ($550) plus the cost to add the additional port. Based on engineering estimates, the change would only cost an additional $5 to $10 to make and would result in profits increasing by $1.7 million to $2.2 million (Exhibit 3).

Case 2: Understanding customer profitability to improve economic profit

An international consumer packaged goods contract manufacturer (Consumer Co) was having difficulty balancing the demands of its three largest customers. These customers were pressuring Consumer Co to reduce minimum order quantities and order frozen zones (e.g., periods where no changes can be made to work orders), decrease prices, increase SKU variety, and hold more inventory for longer periods of time.

Management needed to understand the impact of these demands on the business

EXHIBIT 5 Operating Margin by Country



Metric	Country A	Country B	Country C	Country D	Country E
Revenue ($M)	$100	$220	$440	$950	$1,000
Operating Profit ($M)	$4	$18	$48	$200	$413
SKUs	374	467	471	478	209

while finding a way to profitably navigate them. Finance, supply chain, and operations worked together to identify and quantify the growth in NVA activities based on impacts of the increased customer demands. In doing so, it was discovered that:

- reduced order quantities and a smaller frozen zone mandated the need for growth in the sales team;
- increased SKU variety facilitated the need to hold greater amounts of materials and ingredients in reserve, driving up these costs; and
- holding more customer inventory, and for longer, required the leasing of additional warehouse space.

Previously, these costs would have been spread evenly across all products, but by identifying them as complexity costs it was now possible to associate the costs with a specific customer. WP&C leveraged SRC and calculated the complexity-adjusted economic profit for all three customers — taking the identified complexity costs and reallocating based on both the manufacturing volume of the respective products and purchase volumes of each customer. This immediately helped the company understand how each customer's particular demands and behaviors were impacting profits.

When factoring in the assets used to generate this revenue and the high levels of finished goods and work-in-progress inventory required by Customer C's current contract, an extreme picture emerged. Customer C was destroying economic profit, generating a loss of $1.6 million (Exhibit 4).

Consumer Co used this insight to inform the structure of new contracts with customers. They renegotiated pricing and terms to better balance customer demands with plant capacity.

The manufacturer also built new consignment inventory arrangements with some clients to ensure they were not bearing the burden of inventory carrying costs, which drove down Consumer Co's inventory complexity costs. These changes drove improvements in profitability and customer service while creating better flexibility to manage future SKU growth.

Case 3: Assessing country profitability to shape international strategy

A multibillion-dollar international cosmetics company (Cosmo Co) had been pur-

suing international growth by adding new products to its international portfolios. While innovation was only initiated by large strategic markets, once a product was introduced, any small market could include the SKU in its specific portfolio.

This "everything available everywhere" approach to the country portfolio meant that smaller markets could offer a huge variety of products with the belief that product development contained most of the cost of bringing a product to market, and therefore, offering additional SKUs in new markets carried no extra costs. Through examination, the WP&C team found that hidden costs such as marketing and inventory management significantly impacted profitability as regional portfolios continued to grow. It was identified that these hidden costs had previously been spread across not only products, but also across markets, with lower margin markets being subsidized by higher margin markets. Through SRC costing, these costs were applied more significantly and appropriately to the low-volume products and markets.

SRC illuminated the fact that larger markets with fewer products were able to build revenue density and scale while small markets bore higher costs to support larger portfolios.

In countries like Russia where the physical size of the country is vast and difficult to navigate, each additional product caused distribution costs to grow. Thus, small-volume products were difficult to deliver to market. Retail prices also varied between regions and were subject to exchange rates, which further exposed how different markets required different product offerings and strategies.

By using SRC to understand cost drivers and their impact on profitability, the WP&C team was able to pinpoint variables that predicted success for geographic and portfolio expansion. The identified variables included pricing power, market size, and portfolio efficiency. These variables and others were loaded into a multivariate regression model, which enabled Cosmo Co to the see the impact of several variables modified simultaneously. Using the multivariate regression, it was illustrated that pricing power, market size, and portfolio efficiency significantly drove total profit and operating margin. When revenue density (revenue/SKU) was higher, markets were able to leverage scale and grow revenue faster than complexity.

In other words, those markets with more targeted portfolios (rather than the one-size-fits-all approach) were able to gain share with fewer SKUs, thus reducing cost and increasing margin (Exhibit 5).

Armed with this information, the WP&C team helped Cosmo Co build targeted product-market strategies by creating country level playbooks highlighting opportunities for SKU rationalization, investment, pricing, and service changes.

Conclusion

As the world continues to evolve and businesses compete in new, unpredictable ways, companies that are best positioned to succeed are those that are best informed. Managing a business with inaccurate cost and profit numbers will lead to poor decision-making, a false understanding of how to grow the bottom line, and a bloated portfolio filled with redundancies.

By using SRC, companies can gain a true understanding of how different SKUs and customer segments drive profitability. They can also build better strategies around business problems such as product mix, innovation, and international expansion — enabling them to better compete in our complex world. ■