A WORKSHOP TO TEACH THE VALUE ANALYSIS PROCESS

This article presents an overview of an interactive workshop organizations can use to teach the value analysis process.

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Today's global competition pressures companies to reduce costs and increase product performance. Past practices of "getting the product to market and then taking cost out" are no longer sustainable. Getting the cost right and creating the desired margin (i.e., target costing) is much more effective when done at the design stage of new product development, and value analysis plays an essential role in this process. The purpose of this article is to provide organizations with a framework for teaching value analysis. The workshop described takes an interactive approach, using passenger vehicles to depict the application of value analysis.

Introduction

Value analysis helps organizations direct their product development activities to the areas that create the greatest customer value. Through value analysis, organizations invest in the product features and functionalities most valued by their customers, and avoid spending in areas that provide minimal customer value.

Value analysis is also key to successful target costing, a profit-planning and cost management system organizations use to control costs during the design stage of new product development. At a very basic level, target costing is a simple equation: market price – profit margin = target cost. The organization then strives to develop a product that satisfies customer requirements within the constraints of a cost target. Target costing is not, however, just about cost cutting; its more important function is increasing customer value through value analysis.

To support target costing, value analysis equips product developers with two

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important goals. Initially, they strive to *reduce* the product's cost in areas that provide little customer value. However, they are willing to *add* costs if the new design incorporates features and functionalities that customers greatly value. Product designers increase customer value in both cases, providing a cost-effective but highly functional design. Therefore, an understanding of a product's features and functionalities, their relative importance to the customer, and their cost is critical to value analysis.[1]

Value analysis workshop

The purpose of this article is to provide organizations with a framework for teaching value analysis. The described workshop takes an interactive approach, using passenger vehicles to demonstrate the application of value analysis. Because consumers in the automobile industry have distinctive preferences and place different values on certain features and functionalities, vehicles can effectively illustrate the value analysis process.

The workshop is broken down into the following sections:

1. identifying customers' desired functional requirements for the product (this part requires audience participation and takes the most time to complete);
2. breaking down product costs by major systems;
3. correlating customers' functional requirements with the major systems costs;
4. assigning customer value scores to each system; and
5. developing a value index.

Customer functional requirements

The first step in value analysis is to identify the customers' desired functional requirements. Functional requirements are expressed in terms of what the customer wants the product to do and not how it is done. For example, a customer requirement could be the ability to block direct sunlight. The design solution, or feature, could be a mechanical visor or auto-darkening glass. Value analysis will dictate, based on the relative importance of blocking direct sunlight, which feature will be the design solution. Knowing what customers value in a product helps focus the product development process by aligning spending with desired customer outcomes.

Organizations generally identify 7–15 functional requirements. Too few will not adequately describe what the customer requires, and too many will dilute the value placed on those that are most important. Below is a comprehensive list of functional requirements for passenger vehicles, but the importance of each to consumers will differ depending on the type of vehicle they wish to purchase.

1. Performance:
   - *Speed*. This feature includes characteristics such as top speed and acceleration. It is the vehicle's ability to accelerate quickly and operate safely at high speeds.
   - *Handling*. This feature, also known as control, refers to the vehicle's ability to maneuver through tight spaces and move safely in different directions at various speeds. Minimal body lean, quick steering response, and communicative steering feedback indicate superior handling capabilities.
   - *Sound*. This is the engine's ability to produce a distinctive sound that is pleasing to the customer. Customers generally associate sound with performance.
   - *All-terrain capability*. This feature allows the vehicle to operate more effectively in adverse conditions, such as off-roading and inclement weather.
   - *Towing*. This is the vehicle's capability to draw or pull a load. Some vehicles possess virtually no towing capability, and others vary from relatively low to very high towing capacity ratings.
2. Cost efficiency:
   - *Fuel economy*. Also referred to as fuel efficiency, this feature is measured in terms of miles per gallon.
   - *Operating costs*. Other than fuel costs, this includes the cost of operating and maintaining the vehicle.
   - *Reliability*. Reliability ratings show how well vehicles have held up over the years. More specifically, the ratings predict the likelihood of problems and repairs in areas such as the engine,

transmission, climate control, braking, electrical system, and power accessories.

