Quality Perception beyond split lines - Learning from automotive practice

Product Development Symposium 2017
ROBUST DESIGN DAY

WEDNESDAY 8TH NOVEMBER, TECHNICAL UNIVERSITY OF DENMARK

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CONTENT

- Background
- Introduction to Perceived Quality
- Perceived Quality Attributes
- Voice Of the Customer
- Understanding Customer Preferences
- Systems Engineering Approach – Decomposition and Verification
- Research Project – Sound Quality
- Summary
Envisage Group are a bespoke engineering services company providing consultancy and full service supply.

Our Customers
Creative Design

Lead: Oliver Le Grice
Designer: Michael Mills
SHOW CARS
CUBING
04

BODY AND PANEL MANUFACTURE
Multi-Disciplined Team of:

Body
Structure
Closure
Interior
Seating
Vehicle Integration

Engineers

Concept Engineering Design
Product Engineering
Design Engineers
Test & Validation
PMST
FEA
COMPANY OVERVIEW

01 CREATIVE DESIGN

02 SHOW CARS

03 CUBING

04 BODY AND PANEL MANUFACTURE

05 BESPOKE VEHICLE BUILD

06 ENGINEERING

PERCEIVED QUALITY LAB
Perceived quality is one of the most important attributes affecting customers buying decisions when considering a new vehicle and continues to effect overall customer satisfaction during ownership.

Automotive manufacturers have made significant improvements in quality over the past 20 years, reducing the gap between traditional “Luxury” and mainstream OEM’s.

Identifying and delivering products that provide a competitive advantage in terms of perceived quality is more important than ever.

Design engineers and product leaders need clear specifications that enable vehicles to be optimised to meet customer requirements and reduce development time.
Perceived Quality can be defined as the customer’s perception of the overall quality or superiority of a product or service with respect to its intended purpose, relative to alternatives.

<table>
<thead>
<tr>
<th>Conformance to specification</th>
<th>Value of the Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitness for use</td>
<td>Support given to Product</td>
</tr>
<tr>
<td>Psychological Impression</td>
<td>Perceived Quality</td>
</tr>
</tbody>
</table>
INTRODUCTION TO PERCEIVED QUALITY

Quality vs. Familiarity

- Chrysler, Dodge, Jeep, GMC, Buick, Hyundai, Kia, Ram, Jaguar, Mazda, Kia, Ram, Jaguar, Mazda
- Cadillac, Lincoln, Nissan, Volkswagen, Toyota, Honda, Mercedes-Benz, Lexus, BMW, Audi, Acura, Porsche

Familiarity
- Fiat, Mitsubishi, Saab, Land Rover, MINI, Alfa Romeo, Scion, smart, Lotus

Perception of Quality
- PQS average

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INTRODUCTION TO PERCEIVED QUALITY

Owner vs. Non-Owner Quality Perception

Non-Owner PQS average

Only brands with 50 owners or more included
Perceived Quality is the perception of quality that customers acknowledge via their sensory interaction and emotional impact of a car.

Automotive companies use systematic techniques to enhance both the quality feel and the craftsmanship perceivable through the senses:

- **Design** – Internal and Exterior Styling and Execution;
- **Features** – Content, Tactility and Refinement of Operations;
- **Build Quality** – Care in Manufacture, Superior Fit + Finish;
- **Material** – Authenticity and Finish.
QUALITY ATTRIBUTES

Perceived Quality Attributes

Haptics
Firmness / Solidity
Gaps / Radii
Surface Integration
Kinematics
Sound
Ambient Lighting
Material Content

Classiﬁcation of Sound Event

Level
Duration Time
Spectral Contribution
Signal Information
Temporal Structure
Subjective Attitude
Spatial Distribution
Quantity

The foamed fabric on door panel creates the illusion that the medallion is a separate part (see section 14)

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Perceived quality – Nissan Navara

However, the cabin does leave me wanting. I couldn’t care less if a car has cheap, scratchy plastics in the footwell, but it irritates me that my elbow rests on the equivalent of a kitchen counter top.

Granted, there is an ‘armrest’ with some padding, but it’s sited too low for real-world use. I wish the top of the door card was more protruding and had a padded armrest. I also think the absence of rake and reach adjustment for the steering is rather stingy on a £29,000 vehicle. Overall, rivals like the Toyota Hilux and Volkswagen Amarok surpass the Navara in perceived quality, because they have those extra touches.

Make the cabin out of the hardest, scratchiest plastics you want. Just sort out the contact points.

Autocar May 2017 – Long term test review
Automotive companies and research institutes collect and analyse huge amounts of data from different quality sources e.g.

- Customer Clinics
- JD Powers [IQS, APEAL, VDS]
- Warranty
"Things gone wrong" are categorised into faults in assembly or design issues.

### 13. Things Gone Wrong

Please mark below ALL problems you have experienced with your NEW vehicle. Later in the survey you will rate things you like and dislike. Please focus on the original equipment on your vehicle (exclude items installed after purchase/lease).

