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Biomass residential heating: semantic structure and implications for advertising

For a business, knowing current stakeholder product knowledge is essential to influencing behaviour. What do consumers think and feel about biomass residential heating? An assessment of consumers' semantic structure about a biomass residential heating product: pellet stove/furnace, reveals that consumers perceive the product as natural but laborious to maintain, and dirty/smelly. An exploratory analysis of the industry's marketing communications suggests that the industry is not addressing the 'ease-of-use' issue.

Keywords: marketing communications, pellet fuel, HVAC systems

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Introduction

"Smoke from (wood) burning is a major risk factor for respiratory infections and the fever that often accompanies them" (Smith, 2008, p.97). Chemically, biomass such as wood is mostly carbon, hydrogen and oxygen. In special combustion conditions (c.f. the pellet stove for residential heating[1]) it can be burned to non-toxic carbon dioxide and water. However, if combustion is incomplete, as it is in many household fire places and wood stoves, biomass releases much of its carbon as irrespirable particles and carbon monoxide (Naeher *et al*., 2007).

But what is it that the consumer is learning? It is now an established principle in consumer behaviour that information exposure energises the consumer's attitude which results in product purchases (see the buyer-response steps in Rossiter and Percy, 1997). However, since only 3 per cent of households in the United States use biomass for space heating (Athiyaman, 2014), it appears that only a small proportion of consumers view 'burning biomass' positively.

For a business, knowing current stakeholder product knowledge is essential to influencing behaviour; to reach a desired perception of stakeholders, a business manager should take into account stakeholders' existing product knowledge. What do consumers think and feel about biomass residential heating? What are the choice criteria for biomass heating-appliance purchase? What are the communication objectives of biomass residential heating equipment manufacturers? This paper addresses these and similar questions.

Theoretical framework

What is the consumer learning? From a systems view, marketing information is the input to consumer learning and purchase is the output. The learning process is concept formation, or concept utilisation (Hilgard, 1987).

Concept formation and utilisation

Assume that a person gets exposed to a new product such as the biomass pellet stove. Since humans learn by grouping and distinguishing (c.f. the contrast theory conceptualisation in 'categorisation' studies (Smith and Osherson, 1995)), the consumer has to group the product with something it resembles (for example, a space-heating device) and distinguish it from other things in the product class (for example, unlike fossil fuel furnaces, the biomass pellet stove is 'eco-friendly' or 'green'). In this way, consumers form a concept of a product class called 'biomass heaters'. Thus, concept formation is defined as the process of developing the criteria for identifying and evaluating a product. In contrast, concept utilisation occurs when the consumer has formed criteria – that is, the consumer is aware of the product class and has a positive, neutral or negative attitude towards it (Rossiter and Percy, 1997).

Analysis of consumer learning

Theory on mental representation differentiates between verbal representations (for example, human languages) and non-verbal, object representations (for example, maps and images) (Barsalou, 1999). In marketing, most work focuses on consumer semantic memory – verbal, categorical and conceptual knowledge consisting of abstract, context-free information and general facts about an object (Epstein, 1994; Tulving, 2002). For example, Keller (1993) posits that brand image consists of perceptions about attributes and benefits.

While semantic memory is explicit, behaviours that consumers acquire non-reflectively (for example, nostalgic feelings elicited by household fireplaces) are part of the implicit, episodic memory system (Paivio, 1986). The episodic memory system contains event-specific, personal experiences with the product. Figure 1 illustrates the explicit/implicit memory dichotomy using the product, 'biomass heaters' as an example.

The contents of customers' semantic and episodic memory could be used to create a favourable product attitude which then causes purchase behaviour. We make the leap from data to wise action in the future using relevant princi-

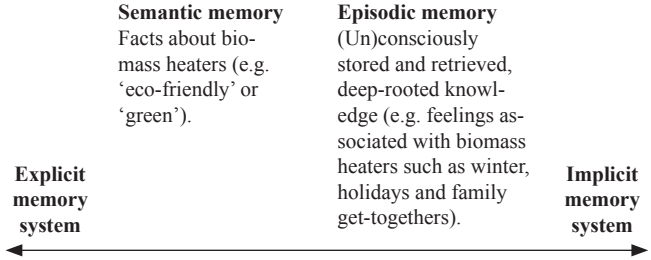

Figure 1: Consumer product knowledge representation: biomass heaters.