3. Other areas:

- *Appearance*. This measures the extent to which the vehicle is attractive and pleasing to its target market.
- *Customization*. This is the extent to which a consumer can customize the vehicle to meet his or her unique requirements.
- *Comfort*. This category is relatively broad and includes areas such as noise level, ease of entry, amount of headroom, and seating comfort.
- *Safety*. Government regulatory requirements are baseline design constraints. However, customer desires for safety above and beyond regulatory levels are considered customer requirements. For example, some manufacturers provide additional crash avoidance technologies, such as lane departure warning systems, rearview cameras, blind spot warning systems, and automatic braking systems. The manufacturer could also provide better structural integrity to improve crash test results. Visibility also affects the vehicle's safety. Some designs restrict rear visibility, and other styling considerations compromise views to the sides or even in front of the vehicle.
- *Cargo space*. The versatility of the vehicle's design solution can add to the amount of useable cargo space. For example, a split-back design allows users to fold down one side of the rear seat while a passenger occupies the other rear seat, effectively adding cargo space without adding space to the overall vehicle.

Product categories

For this workshop, we chose three distinct product categories for passenger vehicles: supercars, large sport utility vehicles (SUVs), and subcompacts. The categories are quite different to illustrate how customer requirements can vary greatly among segments of the automobile market. Workshop participants should work in groups, and the workshop leader assigns one of the three product categories to each group. The groups should then collaborate to rank the relative importance of each functional requirement for a generic vehicle in their category (see Exhibit 1). Each group will present their results to demonstrate how customer preferences differ among product categories. A description of each product category is included in the following section.

EXHIBIT 1 Functional Requirements Ranking: Generic Large SUV

Customer Functional Requirements	Relative Importance*
A. Performance	
A-1 Speed	10%
A-2 Handling	10%
A-3 Sound	0%
A-4 All-terrain Capability	5%
A-5 Towing Capability	5%
Subtotal	30%
B. Cost Efficiency	
B-1 Fuel Economy	10%
B-2 Operating Costs	5%
B-3 Reliability	5%
Subtotal	20%
C. Appearance	10%
D. Customization	0%
E. Comfort	15%
F. Safety	10%
G. Cargo Space	15%
Grand Total	100%

*The groups rank (using percentages) the importance of each customer requirement for a generic vehicle in one of the three product categories. Note: The sum of the customer requirement percentages should equal 100%.

Supercars. Supercars are high-performance, luxurious, and very expensive sports cars. Other terms used to describe supercars include fast, powerful, precise, unique, sleek, sexy, and beautiful. Automakers generally produce supercars in low volumes to provide owners with exclusivity and brand appeal.

Large SUVs. Large SUVs are a type of station wagon or estate car with off-road capabilities, such as raised ground clearance,

EXHIBIT 2 Vehicle Information

Ferrari 488

The Ferrari 488 falls into the supercar segment of the car market. The 488 has three variants, including the 488 Spider, which is a convertible with a folding hardtop. The other two variants include the 488 Pista and GTE coupes, which have enhanced performance capabilities.

The 488 is a two-seater, mid-engine sports car that was introduced in 2015 to replace the 458. It sells for approximately $250,000, is powered by a 3.9-litre twin-turbocharged V8, and is known for its speed and handling capabilities. The Ferrari 488 delivers 661 horsepower, accelerates from 0 to 60 mph in 2.9 seconds, and has a top speed of more than 200 mph. The EPA rates the 488's fuel economy at 15 mpg city, 22 highway, and 18 combined.

Ferraris have excellent cornering ability, measured in terms of "lateral acceleration," which is the amount of acceleration the vehicle can achieve when turning a corner. The 488 also comes with electronic sideslip angle control to improve stability and traction on wet or winding roads.

A distinctive feature of a Ferrari is its "sound." Sound from the engine originates from the air intake, firing the cylinders, and the exhaust. However, the rhythmic sound of the pulsating cylinders, growing louder and louder as the vehicle accelerates, is what delights Ferrari's customers.

