Technological frames of car engines

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A B S T R A C T

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In this paper we analyze how car users frame car engines. Car engines have been build on internal combustion (IC) technologies for more than hundred years now; however, in the last decade hybrid-electric engines have been successfully introduced. The coexistence of conventional and unconventional technologies raises the interesting question to what extent these different engine technologies are framed differently, and how they change over time. Studies of technological frames and mental models suggest that frames of established technologies are more obdurate.

In this paper we analyze technological frames of a few types of car engines and how frames have shifted during market evolution between 1990 and 2005. We find that engines are framed rather differently. Frames of conventional diesel engines emphasize *engine capacity* (measured in kW), engine *volume* (measured in liters) and *torque* (measured in Nm), whereas for hybrids *fuel efficiency* is by far the most prominent attribute. Further we find that the frame of the conventional engine (diesel) is more stable than that of an unconventional engine (hybrid and full-electric), which confirms the obduracy hypothesis that is raised in earlier studies of technological frames.

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1. Introduction

In the last decade attention for cleaner cars has steadily grown and this has coincided with a period of high oil prices and growing climate change concerns. Most conventional internal combustion car engines (ICEs) have improved in energy efficiency and emissions. Moreover, a market niche of hybrid-electric vehicles has emerged after 2000. Hybrid-electric vehicles (HEVs) have been sold more than 1.5 million times now worldwide. In the last three years battery-electric vehicles ('pure' electrics) are also under renewed attention.

From a socio-technical perspective products are socially constructed [1] and markets are socially embedded [2]. Producers' and consumers' mental models or *frames* are mutually dependent and shaped during market evolution

[3]. In this paper we take a socio-cognitive view of the market for car engines and analyze technological frames of car consumers with two questions: how do consumers frame different types of cleaner engines (diesel, hybrid-electric, battery-electric), and how have frames shifted during market evolution between 1990 and 2005?

Bijker [1] regards technological frames as *structuring interactions among social relevant groups*. Individuals will have a certain degree of inclusion in the frame, where high inclusion means that an actor acts, interacts, and thinks to a great degree in terms of that frame. Whereas in the early development stages of a technology a frame is typically still malleable and exposes interpretative flexibility, later on it will reach a point of 'closure' and becomes obdurate. *The relevant social groups have, in building up the technological frame, invested so much in the artifact that its meaning has become quite fixed – it cannot be changed easily, and it forms part of a hardened network of practices, theories and social institutions* ([1] p. 282).

In our paper the *frame* of car users is the way in which the innovation is described or interpreted by car consumers,

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more like a mental model [4]. We understand the framing metaphor as a window or spectacles (worn by the actor group) that filters the total amount of information in a first impression (what it is about and what it important for them), and focuses attention on key elements and aspects within. More precisely, it is the structure of (relevant) beliefs, knowledge, perceptions and appreciation which underlie consumer attitudes. Although frame analysis has a long history in political sciences [5,6] and communication sciences [7,8], currently no fully fledged, standard methodology exists to analyze frames [9].

In this paper we analyze technological frames through a discourse analysis of stories. Consumers use *stories* to understand new products, to determine their value to them [10]. Through interpersonal communication or media reports people spread marketplace information, and this affects evaluations and choices [11]. Stories *carry* the way market actors frame and appraise innovations. As such, stories are important to understand the evolution and success of product markets [12]. From a cognitive science perspective, market stories help to generate the 'knowledge structures' that enable market actors to reconcile current experiences and behaviors with pre-existing beliefs. By doing so, stories shape future consumer behavior (ibid., p. 199).

Although several studies have analyzed consumer perspectives on automobiles in general [13,14], hardly any examined perceptions of car *engines* specifically. Most notably is one study reporting that a majority of HEV owners saw their vehicle projecting images that were linked to larger values as social awareness, responsibility and concern for others [15], and another study finding that 31 percent of HEV buyers said they purchased an HEV because the vehicle 'makes a statement about me' [16]. Steg et al. [14] find that for car buyers symbolic value plays a significant role next to functional characteristics, but the question how people frame their vehicles' propulsion technology remains unresolved. Another study analyzed the relative importance of fuel economy, next to other consumer car preferences [17]. The author argues that the oil price shocks of the 1970s seem to have marked the early 1980s preference structure with its emphasis on fuel economy, whereas five years later, fuel economy was of least important to consumers, whereas price and reliability had become the prime concern.

Business consultants from Maritz-research [18] studied (stated) changes of consumer habits due to rising fuel prices (in France, Germany and the UK, in 2006, with responses of 1240 new vehicle owners). On the statement 'I think about buying, or have bought, a vehicle with a more economical engine', 57% agrees mildly or strongly, while only 23% disagrees mildly or strongly. Based on these figures they conclude that a major share of European drivers is changing their car purchase considerations, due to rising fuel prices. How familiar are people with new propulsion systems? In the same research Maritz found 20% is very familiar with hybrid-electric petrol engines, 34% somewhat familiar, 39% has heard of the technology, and 8% is not at all familiar. Full electric vehicles are somewhat less well-known: 9% very familiar, 35% somewhat familiar, 48% has heard of the technology, and 8% is not at all

familiar. Of all new/alternative engine technologies, hybrids are most familiar.

Although insightful, these studies have not clarified how consumers multifariously frame different types of engines (diesel, hybrid-electric, full-electric), and how those frames have shifted after 1990. This is where we focus on in this paper. Additionally, we contribute to the literature of technological frames with mostly qualitative approaches, by offering a quantitative approach.

Section 2 describes how we analyze frames from stories: a method for discourse analysis. In Section 3 we present the results of our analysis on car engine market stories from national newspapers in the Netherlands. Section 4 discusses patterns in the data whereas Section 5 answers our central question and draws conclusions.

2. Method for discourse analysis

Frames become manifest in stories. As noted, currently no coherent methodology exists for frame analysis. Rather, frame analyses are a number of related, even though sometimes partially incompatible methods for the analysis of discourses [19]. Since car engines are objects, we acknowledge that *attribute framing* is a useful method for analyzing frames in this chapter. This method tracks the accentuation of some characteristics of objects, and the neglect of others. Accordingly, it highlights the (conscious or unconscious) bias of information procession in terms of focal attributes.

Rosa and Spanjol [12] discuss ways to analyze market narratives or stories. Although they do not explicitly link the concept of stories with frames, they do provide a number of applicable aspects of these stories told by market actors. Main aspects they touch upon are:

- complexity of the story – this is the number of attributes that (market) actors use to describe competing product models.
- ordinality in the story – this is the extent to which market actors use 'ordered categories' (where a category is ordered when it can be presented on a rated scale, more or less precise).
- Subjective-evaluative centrality of the story – this is the proportion of attributes that is subjectively evaluated (in contrast to valence-neutral observations).

Whereas *complexity* is driven partly by the product's technical features, *ordinality* and *precision* are variable properties of cognitive object attributes in (shared) knowledge structures of market actors [20]. Market actors are defined as:

…*buyers, sellers, and others who interact in market arenas* ([12], p. 199). Narratives of market actors are not restricted to consumers' word of mouth, *but include stories 'circulated by producers and cultural intermediaries such as the media and advertisers'. This suggests that in any product market, market actors can include consumers, producers, retailers and intermediaries, media, government agencies, and other organizations. Moreover, stories that actors tell in social settings are not independent but rather interdependent (Weick 1995). Market actors tell stories to one another,*