<table>
<thead>
<tr>
<th>Exterior</th>
<th>Hard to Open</th>
<th>Hard to Close</th>
<th>Squeaks/Abnormal Noise</th>
<th>Handle/Latch Broken/Not Working</th>
<th>Handle/Latch Difficult to Operate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front doors</td>
<td>X10</td>
<td>X11</td>
<td>X12</td>
<td>X13</td>
<td>X14</td>
</tr>
<tr>
<td>Sliding doors</td>
<td>X15</td>
<td>X16</td>
<td>X17</td>
<td>X18</td>
<td>X19</td>
</tr>
<tr>
<td>Rear side doors</td>
<td>X20</td>
<td>X21</td>
<td>X22</td>
<td>X23</td>
<td>X24</td>
</tr>
<tr>
<td>Trunk/hatch/tailgate</td>
<td>X25</td>
<td>X26</td>
<td>X27</td>
<td>X28</td>
<td>X29</td>
</tr>
</tbody>
</table>

### 17. Vehicle Interior

- a. How well the exterior and interior colors are coordinated
- b. Attractiveness of instrument panel and dashboard
- c. Look and feel of steering wheel
- d. Ability to comfortably rest arms while driving
- e. Interior materials convey an impression of high quality
- f. How well interior colors/materials are coordinated
- g. Appearance/Illumination of gauges/controls
- h. Overall interior quietness
- i. Pleasantness of audible signals (e.g., chimes, turn signals)
- j. Usefulness of courtesy lights
- k. Attractiveness of interior lighting
- l. Smell of vehicle interior
- m. Overall rating of attractiveness of vehicle’s interior

2009 JD Powers IQS
Kano Model

A method by which you can characterise and illustrate customer needs in order to understand what drives customer satisfaction.

Assessments undertaken to understand what would be considered;
1. Customer Enhancement,
2. Performance Feature,
3. Basic Feature.

The Kano model offers some insight into the product attributes which are perceived to be important to customers. The purpose of the tool is to support product specification and discussion through better development of team understanding. Kano's model focuses on differentiating product features, as opposed to focusing initially on customer needs.
CUSTOMER PREFERENCES

Shaded Area identified as Genuine Leather (typical)
CUSTOMER PREFERENCES

How much would these materials improve quality perception?
## CUSTOMER PREFERENCES

### Which vehicle provides best armrest comfort?

<table>
<thead>
<tr>
<th>17. Vehicle Interior</th>
<th>Unacceptable</th>
<th>Average</th>
<th>Outstanding</th>
<th>Truly Exceptional</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. How well the exterior and interior colors are coordinated</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>b. Attractiveness of instrument panel and dashboard</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>c. Look and feel of steering wheel</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Ability to comfortably rest arms while driving</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>e. Interior materials convey an impression of high quality</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>f. How well interior colors/materials are coordinated</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Which vehicle provides best armrest comfort?
CUSTOMER PREFERENCES

Comfortable armrest Specification

- Surface material
- Foam thickness
- Foam density
- Substrate stiffness
- Radii
Challenges facing automotive engineering:

- Translating customer preferences
- Plotting loss curves
- Verification Methods during development

Translation of customer preferences into engineering parameters is possible
Systems Engineering Approach

Traditional Project delivery process

Design Research

Concept Development

Product Design and Validation

Pre-Production Manufacturing

Production

Systems Engineering Process

[<V Diagram>]

Timeline
Systems Engineering Approach

Traditional Project delivery process

Design Research  Concept Development  Product Design and Validation  Pre-Production Manufacturing  Production

- Feasibility Study / Concept Exploration
- Customer Requirements
- System Requirements
- System Validation Plan
- System Verification Plan
- High-Level Design
- Sub-system Verification Plan
- Detailed Design
- Component test plan
- Component verification
- Subsystem verification
- System validation & deployment
- System verification & deployment
- Implementaion

Systems Engineering Process [V Diagram]

Operations and Maintenance  Changes and Upgrades

Timeline
Systems Engineering Approach

Traditional Project delivery process

Design Research          Concept Development          Product Design and Validation          Pre-Production Manufacturing          Production

Product planning        Feasibility Study / Concept Exploration

Customer Requirements  System Validation Plan

System Verification Plan  Sub-system: System Verification Plan

High-Level Design Component test plan

Detailed Design Component verification

Integration and Recomposition

Timeline

Systems Engineering Process [V Diagram]

Haptics
Develop method for defining ideal “sound event” targets, decomposition, and verification of glovebox operational noise.
SenseLab is highly qualified in the field of doing listening tests, starting from setting up and analysing data from different standardised and custom-made listening tests through to development of perceptual models.
System decomposition

Inner substrate and finish

Outer substrate and finish

Release mechanism

Latch striker

Interior Volume

Sound deadening

Buffer design

Motion Control mechanism

Hinge Design

Latch design and material

Environment
RESEARCH PROJECT – SOUND QUALITY

➢ Detailed design review

➢ Alternative designs and materials characterised

➢ Documentation of technical specification – verification methods
SUMMARY

Challenges in achieving Product Perceived Quality:

Customer preferences not easily understood

Verification of design at the right time is critical

Verification Methods are not fully developed currently

THANKS FOR YOUR ATTENTION