To test driver skills, the 488 comes with controls to manipulate the level of electronic assistance provided to improve stability and traction. In fact, controls on the steering wheel have wet, sport, race, and off positions. An additional dial will also turn the stability control feature on and off. The primary purpose for these controls is to help the driving enthusiast avoid driving mistakes. Furthermore, customers can customize the 488's color, interior finish, and materials.

The ergonomic design of the 488's cabin enhances driver comfort. The vehicle also comes with plush and rich interior materials, such as fine leather. Using careful engineering and aerodynamics in its design, drivers can carry on a conversation at a comfortable volume inside the cabin, with the top down, driving well above typical American highway speeds. Designers of the 488 also added enough storage space to accommodate a bag of golf clubs.

Hummer H2

The Hummer H2 is a large SUV that General Motors marketed and sold from 2002 until 2009, when production stopped. The H2 had a sales price of approximately $70,000 and is known for its striking features, off-roading, and towing capabilities. It is nearly seven feet wide and can seat six passengers, but it has limited cargo space.

The aim of the Hummer H2 was to mix the original H1's "commando" charm and the traditional luxury of a high-end SUV. The H2 delivers 393 horsepower, goes from 0 to 60 mph in 9.1 seconds, and has a top speed of 100 mph. It handles pretty well for a large SUV, has adequate cornering ability, and responds well to abrupt changes in direction.The EPA did not rate fuel economy for the Hummer H2 due to its weight. Nevertheless, it reportedly pro-vides 10–12 mpg in highway driving and 8–9 mpg in the city.

The Hummer has excellent off-road capabilities, accommodating rugged terrain, muddy roads, and shallow streams. With nearly 10 inches of ground clearance, large wheels, and a protected underbody, the H2 can take on any type of terrain without sustaining damage or getting stuck. The towing capacity for the H2 is 8,200 pounds, which is relatively high for a large SUV.

durability, and available four-wheel or all-wheel drive. Automakers often build large SUVs on a light-truck chassis, designed for off-road surfaces, even though they generally operate as a family vehicle. SUVs have an upright built body and tall interior packaging, with high seating positions and centers of gravity. Some SUVs include the towing capacity of a pickup truck with the passenger carrying space of a minivan.

Subcompacts. Subcompacts are small economical vehicles known for high gas mileage and low operating costs. The primary difference between a subcompact car and a compact car is cargo space and passenger room. Subcompact cars do not

EXHIBIT 2 Vehicle Information, cont'd

The interior is snug with regard to rear-seat legroom. It has a third-row seat, but it is small and difficult to reach. The H2 also suffers from a lack of headroom in the rear. Despite its size, cargo space is limited. Due to its high ground clearance, designers placed many engine and transmission components inside the cab itself, taking up to three feet of space in some places. Furthermore, the Hummer is noisier than most other large SUVs.

Rear visibility is particularly difficult through the small back window, and front visibility over the tall, boxy hood can be a challenge for drivers under six feet tall. The H2 is very heavy, which slows its stopping ability in emergency braking situations, and its seven-foot width limits its maneuverability on narrow roads. However, the Hummer receives high scores for its crash and rollover safety ratings.

Tata Nano

The Tata Nano is a small subcompact vehicle manufactured only in India from 2009 to 2018, when production ended. Tata Motor's goal was to build an inexpensive car for families and provide an alternative to two-wheeler motorcycles. The Nano sold for approximately $2,400, which was considerably below competitor prices.

Based on 1,000 display vehicles and a low selling price, potential customers applied to purchase over 200,000 vehicles before the Nano officially launched. However, although initial interest was strong, production delays, distribution problems, political roadblocks, and bad press ultimately damaged the Nano's reputation beyond repair.

The initial goal of Tata Motors was to design a passenger vehicle that would sell for approximately $2,000, which was the price of the most expensive two-wheelers in India at the time. To reduce costs and increase interior space, Tata collaborated with the Bosch Corporation to develop a small two-cylinder engine that provided only 33 horsepower. The trade-off was one of the slowest cars ever produced — it takes the Nano about 30 seconds to accelerate from 0 to 60 mph with a maximum speed of 65 mph. However, the small engine helps maximize interior space and fuel economy while reducing maintenance costs. The Nano achieves 42 mpg for combined city and highway driving.

