MANAGING CHANGING QUALITY NEEDS IN AUTOMOTIVE AND CONSUMER PRODUCT INDUSTRIES
ABSTRACT

As the perceptive areas of experience and branding are becoming increasingly prevalent in today’s market to impact the consumer’s choices, improving the quality of production to exceed customer’s expectations cost-effectively is now an imperative for manufacturers. However, design trends change so rapidly that a lengthy development cycle may result in the output of products which no longer match consumer demand. To optimize time-to-market, product stakeholders must improve their efficiency in both product and process design to deliver “right-first-time” products. As opposed to traditional design and quality tools, new sophisticated quality and visualization tools can help predict manufacturing variation and their impact on perceived quality at an earlier stage, with visual input to address visually perceptive issues. In this white paper, discover how preliminary quality assessment is becoming a must-have in current design processes, for a more streamlined product development lifecycle, with a shortened lead time from concept to production.

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In today’s market, customers want to experience increased functionality and quality at no extra cost. The industry is already acting upon these heightened expectations, with the build quality and feature set of products ranging from mobile phones to family cars improving at a rate vastly disproportionate to the rise in the purchase price.

Though, lessons learned in technology, design innovation, and buyer aspirations can and should be applied across product industries. To achieve an optimum balance in areas such as the quality-cost trade-off, an understanding of how customers perceive quality in a product is crucial. In other words, what makes the consumer favor BMW over Lexus or the Apple iPhone over the Samsung Galaxy?

Customers are changing the way they buy products. Just 10 years ago, quality was considered a differentiable value offering for many manufacturers; an area in which they could gain market advantage over their competitors. As minimum quality requirements rise, however, absolute quality no longer acts as a positive differentiator; it becomes mandatory.

Of course, consumers’ choice is based on many decision criteria, centered, in many cases, on function, form, and price. What is becoming increasingly prevalent in today’s market is an emphasis on experience and branding, design and quality. These more ‘perceptive’ areas focus on product aesthetics, more specifically the sensory and emotive elements of sight, sound, touch, and taste. Whether driving a Rolls-Royce or a Skoda, the principle of transportation – getting from A to B - is the same, it is the experience that becomes significant. What companies now need to boast is brand equity and a proven record of quality and performance.

“This is no longer a market where quality is the differentiator. Quality is now a given. It is a price of entry for consideration; and if you don’t have it, the consumer has many, many other choices to turn to.”

Mike Vannieuwkuuyk, Executive director of global vehicle research for J.D. Power and Associates.

Source: Speech at the Automotive News World Congress, 2011
Quality, of course, is an abstract term. It can be achieved with limited resources if manufacturers realize that an appreciation of a product’s quality relies as much on customer perception as much as the product’s intrinsic value. As such we can classify ‘quality’ into two different types:

- **Measurable quality**: designed in with deliberate tolerance and monitored by manufacturers’ quality assurance programs
- **Perceived quality**: perception formed in the mind of the consumer

In the case of an iPhone, its ‘quality’ is arguably as much about Apple’s branding and packaging as it is about the product’s polished interface and pleasingly minimalistic design. One could argue that the perceived quality of a brand is such that customers often rely on the company’s reputation for quality to augment an individual product’s merits, allowing the company to command a premium price position across their product line; examples being companies such as Bang & Olufsen, Dyson and Rolls Royce. For consumer goods, in particular, the packaging, marketing and the aesthetics of the product are increasingly essential to a product’s success in today’s market. Quality, in this case, becomes about ensuring that expectations, indeed aspirations, are met before, during and after the customers open the box.

“Even in different industries it’s important to remember that one’s dealing with the same consumer.”

Phil Gray, Managing Director
Quadro Design Associates

**EFFECT ON CONSUMER PRODUCT SUPPLIERS**

In today’s global market there are always low-cost competitors. The need to compete on value-for-money must be weighed against the desirability of high-quality products. For manufacturers, therefore, improving the quality of production to exceed customer’s expectations cost-effectively is now an imperative. Moreover, consumers now tend to think of excellence in the broader context of dependability, convenience, satisfaction, and attraction, not just being ‘well made’.

