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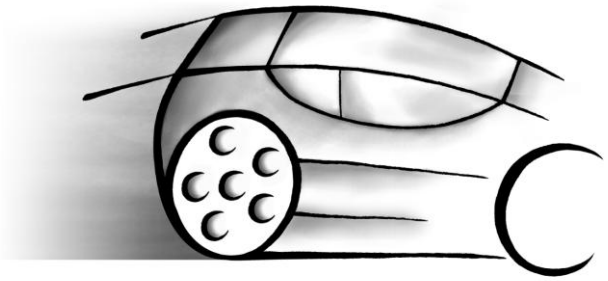

CAMA-Studie zur Automobilindustrie

Coming out of the crisis in the auto industry: Ambidextrous management of the transition to electric mobility

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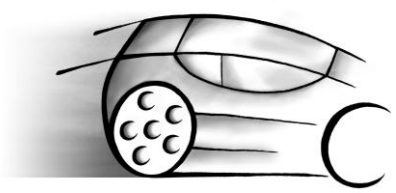

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Coming out of the crisis in the auto industry: Ambidextrous management of the transition to electric mobility

The transition to electric mobility is an essential option for growth and thus for overcoming the crisis in the automotive industry. Since existing business models for vehicles with combustion engines will have to be optimized for at least the next 20 to 30 years alongside the development of fundamentally new business models, the specific challenge in the transition to electric mobility lies in the fact that it constitutes a discontinuous radical transformation of a previously unknown long term nature. To handle this,

simultaneous ambidextrous management of conflicting aspects of organizational decision-making and action is required over a long period of time. It is shown that ambidexterity creates benefits, but also leads to costs. As a first step in long term research, nine hypotheses are theoretically deduced. They show approaches to reducing integration costs caused by ambidexterity before and after the tipping point to electric mobility. The hypotheses were discussed with 15 German and American automotive manufacturers and suppliers at their parent companies and foreign subsidiaries in the autumn of 2008 and the spring of 2009. All respondents realize the necessity of addressing (ambidextrous) management of the transition to electric mobility, since they see a need to take decisions soon in order to overcome the present crisis, as well as in view of the long lead times in the automotive industry.

1. Introduction

Today, 18 months after the outbreak of the current financial and economic crisis, it is difficult to suggest how the traditional automotive companies (both automobile manufacturers and suppliers) could overcome the present sales crisis – not even the scale and duration of the crisis can be measured precisely. A massive decline in sales is expected in many European countries after the scrappage bonus schemes are phased out. The trend outside European markets cannot be forecasted exactly either. Even a second wave of insolvency among automotive companies cannot be ruled out for 2010.

However, it is true to say that traditional automotive companies have two essential options for growth and thus for overcoming the crisis:

1. through a yet stronger, locally adapted and therefore more systematic commitment to the growing markets of the BRIC countries Brazil, Russia, India and China and
2. through the transition to electric mobility.

This article focuses on the second growth option: overcoming the automotive crisis through the transition to electric mobility.

Since existing business models for vehicles with combustion engines will have to be optimized for at least the next 20 to 30 years alongside the development of fundamentally new business models, the specific challenge in the transition to electric mobility lies in the fact that it constitutes a discontinuous radical transformation of a previously unknown long term nature.

The transition from traditional powertrain technologies into electric mobility is *radical* because totally new vehicles will come from radical innovations, rather than the previous minor incremental innovations such as ABS or the airbag.