[1] http://www.pelletheat.org/assets/docs/fact.pdf

ples or rules from consumer behaviour put forward by theorists such as Ajzen (1988) and Fishbein and Ajzen (1975). To elaborate, attitude towards a concept could be defined as an overall evaluation of the concept (Athiyaman, 1997). Mathematically,

$$A_o = \sum_{i=1}^{n} b_i \times e_i \quad (1)$$

where A_o = the overall attitude toward the object *o*, b_i = belief about the attribute *i* in relation to the object (think of it as a fact stored in the consumer's semantic memory such as 'green' product), and e_i = the evaluative consequence of the belief (for example, having a less polluting residential heating system is good for environment).

Thus, for product (biomass heater) purchase to take place, the buyer's *need* should be *met by the specific benefits* that the product offers, for example cost efficiency, eco-friendly etc. Put simply, the buyer has a belief about where the brand is located on each criterion. These beliefs are weighted for desirability and then summed to yield a single estimate called 'attitude'. Consumers are likely to buy the product if their attitude is favourable. This is why large advertising agencies recommend clients to think of product positioning in statement form as follows:

> To the target audience _____ /
> _____ is the product of (need) /
> that offers benefits _____.

Methodology

Methods for retrieving consumer product knowledge differ for the memory systems. For semantic memory, it is the free association technique (Deese, 1965). For episodic memory, there are the projective tests (Barsalou, 1992). To assess consumer semantic structure for biomass residential heating, a sample of households in Macomb IL, USA were interviewed. Heads of households were the population of interest; or raters of the product, 'biomass residential heaters'. As word association studies require at least 30 respondents (Deese, 1965; Wells, 1993), we chose 37 specific addresses, with designation of a particular member of the family to be interviewed. Technically, this amounts to specifying the residential block and some rule for picking out certain households within it for the interviews (Deming, 2006). The heads of households were asked to answer the following question:

> "Please write down your thoughts (one per space provided) when you think of biomass residential heaters such as the one illustrated here".

As the question implies, a picture of a biomass heater was included on the survey sheet. The respondents were given the opportunity to write down the words that came to mind. As mentioned earlier, the focus was on retrieving 'conscious' product knowledge.

To assess consumers' 'deep-rooted' product knowledge we used an indirect approach. Specifically, two shopping lists for heating, ventilation and air conditioning (HVAC) systems were prepared. They were identical in all respects, except that one specified 'biomass heater' and another 'gas-fired heater'. They were administered to a new group of 69 subjects (all home owners/renters residing in Macomb IL), with no subject knowing of the existence of the other list. The instructions were as follows and the two shopping lists are shown in Table 1:

> "Read the home improvement shopping lists below. Try to project yourself into the situation as far as possible until you can more or less characterise the homeowner who bought the heating, ventilation and air conditioning (HVAC) system. Then write a brief description of the homeowner's personality and character. Where ever possible indicate what factors influenced your judgment".

Table 1: Shopping lists included in the survey designed to assess consumers' 'deep-rooted' product knowledge.

Shopping list 1	Shopping list 2
1. Biomass central furnace: burns biomass such as sawdust, wood chips, bark, agricultural crop waste, waste paper, and other organic materials. Heats air and distributes it throughout the house using ducts; 2. Programmable thermostat; and 3. New ductwork.	1. New gas-fired, energy-star rated, central furnace: heats air and distributes it throughout the house using ducts; 2. Programmable thermostat; and 3. New ductwork.

Finally, to understand the product's positioning, we content analysed biomass residential heating industry advertisements. These advertisements were from the residential heating industry companies highlighted by Consumer Reports (2015). The content analysis measure was the frequency of mention of words such as 'cost' and 'quality' in the advertisements. The author performed the role of 'clinician'; observing and then inferring to reach a diagnosis about product positioning in the marketplace.