“.. perceived quality is real quality, from the customer’s perspective, developed by creating and enticing a sensory experience of sight, touch, sound, and feel. Perceived quality from a technical approach is a systemic approach and focuses on: 1) knowing customer wants and needs, and the competitive landscape they have to choose from; and 2) “must-have” design, great parts engineered and tooled superbly, manufactured and assembled with precision.”

Anne Asensio
Source: Steering the brand in the auto industry. Design Management Journal
Companies continuously look for options to shorten product lead time. Trends change so rapidly that a lengthy development cycle may result in the output of products which no longer match consumer demand. To optimize time-to-market, product stakeholders must improve their efficiency in both product and process design leveraging emerging technologies and methodologies to deliver “right-first-time” products.

Traditionally, engineers and designers focus on the measurable performance or capabilities of the product. To answer the question “Is the product good enough?”, they conduct a series of tests, simulated or actualized, to find the answer. In the consumer world, what matters is the product’s point of difference – what makes it stand out in today’s competitive market – which is increasingly centered on aesthetics. Unlike manufacturers’ ‘measurable quality’ concerns, consumers concerns are based on a product’s perceived quality: “Will this look good in my house?”, “Does this reinforce my image?”

“The product, its actual or perceived quality, as well as price are all decisive factors. This doesn’t mean we should be making inexpensive products. Our position is this: tangible quality and perceived value!”

Cyrille Vigneron
CEO of Cartier

Source: Interview with Haute Horlogerie, Feb. 2018

As many competing companies have access to similar technologies, and with the market typically setting the price point, the design is a crucial differentiator. However, as designers continue to set new trends, there inevitably follows a whole new set of quality issues to address. In such a design-led market, one needs to consider each finished product in its entirety; not as a collection of its parts. An example drawn from the automotive world will illustrate the importance of this consideration. In the past, a car’s headlight and taillight clusters were treated in isolation – separate from the design of the car body. As aesthetics became increasingly important in car design, these clusters are no longer add-ons, now they have to fit with higher tolerance into the styled shape of the car – an expensive but aesthetically pleasing development.

SOFTWARE TOOLS FOR DESIGN QUALITY

Traditional design and quality tools

Creative design and visualization tools (e.g., products such as Autodesk’s AliasStudio) help facilitate the styling of the products. As a result, designers can better project how their product will look when it is made. Such software also allows design teams to assess and analyze designs in the virtual world, flagging up potential problems at an early stage.

Moreover, 3D visualization is so realistic that designers and business teams can assess a design from a customer’s point of view, rather than in a schematic diagram. Simulation such as the refraction of headlamps and the realistic recreation of a product’s texture and material can be used to accurately assess how the product will appear in the real world.
Traditionally, these styling packages take little if any account of the work of design tools such as Dassault Systèmes CATIA and Siemens PLM Software’s NX – CAD packages which produce a model viable for manufacture. Styling tools, therefore, do not typically factor in the dimensions or the tolerances of the product. Such work is completed at a later stage.

Tolerance analysis software (e.g., Siemens VisVSA and Dimensional Control Systems Inc. 3DCS), help to identify potential manufacturing problems at the engineering stage. They calculate detailed tolerance stack-up to ensure assembly conditions are not violated, for instance, whether the holes in flat-pack furniture are correctly aligned. Their analysis is mainly numerical, meaning that the production of tangible models is usually necessary. Clay and rapid prototype models using stereo-lithography allow ‘sign-off’ of a design before the full product is built. These may also be used as a low-cost way to mock-up new designs at an early stage. Mock-ups can be so good that designers can perform tests on them to assess the product’s form, fit, and functionality as well as specific areas of quality.