The transition to electric mobility is *discontinuous* because it is a one-time disruption of an entire industry which will change the automotive companies' business models (manufacturers, suppliers and automotive service providers). Unlike, for example, the dynamic pharmaceuticals or computer industries – in which frequent, strong changes (revolutionary periods of resource renewal) constantly alternate with evolutionary periods of resource exploitation (Vermeulen, Barkema 2001; Burgelmann 2002), always producing radical product innovations and demanding product innovation strategies in the process (cf. the classification of business unit strategies e.g. in Proff, Proff 2008, pp. 26-27) to which these industries have adapted their business models, the breakthrough of electric mobility means a unique, major disruption in the automotive industry which will also change its business models. Companies are no longer operating in the largely stable environment of the traditional automotive industry with rare and weak changes, but are finding themselves in a transition to a dynamic environment with the frequent, strong changes of the electronics industry (for measurement of the environmental dynamics cf. e.g. Basil, Cook 1974; Sanchez 1997 or Proff 2002). They therefore have to transform themselves from traditional cost leaders, differentiators or cost-minimizing differentiators with hybrid strategies – with incremental innovations at best - into (radical) product innovators, and change their entire value chain through totally new vehicle concepts.

The transition to electric mobility will take several decades and is clearly distinguished by this *previously unknown long-term characteristic* from the well-known type of discontinuous change which took place, e.g., in the move from Super-8 film to video technology and which is described as punctuating abrupt change to a new technology because it happened within a very short time ("punctuated equilibrium", Gersick 1991, as well as Vermeulen, Barkema 2001; Burgelmann 2002 and Siggelkow, Levinthal 2003). Here, long convergence periods (first Super-8 and then video technology) were interrupted by a brief period of discontinuous change (cf. Tushman, Romanelli 1985).

To handle this long-term discontinuous radical change, *simultaneous ambidextrous management* of conflicting aspects of organizational decision-making and action is required over a long period of time. According to the definitions of Duncan (1976) or Tushman, O´Reilly (1996), such ambidextrous management must accomplish the following simultaneously:

- exploit available resources (to optimize traditional powertrains) to tap their full value, which requires a strong efficiency orientation, and
- develop (explore) new resources (in electric mobility) by being adaptable to environmental changes, the prerequisite for which is a very high flexibility orientation,

that is, handle the coexistence of "diverging logics" (Konlechner, Güttel 200, p. 45) or "competing frames" (Gilbert 2006, p. 150) between which goal conflicts exist (cf. e.g. Proff 2002 and 2006).

Ambidextrous strategies facilitate a comprehensive, balanced development of competencies, since they use the spectrum of organizational development and learning modes to the full. However, the divergent

logics also lead to operating costs of a kind often examined in strategic questions (cf. e.g. Proff, Haberle 2008, p. 461). As defined by Milgrom, Roberts (1990, 1992), it can be shown that simultaneous or ambidextrous management of conflicting activity patterns leads to integration costs (cf. e.g. Lawrence, Lorsch 1967, p. 95-96, 137) which should be avoided – wherever possible, because they lead to frictions and deviations from profit-maximizing organizational performance. In ambidexterity research, such integration costs are viewed as the result of tensions ("challenging tensions", Andriopoulos, Lewis 2009, p. 696) which arise, e.g., when structurally separate paradoxes are controlled at the superordinate level in order to consolidate information asymmetries within the company and make them useful (Lubatkin et al. 2006). However, integration costs are rarely explicitly mentioned. Exceptions include, e.g., Gibson, Birkinshaw (2004, 213), who talk of "costs of implementing the systems and processes to achieve ambidexterity".

This article therefore poses the question of how automotive companies can achieve the transition to electric mobility and by doing so overcome the present crisis. In this regard, approaches to an explanation of radical change are presented in Section 2. First, explanations of continuous radical change through cyclical development of competencies are given (Section 2.1) in order to distinguish from them explanations of discontinuous radical change through a technology leap in which entirely new competencies are built (Section 2.2). Since they do not take place in a punctuating manner, specifically where the transition periods are long, but require ambidextrous management, the concept of ambidexterity is presented briefly in Section 2.3. It is shown that ambidexterity creates benefits, but also leads to costs, which are discussed in Section 3, in order to build on this in Section 4 by examining initial approaches to reduce the integration costs of ambidexterity in the transition to electric mobility (to overcome the crisis in the

traditional automotive industry). Section 5 provides initial indications to the validation of the importance of these approaches to the automotive industry.