Other cost innovations include front seats that have no seat frame and are adjustable to only three positions. The Nano's door handles contain 70% fewer parts than the cheapest European vehicles. The dashboard has a minimalist instrumentation panel with only a speedometer, odometer, and fuel gauge. Tata made the Nano's wheels from a low-cost metal alloy using only three lug nuts, and the body panels from lightweight sheet metal.

While cost reduction was an important consideration in the Nano's design, Tata Motors also strove to develop a vehicle that met customer needs and regulatory requirements. Its mandate was to provide safe, comfortable, and reliable transportation. Therefore, the design of all Nanos included four doors. Omitting easy access to the rear seats would greatly inconvenience large, multigenerational Indian families. Its two-cylinder engine is in the rear of the vehicle, enabling a rear-wheel drive design that provides more space for the driver and passengers. The Nano is 4 percent wider, 14 percent taller, and has 21 percent more interior space than the market leader in the subcompact segment of the Indian market.

The Nano also has a very tight steering angle, enabling a turning circle of only 26 feet and 3 inches and making it easy to park and maneuver. It is equipped with an impact cushioning crumple zone and a reinforced front body structure for enhanced frontal crash safety. While comparable to other small cars in India, the Nano meets industry standards for safety in India and is much safer than two-wheelers.

have much of either, and compacts have just a little more.

Specific vehicles

The workshop groups should repeat this exercise for a specific vehicle within their product category. For example, we used a Ferrari 488 to represent the supercar category, and the Hummer H2 and the Tata Nano to represent the large SUV and subcompact categories, respectively. Exhibit 2 provides more information about each vehicle.

The groups then rank the importance of each customer requirement based on how the manufacturer *designed* its specific vehicle. (See Exhibit 3.) For example, based on the Hummer H2's design, the manufacturer

EXHIBIT 3 Functional Requirements Ranking: Hummer H2

Customer Functional Requirements	Relative Importance*
A. Performance	
A-1 Speed	10%
A-2 Handling	10%
A-3 Sound	0%
A-4 All-terrain Capability	20%
A-5 Towing Capability	5%
Subtotal	45%
B. Cost Efficiency	
B-1 Fuel Economy	5%
B-2 Operating Costs	5%
B-3 Reliability	5%
Subtotal	15%
C. Appearance	20%
D. Customization	0%
E. Comfort	5%
F. Safety	10%
G. Cargo Space	5%
Grand Total	100%

*The groups rank (using percentages) the importance of each customer requirement, based on how the manufacturer designed the vehicle. Note: the sum of the customer requirement percentages should equal 100%.

committed significant resources to all-terrain capabilities. Therefore, workshop participants generally rank all-terrain capabilities higher for the Hummer H2 than they would for a generic large SUV. Once again, participants should present their results to the other groups and discuss any differences they found between the functional requirements of the generic and specific vehicles within their product category. The purpose of this exercise is to see whether the manufacturers designed vehicles that matched the customer requirements for their product categories.

Discussion

Workshop participants should now have a basic understanding of how a product's functional requirements relate to value analysis. As a group, they first ranked the functional requirements for three generic vehicle categories. [2] Next, they rank the functional requirements for a specific vehicle — Ferrari 488, Hummer H2, or Tata Nano — within each product category. At this point in the workshop, the instructor should continue the discussion about the three vehicles. For example, Ferrari is a highly profitable company — could this indicate that Ferrari does a good job of developing product designs that satisfy their customers' functional requirements? Conversely, both the Hummer H2 and Tata Nano were discontinued. Is this a sign that these companies were less successful in designing vehicles that met their customer requirements? Based on previous workshops, we have observed the following comments from participants.

Ferrari. Participants generally concluded that Ferrari has a good understanding of its customers' functional requirements, and designs vehicles that satisfy those requirements. While the percentages differed to some degree, participants in the generic supercar category assigned the highest relative importance percentages to performance and appearance. When participants ranked the functional requirements for Ferrari, they also assigned the highest relative importance to these same two categories. Furthermore, Ferrari appears to excel at executing its strategy. Car magazine *Top Gear* named the Ferrari 488 GTB "Supercar of the Year 2015," and *Motor Trend* named it the "Best Driver's Car" in 2017. Ferrari is also one of the most profitable vehicle manufacturers.