In conventional design processes, designers design and build prototypes to nominal dimensions; assuming perfect manufacturing. To assess the inevitable variation caused by imperfect manufacturing, a series of test models are built. A typical sequence in the automotive industry involves:

- A number of clay models for signoff on design, both interior and exterior
- A 2-car design prototype run
- A subsequent 4-car prototype run
- A 20-car production run
- A final 200-car pre-production run

Even the 200-car production run, however, gives an insignificant idea of the variation that would be present in a realistic run of 100,000 units per year. Equally problematic is the relatively long time the models take to be produced, always about 6 weeks behind the current design. We will now have a look at the opportunity to change this model of operation.

“[Bentley Motors] are constantly seeking ways to improve the design processes required to achieve quality in manufacturing. However, the practicalities of getting everyone involved to agree the gap and flush conditions ahead of the Class A surfacing process meant there was a reluctance to commit to them early enough in the design process. This was resulting in agreements only being reached after tooling prove-out models had been milled and stacked, which was leading to loops in the Class A surfacing activity that were eating into the development timeline.”

Jim Shaw, Manager of Concept Engineering at Bentley Motors

Coping with imperfect manufacturing

Assuming a design has been verified to specification and it will deliver acceptable quality, what designers really find valuable is the ability to visualize the effects of the manufacturing variations on an entire batch of products, say 10,000 items. Traditional quality tools do not allow designers to do this. While most good designers believe they can second guess where potential problems may occur, problem-solving using conventional quality tools can be a hit-and-miss affair; since it is hard to understand the effects of variation in one part of the design may have on another part.

“Typically, variation analysis is performed at a much later stage in the design process and is often too late to influence the design.”

Dr. Elena Bergadano
Engineering Quality and Craftsmanship Manager, FIAT Group Automobiles S.p.A
Nonetheless, the ability to predict variation at an early stage allows designers to make any necessary changes to the design before prototype tooling is commissioned. As each set of tooling can cost between half a million and two million euros, limiting re-tooling (as a result of changes in design) can save significant time and money. Although precision tooling usually produces a high-quality product, the higher the tolerance on tooling, the higher the cost. Designers must, therefore, weigh the benefits of high tolerance and the quality it produces against the increase in cost. Conversely, if there is too lose a specification, there may be an excessively high scrap rate or late corrective action may be required on the production line. Both of these add inefficiency and cost to the business.

This can flag up issues at the most initial stages of the digital product design process avoiding expensive re-tooling after the first batch of models is produced. The use of these solutions, in 2D or in Virtual Reality, facilitates a significantly more streamlined design to production methodology to the one cited before. The new process involves:

- Clay models for design sign-off, as before
- A few design models – about half as many as usual
- A 200-car pre-production run
- Removing the need for the 20-car production run altogether

Where variation causes the design to be out of its quality specification, leading software solutions can help spot significant elements that contribute to the error. They identify the problem in minutes, rather than the days or weeks that traditional procedures may have taken. Moreover, in some solutions, simulation not only predicts variation, it also allows designers to see multiple data sets and various points in the design at the same time. This is crucial to the designers’ understanding the trends behind the variation and how variations in one part of the design affect other points in the design. By addressing these issues at the earliest possible instance,
companies can help to optimize downstream manufacturing and assembly costs.

“By using AESTHETICA, [FIAT] will be able to actually see the effect that manufacturing variation will have on perceived quality, exactly as the customer will see it. This will enable us to identify and resolve aesthetic problems at a much earlier stage than has ever been possible before. We will be able to work directly with the design teams to ensure we drive up perceived quality.”

Dr. Elena Bergadano
Engineering Quality and Craftsmanship Manager, FIAT Group Automobiles S.p.A

It may be, for instance, that all the pre-defined design tolerances are met, but the accurate visualization of the variation makes the product look poor quality, and the customers’ perception of the quality will be very low. Since the product aesthetics are the most immediate quality differentiator, it would be necessary to modify the design to fix the flaw, or the product will not sell. Similarly, there may be a situation where pre-set design tolerances are not met, but the product actually looks of high quality and satisfies all customer requirements. In this instance, it would make sense not to alter the design and save significant costs. Modern variation visualization packages hypothesize these situations, avoiding unnecessary time and expense improving a product that is already of optimum quality.