2. Approaches to explain radical change

2.1 Explanations of continuous radical change through cyclical development of competencies

According to the dynamic explanations of competence development (cf. e.g. Volberda, Baden-Fuller 1998 and Proff 2007) in the context of strategic competence management, current competencies have to be improved and new competencies built up alternatively under continuous change (Sanchez et al. 1996; Volberda et al. 2001). In this dynamic explanation of competencies within the framework of a competence-based view of strategic management, improvement and renewal of competencies alternate in the course of time (idea of "cycling", cf. also Volberda et al. 2001 and Proff, Proff 2008). The frequency and amplitudes of the cycling are much stronger in highly dynamic industries that cope with multiple and intense environmental changes through constantly radical innovations, such as the pharmaceutical industry or biotechnology (cf. Sanchez 1997), than in mostly stable industries like the traditional automotive industry, coping with rare and weak changes through incremental innovations. That means that in dynamic industries with radical change, competence renewal (cr) exceeds competence improvement (ci) (cr > ci), while in largely stable industries competence improvement prevails (ci > cr, cf. figure 1 a).

2.2 Explanations of discontinuous radical change through a technology leap where totally new competencies are built

During a discontinuous economic and technological change in traditional industries – for instance during the transition from the traditional Super-8 technology (which was not very high tech) to the new (high tech) video technology - existing companies generally lack the competencies required for the new technology. A pure renewal of competence is to be sought after instead of cycling. However, due to path dependencies in the development of technological competencies, this lack of competence most often cannot be regained without a technology leap (so-called "leapfrogging", cf. e.g. Brezis et al. 1991, figure 1b).

A firm has to absorb external knowledge to manage leapfrogging. That requires a high external absorptive capacity (Cohen, Levinthal 1990). Information about environmental changes has to be assimilated

and implemented. Assimilation and implementation are dependent on the state of knowledge, the skills of the employees and their own activities in R&D (cf. ibid.). It is expected that the capability of absorbability of external developments increases cumulatively with the available knowledge (cf. Pavitt 1985, p. 6) and that a high level of knowledge intensifies the absorptive capacity. It increases with the skills of the employees and with in-house research and development because the capability to implement external technological knowledge is then significantly higher than when technological developments are only monitored (cf. Bernstein, Nadiri 1989, p. 251).

There are two starting-points for leapfrogging:

1. Acquisition of external knowledge (McEvily et al 2004) through new employees having the required know-how or by headhunting competitors' or suppliers' employees or through acquisition of firms which have the new know-how. As competencies are normally bound to complex routines and are therefore to be found in teams, the acquisition of firms is the faster, but more risky way to catch up on a technological lag. The acquisition of a firm does not assure successful implementation of know-how. Empirical research has shown that up to three quarters of all acquisitions are unsuccessful (cf. Luchs, Meckl 2002, p. 10). According to Ahujy, Katila (2001) the acquired company should be complementary and feature a medium "technological strangeness", since internal absorbability will then be the highest (cf. Cohen, Levinthal 1990). Furthermore, the managers of this company should be involved in the organization of new competencies.