The Ferrari brand benefits from Formula One racing events, where it holds the record for winning the most Grand Prix racing titles. Ferrari owners also receive perks, such as invitations to a three-day driving tour throughout Italy. Some owners will fly or ship their cars to Italy to be part of this unique event. Ferrari helps promote exclusivity and preserve its brand image by limiting production. Enzo Ferrari, the company founder, has a golden rule: Sell one less car than the market demands. Due to waitlists for the 488 Spider, Ferrari dealerships will sell a pre-owned Ferrari to a customer but then offer to buy it back at a fair price once the new model arrives.

Hummer H2. When evaluating the Hummer H2, participants often speculated that the company misjudged customer requirements over the life of the vehicle. When they compared the Hummer H2 to a generic large SUV, participants felt the relative importance General Motors placed on the H2's all-terrain capability and appearance was too high and the importance placed on its cargo space, comfort, and fuel economy was too low. In the H2's early years (2002–2005), sales were relatively robust, but they fell precipitously until 2009, when General Motors discontinued the brand.

The Hummer brand received a tremendous amount of initial publicity due to Arnold Schwarzenegger's interest in the vehicle. The Hummer's price made it a symbol of wealth and status, but few people bought the vehicle based on actual need. Thus, brand image was very important to the early success of the vehicle. Its image suffered, however, as the Hummer became a symbol of excess and harmfulness to the environment.

Tata Nano. Participants generally ranked the Tata Nano's functional requirement scores similarly to those of a generic subcompact vehicle. The cost efficiency category received the highest scores. Comfort was slightly higher for the Nano than for a generic subcompact, whereas the reverse was true for performance. This might be due, in part, to India's emerging market characteristics. The Tata Group targeted customers who were looking for basic transportation. However, like the Hummer H2, the Nano was discontinued. Production began in 2009, but sales declined rapidly until the company stopped production in 2018.

Based on initial orders for the Nano, the Tata Group seemed to understand its customers' functional requirements; however, it failed to execute them strategically. The Tata Group envisioned an innovative distribution strategy to increase sales and strengthen its brand appeal. For example, it considered distributing the Nano through nontraditional channels, such as electronics retailer Crom[amacr] and fashion retailer Westside. Tata also considered shipping its vehicles in semi–knocked down kits to satellite mini factories. The mini factories would then assemble the Nanos and ship them directly to buyers. The Tata Group developed this dual strategy to reach a mass market of Indian buyers.

However, due to severe production mishaps and delays, Tata deviated from its original strategy and instead distributed the vehicles through traditional dealerships. Motorcycle drivers had been the target market for the Nano, but they were reluctant to enter the large automobile showrooms frequented by more affluent car buyers. Therefore, most Nano buyers were existing car owners who were relatively affluent and purchased the Nano as a cheap second car. Nano's reputation transformed from the "people's car" to the "cheapest car," and motorcycle owners lost interest.

EXHIBIT 4 Product Cost Breakdown: Hummer H2

Brakes	1.0%
Drivetrain	15.0%
Engine	27.0%
Electronics	7.0%
Exterior body panels	19.0%
Frame assembly	14.0%
Interior trim	5.0%
Seating	2.0%
Suspension	10.0%
Total	100.0%

Product cost breakdown

The next step in the workshop is presenting product costs for each major system. (The instructor should prepare this information in advance of the workshop.) Essentially, a major system is a set of components that have a common purpose. For example, the drivetrain consists of a transmission, drive shaft, axles, and other components, depending on the type of vehicle. Exhibit 4 lists the major systems for a passenger vehicle, using the Hummer H2 as an example.

Correlation matrix

Now that we have identified the customer requirements and have listed the cost of each major system, we need to develop a correlation matrix for the two areas. Each

customer requirement for a passenger vehicle relates to more than one specific system. For example, the engine, drivetrain, frame assembly, and suspension are the major systems that determine the Hummer H2's all-terrain capability. However, the strength of the correlation between its all-terrain capability and major systems varies. For example, the drivetrain, frame assembly, and suspension strongly affect all-terrain capability, but the engine has only a moderate effect. Exhibit 5 presents the correlations between customer requirements and the major systems. The strength of the relationships (correlations) are represented as strong (S), moderate (M), or weak (W).