Results

Consumer semantic structure

The 37 respondents produced a total of 280 words as response to the stimulus *biomass heater* (Table 2). These words can be sorted into four groups: (a) nominal words of the same type, (b) nominal words of a different type, (c) attributive words, and (d) other words. *Nominal words of the same type* include: energy, fire, hot, smoke, stove and warm. These can be intuitively arranged in a superordinate-subordinate hierarchy or tree which shows how consumers conceptualise biomass heaters (Figure 2). *Nominal words of a different type* include words such as: Amish, conversation, eggnog, marsh-mellows, time with family, winter and Christmas. These words tend to represent the context surrounding biomass heating. *Attribute words* both identify and evaluate a product. In general, the respondents perceive the product as natural, and visually appealing (nice to look at) – all positive evaluations. The negatives include: dirty, smelly, fire hazard, splinters, and the laborious acts of cutting wood

Table 2: Word association task: summary findings.

Knowledge aspect	Frequency
Functional benefits (benefits of use such as non-polluting, high efficiency etc.)	35
Facts about the product	50
Sample size	37
Elements per informant - high	10
Experiential benefits (e.g. sensory pleasure such as "wood-burning smells good" etc.)	21
Usage imagery	24
Total knowledge elements uncovered	280
Elements per informant – low	3

Table 3: Word association frequencies.

	Green	Efficient	Laborious	Smelly/dirty	Hazardous	Nostalgic
Green	–	8	7	0	2	5
Efficient	8	–	12	8	3	6
Laborious	5	12	–	8	6	9
Smelly/dirty	4	3	15	–	5	13
Hazardous	1	0	3	8	–	4
Nostalgic	9	8	8	15	0	–

Table 4: Examples of survey respondents' perceptions of biomass furnace and gas furnace purchasers.

Biomass furnace purchaser	Gas furnace purchaser
1. A wealthy, eco-conscious individual who has the financial resources needed to purchase and install a biomass furnace. A vegan hipster doing what is right for the earth; 2. A person who farms in rural America.	1. An individual more concerned about faster heating than the environment; 2. A city or suburban dweller; is not living in the middle of nowhere. Does not care about the environment; probably a member of the Republican Party.

Table 5: Advertising attributes: frequency.

Attribute	Frequency	Attribute	Frequency
Price	10	Availability	7
Quality	14	Special offers	10
Performance	19	Warranties	4
Components	20	Safety	6

and cleaning out the ash. Note that these are the choice criteria for the product. *Other words* are echh, good, hate and old. They are general evaluative terms that do not identify specific attributes.

Table 3 shows the frequently occurring words across all respondents. The most commonly evoked words are laborious and smelly/dirty. If we assume that the association frequency represents proximity measures, then we can use multidimensional scaling to represent the concepts in a semantic map. The meaningful directions in the space correspond to 'emotion' and 'cost/work efficiency' (Figure 3).

Projective tests

Thirty-three per cent of the respondents to the shopping lists described the homeowner who bought the biomass furnace as 'green'; 18 per cent described the homeowner who bought gas-fired furnace as 'green'. Seventeen percent of the respondents described the homeowner who bought

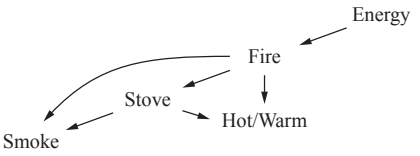

Figure 2: Superordinate-subordinate hierarchy of nominal words of the same type.

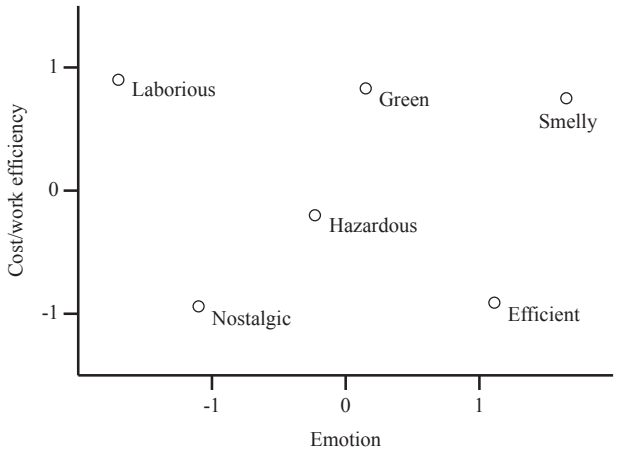

Figure 3: Representations of biomass residential heater in consumer memory.