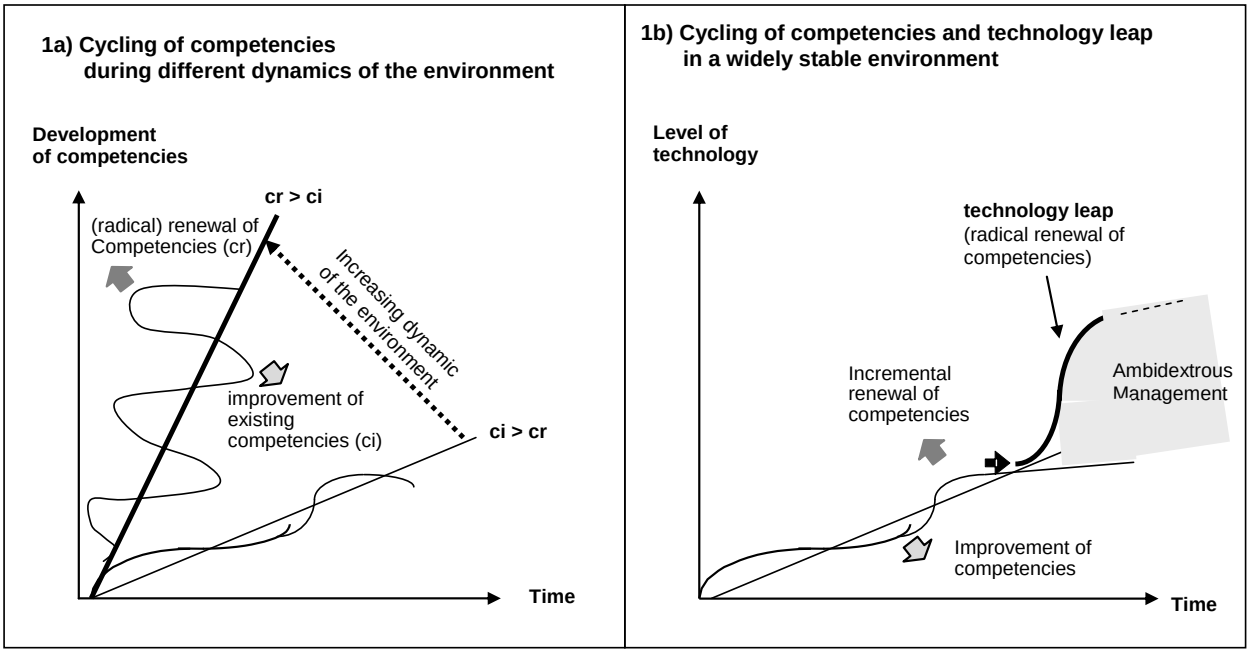
2. Cooperation in the case of absence of knowledge. Instead of acquisition, a technological gap could also be overcome by cooperation with a technologically superior company. This attempt can close the competence gap without building up competencies in house. However, this requires intensive contacts and trust-based cooperation.

All the traditional automotive companies have now realized that they cannot develop the new technology from their previous business, but have to get ready for a technology leap. The German manufacturers VW, BMW and Daimler, for example, are therefore not only seeking to recruit more electrical engineers, but also looking for new alliances. Daimler is working, for example, with energy supplier Evonik to produce lithium ion batteries to the point of scale manufacture, BMW with Vattenfall and VW with e.on. VW has also allied itself with the Chinese battery and automotive manufacturer BYD: in 2011,

VW aims to launch a test fleet of 500 electricity-powered Golfs, in 2012 a hybrid version of the Jetta for the US market is to be introduced and from 2013 onwards the E-UP is planned to go into scale production. And Daimler is hoping for access to competencies in building small cars from its latest cooperation with Renault/Nissan, because although electric vehicles have to be designed completely from scratch, they will tend to be smaller, so that small car know-how will be decisive.

Because, however, the existing (internal combustion) technology will still be in use for a long time to come, the technology leap into the new (electric) technology will by no means come soon. That is why ambidextrous management of the improvement of the existing and development of the new technology by leapfrogging is required (see also figure 1b). However, this challenge has hardly been on the agenda so far in the automotive industry – although making the transition to the new technology and thereby overcoming the present crisis and surviving depends on it.