In Exhibit 6, these correlations are given numerical values. A strong correlation

EXHIBIT 5 Correlations Matrix for the Hummer H2 by Correlation Strength

	Major Systems								
	Brakes	**Drivetrain**	**Engine**	**Electronics**	**Exterior Body Panels**	**Frame Assembly**	**Interior Trim**	**Seating**	**Suspension**
Speed		W	S						W
Handling			W			M			S
Sound			S	W					
All-terrain capability		S	M			S			S
Towing capability		M	W			S			W
Fuel economy		W	S	W	W				
Operating costs	W	W	S	W					
Reliability	W	M	S	M					
Appearance					S		M		
Customization					S		S		
Comfort						M		S	S
Safety				S	W	S			W
Cargo space		M				S			

S = Strong correlation; M = Moderate Correlation; W = Weak correlation

receives a value of nine, a moderate correlation receives a value of three, and a weak correlation receives a value of one. Therefore, a strong correlation is three times the magnitude of a moderate correlation, and a moderate correlation is three times the magnitude of a weak correlation. In practice, these scores are just starting points. Design engineers will modify scores to reflect a more accurate relationship between the vehicle's major systems and its customer requirements.

EXHIBIT 6 Correlations Matrix for Hummer H2 with Relative Values

	Major Systems								
	Brakes	**Drivetrain**	**Engine**	**Electronics**	**Exterior Body Panels**	**Frame Assembly**	**Interior Trim**	**Seating**	**Suspension**
Speed		1	9						1
Handling			1			3			9
Sound			9	1					
All-terrain capability		9	3			9			9
Towing capability		3	1			9			1
Fuel economy		1	9	1	1				
Operating costs	1	1	9	1					
Reliability	1	3	9	3					
Appearance					9		3		
Customization					9		9		
Comfort						3		9	9
Safety				9	1	9			1
Cargo space		3				9			

9 point scale: Strong correlation = 9; Moderate correlation = 3; Weak correlation = 1

Customer value scores

We developed customer value scores for the Hummer H2's major systems. In practice, companies develop their functional requirement rankings for a vehicle by gathering input from customer surveys, customer focus groups, and other interactions with customers (see Exhibit 3). Based on the vehicle's relative value scores (see Exhibit 6), companies will then allocate the customer's functional requirement percentages

EXHIBIT 7 Customer Value Scores for Hummer H2 Major Systems

	Major Systems									
	Brakes	**Drivetrain**	**Engine**	**Electronics**	**Exterior Body Panels**	**Frame Assembly**	**Interior Trim**	**Seating**	**Suspension**	**Total**
Speed		0.9%	8.2%						0.9%	10.0%
Handling			0.8%			2.3%			6.9%	10.0%
All-terrain capability		6.0%	2.0%			6.0%			6.0%	20.0%
Towing capability		1.1%	0.4%			3.2%			0.4%	5.0%
Fuel economy		0.4%	3.8%	0.4%	0.4%					5.0%
Operating costs	0.4%	0.4%	3.8%	0.4%						5.0%
Reliability	0.3%	0.9%	2.8%	0.9%						5.0%
Appearance					15.0%		5.0%			20.0%
Comfort						0.7%		2.1%	2.1%	5.0%
Safety				4.5%	0.5%	4.5%			0.5%	10.0%
Cargo space		1.3%				3.8%				5.0%
Sum of customer value scores	**0.7%**		**21.6%**	**6.3%**	**15.9%**	**20.5%**	**5.0%**	**2.1%**	**16.8%**	**100.0%**

*Based on the Hummer H2's design, sound and customization do not appear to be a customer requirement, so they are not listed in this exhibit.