**WHAT NOW?**

Preliminary quality assessment is becoming a must-have in current design processes, with the integration of variation and visualization technologies enabling a more streamlined product development lifecycle. In this respect, consumer products companies may choose to follow the lead of the automotive industry in adopting technology that will shorten the lead time from concept to production. Moreover, to deliver a better return on investment, some manufacturers increasingly look to holistic rather than a piecemeal approach to design - taking the product as a whole rather than the sum of its parts.

Zero gaps in consumer product and sub-millimeter gap lines in the automotive industry are often seen as the essence of quality. The perceived standards of leading manufacturers are as much about the quality of the product as they are concerned with brand reputation. Brand reputation, of course, cannot be built overnight. Faith in a company is an intangible emotion, based on several factors including company heritage, country of origin and other things that are generally out of the control of product designers. It is interesting to note, however, that consistent production of high-quality products eventually seems to pay off in brand reputation, although this doesn’t necessarily map to an improvement in the perceived quality of the brand.

Within manufacture itself, appreciation of the perceivable notions of quality, as well as the more familiar measurable quality, is essential. New design software encourages this, amalgamating the work of the design and engineering teams under a shared vision of the product. Such technology redresses the conventional belief that product quality is the sole

*Immersive Virtual Reality review of Perceived Quality*
domain of the production and QA departments, while styling and the experiential value of the product are determined only by the design team. Quality, therefore, becomes a remit within which all departments must fall. With technology developing at such an astounding rate, we are witnessing a revolution in the way manufacturers design and engineer product; and early adopters of emerging quality technologies are already seeing significant benefit from its use. While the transition from numerical to 3D visual software has come within our lifetime we may well be privileged with the advent of further advanced technology, even haptic (touch) simulation for instance. Certainly, as manufacturers come to act upon their consumers’ perceived notions of quality, this possibility is already being evaluated and tested.

“Assessing quality issues early helps to minimize the risk of damage to the brand reputation.”

Phil Gray, Managing Director, Quadro Design Associates

“In several pilot projects over recent months it has been clearly demonstrated that AESTHETICA allows [Bentley Motors] to truly visualize the effects of all stake-holders proposals, not just for edge conditions but also for the underlying fixing constraints. Styling, engineering, quality and manufacturing people can therefore appreciate and understand each other’s requirements and reach agreement at a much earlier stage in the development process than was the case before.”

Jim Shaw, Manager of Concept Engineering at Bentley Motors

FOR MORE INFORMATION

ABOUT THE AUTHOR

John Maxfield
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After completing his Ph.D. in Distributed Virtual Environments in 1996 at the University of Leeds, John worked with SGI and as a Research Fellow for 6 years. He co-founded Icona Solutions in 2002, a company specializing in the delivery of Perceived Quality solutions based on his previous research work, where he led product development, support, and consultancy services for over 12 years.

Icona Solutions was acquired by OPTIS Group in October 2013 and John continued as Executive Director of the business, leading the integration and future development of Perceived Quality solutions and technology.

ABOUT OPTIS

OPTIS, the virtual prototyping company, brings life and emotion to all industrial projects. Its world-leading solutions pave the way for a revolutionary design process: towards zero physical prototypes. Since 1989, OPTIS offers its know-how in light and human vision simulation into leading CAD/CAM software and dedicated immersive virtual solutions. This synergy creates true-to-life virtual mock-ups which are used as real decision-making tools. Today, more than 2500 clients in over 50 countries already trust OPTIS and innovate day after day with its solutions to ensure the look and safety of their designs, reduce their ecological footprint and bring their future products faster on the market. For more information about OPTIS, please visit www.optis-world.com
ADDITONAL RESOURCES

The documentary

Last Call For Titan, a film by Jonathan Tavel and Frédéric Ramade
Directed by Frédéric Ramade
Production: Blanche Guichou / AGAT Films & Cie
Coproduction: OPTIS and NHK
With the participation of France 5
With the support of the CNC (Centre National de la Cinématographie) and Procirep/Angoa

See also: www.optis/titan.com

References