Fig. 1: Continuous and discontinuous radical change



2.3 Ambidextrous management in a situation of discontinuous radical change with long transitional periods

Ambidexterity as the simultaneous exploitation and improvement of existing competencies and the development of new ones (e.g. Tushman, O'Reilly 1996) demands a strong orientation to efficiency and a very challenging orientation to flexibility at the same time. Therefore, "diverging logics" (Konlechner, Güttel 2009, p. 45) or "competing frameworks" (Gilbert 2006, p. 150) exist, the conflict between which was formerly considered to be insuperable. More recent research, however, describes ambidextrous organizations which are capable of exploiting existing resources and creating new ones at the same time (cf. Raisch et al. 2009). This article follows the prevailing opinion in ambidexterity research (Simsek et al. 2009) that resource improvement and renewal as defined by March (1991) are opposing points on a continuum which make conflicting demands on a firm. As a result, there are unavoidable goal conflicts between them which can be managed by ambidexterity, aiming simultaneously for a high level of both resource improvement and resource renewal. It follows from this understanding of ambidexterity that it is seen here as (1) *simultaneous* ambidextrous management of (2) *conflicting aspects* of organizational decision making and action (cf. also Proff, Haberle 2010).

Ambidexterity research has multidisciplinary roots, and so far there has been no common understanding of the concept of "ambidexterity" (cf. e.g. Simsek 2009). It engages theoretically with strategy, organization and innovation research and empirically with innovation, learning and development processes. A comprehensive overview of the literature is to be found e.g. in Raisch, Birkinshaw (2008), O´Reilly, Tushman (2008), Simsek (2009), Simsek et al. (2009), Raisch et al. (2009) and Andriopoulos, Lewis (2009, 2010).

Ambidexterity is a phenomenon in situations with a need for transformation that is significant primarily in dynamic environments with frequent, strong change (cf. e.g. Simsek 2009, p. 617). Where existing and new business models are managed (Tushman, O`Reilly 1996) in the transition to new core technologies (Taylor, Helfat 2009), the confrontation with conflicting logics is particularly clear. Above all during this transformation phase, multiple logics and strategic conflicts have to be properly managed, communicated and embedded structurally throughout the organization by top management (Smith, Tushman 2005; Taylor, Helfat 2007).

One approach to simultaneous resource improvement and renewal lies in the organizational separation of explorative and exploitative activities (O`Reilly, Tushman 2004). As a consequence of this structural

differentiation (Tushman, O`Reilly 1996; Gilbert 2006) or "structural ambidexterity" (Gibson, Birkinshaw 2004), individuals can concentrate on one learning and development mode within their organizational units – whether business or functional. (Structural) conflicts arise between the organizational decision-making units which have to be managed on the superordinate level and information asymmetries which have to be brought together and made useful (Lubatkin et al. 2006). "Contextual ambidexterity" has to be distinguished from structural ambidexterity. It describes the behavior of individuals in individually splitting their time resources between exploitative and explorative activities simultaneously (Gibson, Birkinshaw 2004). Successive pursuit of resource improvement and renewal, whether within an organizational unit or across such units, which also forms the basis of (cyclical and reciprocal) types of ambidexterity according to a new typology by Simsek et al. (2009), corresponds to the continuous radical change in dynamic industries such as pharmaceuticals (cf. Section 2.1), but is not considered.