EXHIBIT 8 Value Index: Hummer H2

Major Systems	Customer Value Scores	Product Costs	Value Index*
Brakes	0.7%	1.0%	0.70
Drivetrain	11.0%	15.0%	0.73
Engine	21.6%	27.0%	0.80
Electronics	6.3%	7.0%	0.90
Exterior Body Panels	15.9%	19.0%	0.84
Frame Assembly	20.5%	14.0%	1.46
Interior Trim	5.0%	5.0%	1.00
Seating	2.1%	2.0%	1.05
Suspension	16.8%	10.0%	1.68
Total	100.0%	100.0%	

*The value index is determined by dividing the customer value score by the product cost for each of the major systems.

to the vehicle's major systems. For example, customers ranked the Hummer's appearance as providing 20 percent of its relative value, and the Hummer's external body panels and interior trim determine its appearance. As illustrated in Exhibit 7, with regard to the 20 percent customer value score for appearance, external body panels contributed 15 percent (20 percent x 9/12), and the interior trim contributed 5 percent (20 percent x 3/12).

Value index

Finally, a value index defines the relationship between the cost of a product's major systems (Exhibit 4) and the customer value placed on those systems (Exhibit 7) mathematically. As illustrated in Exhibit 8, the value index is calculated by dividing the customer value score by the product cost for each of the major systems. If the result is less than one, then the cost of the major system is greater than its perceived value as identified by the customer. For example, the value indices for the drivetrain, engine, and exterior body panels are 0.73, 0.80, and 0.84, respectively; therefore, they are all candidates for cost reduction. Alternatively, frame assembly and suspension have value indices of 1.46 and 1.68, respectively. Since their scores are greater than one, these systems are worth additional investment.

As discussed, the design of the Hummer H2 focused too much on all-terrain capabilities and appearance when compared with other vehicles from the large SUV market segment. Given the relationships established in Exhibit 7, reduced spending on the drivetrain would be in line with less emphasis on the H2's all-terrain capabilities. Similarly, less spending on exterior body panels aligns with less emphasis on the vehicle's appearance. As shown in Exhibit 8, the value index supports this strategy by suggesting less investment on the drivetrain and exterior body panels.

Conversely, designers invested too little in the Hummer's fuel economy, comfort, and cargo space. According to Exhibit 7, these three functional requirements relate to the engine, suspension, and frame assembly, respectively. Designing a smaller, less costly engine would have led to better fuel efficiency, and additional investment in the suspension and frame assembly could have improved both comfort and cargo space. The value index supports this strategy by suggesting less spending on the engine and greater investment in the frame assembly and suspension.

Discussion and summary

Fundamentally, value analysis is a tool organizations use to enhance their product

development activities. A thorough understanding of a product's functional requirements, as desired by the customer, is key to its success. Yet addressing the issues identified by the value index can be challenging. In passenger vehicles, most of the customer requirements affect multiple systems. Furthermore, an attempt to improve one requirement could negatively affect another.

Ferrari, which has been highly successful in the supercar market segment, constantly strives to balance conflicting customer requirements. For example, they added a turbocharger to the 488 to improve speed and handling. In addition to increasing power, the turbocharger reduced the vehicle's weight and thus improved handling. However, it also affected the vehicle's sound by flattening and smoothing out both the air intake and exhaust noises, much like a silencer on a gun. Ferrari customers typically associate sound with performance and appreciate hearing the cylinders firing rhythmically and at higher amplifications during acceleration. Eventually, Ferrari found the right balance between performance and harmonics by slightly increasing the diameter of the 488's exhaust pipes, even though it led to a redesign of the car's entire exhaust system.

To improve comfort, Ferrari uses plush and rich interior materials, such as fine leather. These materials, however, create a 10 to 20 lb. weight disadvantage when compared to the synthetic materials used by competitors. Yet Ferrari believes the improved comfort outweighs the negative effect of the added weight on the vehicle's performance. Additionally, designers of the 488 added enough cargo space to accommodate a bag of golf clubs, even though that meant a wider wheelbase and a slight reduction in its handling capability. Given its success in developing the 488, Ferrari has appropriately balanced the conflicting needs and desires of its customer requirements. ■

NOTES

[1] For a more thorough discussion of value analysis, see: Dummer, W., Masters, M., and Swenson, D., Delivering customer value through value analysis, *Cost Management* 29, no. 2 (2015): 1–8.

[2] The percentages correspond with relative importance. Participants assign high percentages to functional requirements that are important, and correspondingly low percentages to those that are not important.