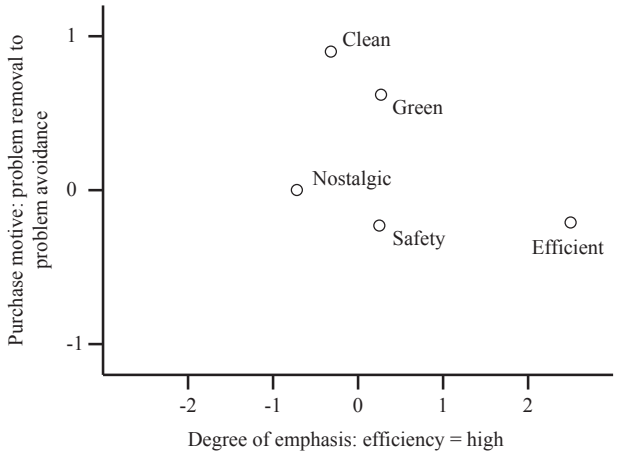

Figure 4: Industry advertising: word associations.

the biomass furnace as 'wealthy'; 9 per cent described the gas furnace purchaser this way. Less than 6 per cent of the respondents thought of the biomass furnace purchaser as 'technologically savvy'; the equivalent figure for the gas furnace purchaser is 19 per cent. One in ten respondents perceive the biomass furnace purchaser as a rural inhabitant and the gas furnace purchaser as an urbanite. Some examples of the responses are given in Table 4.

Positioning

To understand the product's positioning, we content analysed biomass residential heating industry advertisements. The results suggest that the mean number of cues in advertising is two, and these relate to product components, performance and product quality; price and special offers are also prominent cues (Table 5). When plotted on a two-dimensional map (Figure 4), the proximity analysis of advertising

cues reveals that the efficiency aspects of the product are highly emphasised compared to emotional attributes (the x axis). The y axis focuses on purchase motivations: safety and efficiency are related to problem removal (to avoid high fuel oil prices, one needs biomass heating), and green and clean are related to problem avoidance (to preserve the ecosystem one needs to use renewable fuels for residential heating).

Discussion

To categorise an object is to think of it as an instance of a category. Our research shows that the stimulus *biomass heater* is categorised as a subordinate category to the energy/fire concepts. Furthermore, this categorisation has generated inductive inferences about the product such as "using biomass heaters is laborious since one needs to clean out the ash" and "it is dirty and smelly". Positive effects related to the product include 'happiness' that is related to family get-togethers and holidays.

What do consumers think and feel about biomass residential heating? In general, consumers perceive the product as natural and visually appealing (nice to look at) – all positive evaluations. The negatives include: dirty, smelly, fire hazard, splinters, and the laborious acts of cutting wood and cleaning out the ash.

What are the product purchase criteria? Analysis of consumer knowledge about the product reveals that other than beliefs associated with the product (semantic structure), there are also free-standing emotions (episodic memory) associated with it that stimulate product purchase. Technically, creation and maintenance of positive attitude through advertising could be achieved by highlighting the efficiency aspects of the product (that it is cost efficient and it requires little or no effort in day-to-day maintenance) along with visual imagery such as family get-togethers that evoke positive emotions.

Do biomass residential heating advertisements address consumer choice criteria? Industry's communication objectives do focus on brand attitude related benefits such as 'clean', 'green' and 'safe'. However, the industry advertisements do not emphasise the 'ease of use' of the product which, as mentioned earlier (Figure 3), is a major concern for the consumers.

How could the biomass heating industry benefit from this research? This research provides customer insights; a mini-theory of marketing action that can be used to position the industry. In today's marketplace, it is difficult for biomass residential heating companies to differentiate on the 'green' theme alone. Present advertisements do not emphasise the 'ease of use' of the product and the industry should fill this gap in positioning to improve consumer attitude towards biomass heaters.

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