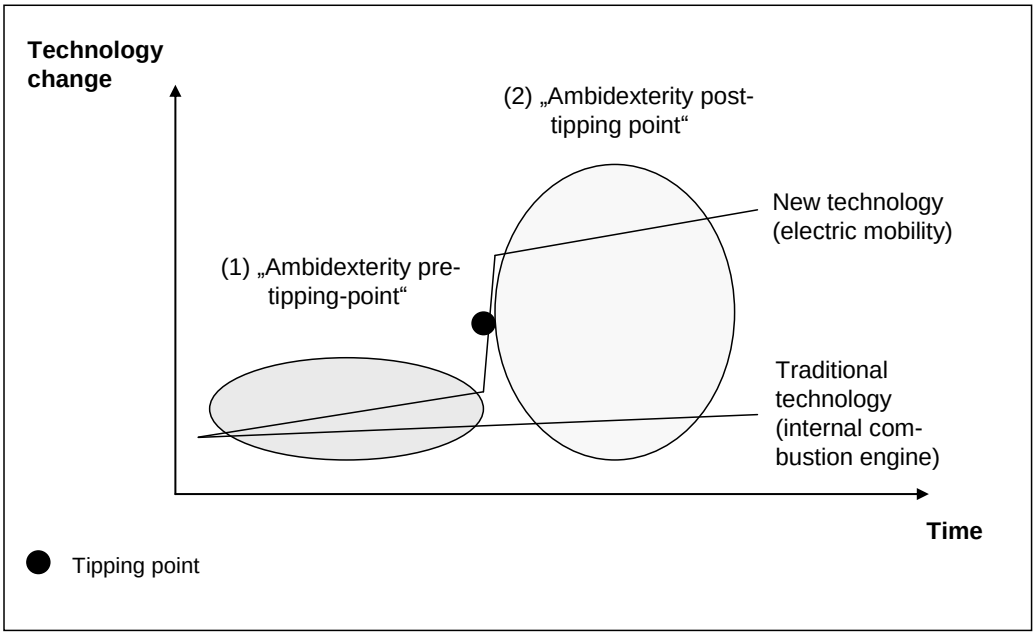
Ambidexterity in long-term radical discontinuous change takes place around a tipping point which helps the new technology to make a breakthrough because at that point, for example, research and development budgets are redirected towards this technology. The tipping point to electric mobility is currently seen at a market share for the new (electric) technology of around 5%, which is likely to be achieved in around 10 to 15 years' time. In view of the long development and model cycles in the automotive industry, that time is not far away. From this point onwards at the latest, for reasons of contextual ambidexterity, a much stronger shift of the production of traditional (internal combustion) technology to emerging markets would have to begin; the old technology will still be in demand in these markets among wide sections of the population with low purchasing power. Companies which have missed out on electric mobility by this time will disappear entirely from the markets (of the industrialized countries).

In the case of a long-term, radical discontinuous change, ambidexterity is important above all in the industrialized countries and here, in particular, in the parent companies up to the tipping point to the new technology (cf. Fig. 2 for this "*ambidexterity pre-tipping point"*). In this process, the old technology is further optimized and the new technology driven forward at the same time. New business models are also developed.

After the tipping point, an at least equally major ambidexterity problem is indicated in the management of the international corporate group as a whole ("*ambidexterity post-tipping point*", also cf. Fig. 2). This is because, when the R&D budget is redirected to the new technology in the industrialized countries at the tipping point but the products with the new technology still have a market share significantly below 5%, the 95% of products with traditional technology still have to be produced somewhere. Their

production will then probably be shifted to selected subsidiaries in emerging markets so as to be able through a low cost base to cushion the price reductions expected by customers for an "old" technology (Proff 2010).

Fig. 2: Ambidexterity in a situation of long-term technology change

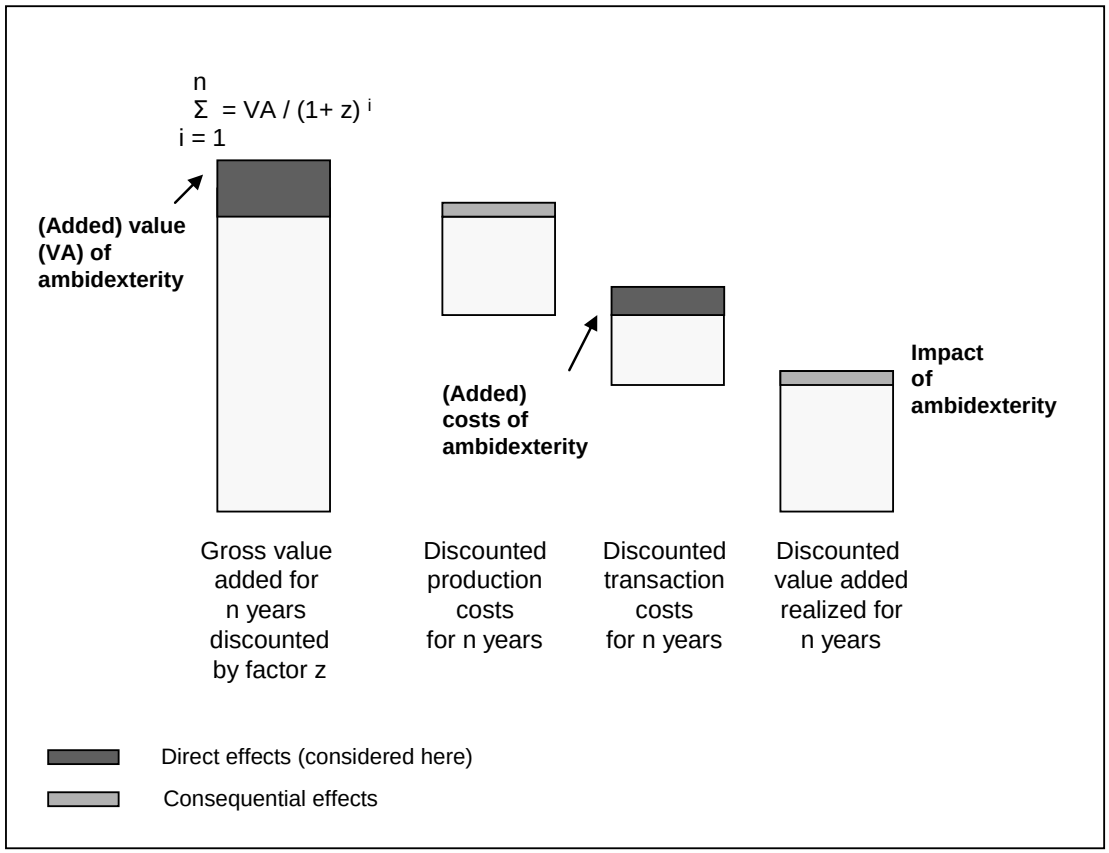


Up to now there has been little empirical research on the profit impact of ambidexterity (cf. e.g. Raisch et al. 2009) and the (opportunity) costs have been little discussed, which is important particularly in strategy research. Although the tensions from the diverging logics mentioned above (e.g. "challenging tensions" according to Andriopoulos, Lewis 2009, p. 696) are perceived, for which top management has to define supporting strategies, structures and contextual factors (Tushman, O`Reilly 1996; Smith, Tushman 2005; Beckman 2006), they are rarely understood as costs. However, interviews with top managers which we conducted in the context of a research project showed that in organizational research the conditions described as tensions demand extremely time-consuming harmonization and problem solving which often leads to unproductive work and keeps top managers from their core tasks. They therefore cause opportunity costs. Gibson, Birkinshaw (2004, p. 213) also identified such "costs of implementing the systems and processes to achieve ambidexterity" in interviews with managers.

3. Benefits and costs of ambidexterity in a situation of long-term, radical discontinuous change

The small number of empirical studies of ambidexterity to date only examines the relationship between an ambidexterity construct and economic performance in a highly aggregated manner, if at all. An explicit distinction is rarely made between the benefits and costs of ambidexterity. It is therefore no wonder that the studies dealing with the profit impact of ambidexterity do not show a clear picture (cf. Simsek 2009, p. 603; similarly Simsek et al. 2009). Here, the costs and benefits of ambidexterity in situations of long-term radical and discontinuous change will be compared (cf. also Proff, Haberle 2010) in order to derive ways of reducing integration costs and therefore improving corporate efficiency. Fig. 3 shows along the analysis of transactions in the internal corporate value creation process (cf. Jost 2009, p. 203) that ambidexterity can, in principle, increase gross value added on average over time through simultaneous resource improvement and renewal (increasing discounted gross value added as a benefit of ambidexterity), but it requires harmonization, which at the same time increases the transaction costs (increasing discounted transaction costs as costs of ambidexterity)

Fig. 3: Costs and benefits of ambidexterity along the analysis of transactions



Source: Based on Jost (2009, p. 203)

3.1 Higher corporate performance caused by ambidexterity in times of change

According to Levinthal, March (1993), simultaneous achievement of resource renewal and resource exploitation has a sustainable positive impact on corporate performance. An adequate level of resource exploitation has to be achieved in order to serve current requirements and market demands, and an adequate level of resource renewal is needed in order to secure the future survival of a company. Therefore, the aim must be a balanced relationship between resource exploitation and renewal (cf. also Tushman, O`Reilly 1996; Benner, Tushman 2003; Gupta et al. 2006), through which the discounted gross value added as a benefit of ambidexterity will increase in accordance with Figure 3.

The positive relationship between an ambidextrous orientation and corporate performance has been empirically confirmed on several occasions (cf. e.g. the overview in Simsek et al. 2009). He, Wong (2004), for example, analyze manufacturing companies and show a positive correlation between an ambidextrous technological innovation behavior and growth in sales volume. Gibson, Birkinshaw (2004)

test the ambidexterity hypothesis at the business unit level and confirm the correlation between ambidextrously oriented business units and their performance. Lubatkin et al. (2006) determine a positive correlation between an ambidextrous orientation of top management and corporate performance (as further empirical studies, cf. also Auh, Menguc 2005 or Jansen et al. 2006). The ambidextrous orientation is favored by integrative top management structures, which enable the open exchange of opposing information and the development of a shared, ambidextrously oriented mentality and attitude.

3.2 Higher integration costs caused by ambidexterity

Despite the profit impact proven in the last section, ambidexterity in a situation of change often only leads to a relative optimum (in the definition of Milgrom, Roberts 1990, 1992). Over time, it also causes transaction costs in the form of integration costs (cf. Fig. 3), which lead to frictions and deviations from profit-maximizing organizational performance (absolute optimum).

Integration costs occur because (structural) inconsistencies arise through the coexistence of resource exploitation on the one hand and resource renewal on the other among the organizational decision making units – whether business units, functional units or subsidiaries – which have to be managed (contextually) by top management:

- before the tipping point to the new technology there are initially conflicts between the activities pursued in the individual organizational units (particularly R&D and production) at the locations with research and development, i.e. above all in industrialized countries and there in particular at the parent companies (cf. Fleck 1995, pp. 14ff.; Proff 2002, p. 74), which can come from inside or outside the organization (cf. Rumelt 1980) and
- after the tipping point to the new technology there are conflicts between the (development and production) activities at different locations (in different subsidiaries) worldwide.

Integration costs before the transition result from *internal* inconsistencies in the form of conflicts between the activities of individual organizational units. They exist when an activity reduces the performance of at least one other activity (cf. Milgrom, Roberts 1990, pp. 513-515 on internal consistency ("complementarity") and with reference to this Proff 2002, p. 75-76).

Up to now, such internal inconsistencies have only been determined in the primary value adding activities of manufacturing, logistics and distribution, which are in a restrictive relationship of interde-

pendency. There is a "critical sequence relationship" between them which is characterized by a lack of buffer times and therefore very small degrees of freedom (cf. Gaitanides 1983, p. 165; Domschke, Scholl 2008, p. 121), which is why these primary value creating activities have to act in the same direction (cf. Thompson 1967; Laux, Liermann 2005). Inconsistencies arise when this is not the case, i.e. when they are not

- either all efficiency oriented (in the sense of a cost leadership or differentiation strategy or corporate centralization of tasks) towards resource exploitation
- or all flexibility oriented (in the sense of a product innovation strategy or corporate competence transfer) towards resource development.

The reason for a goal conflict between the efficiency and flexibility orientations of the restrictively interdependent primary activities in the value chain is that companies cannot maximize efficiency and flexibility simultaneously (cf. Mette 1999, p. 47). This conflict can be explained on the basis of opportunity costs. Flexibility leads to costs e.g. through quantitative and qualitative capacity reserves or through the planning and monitoring of adaptation processes. Such event buffers or "organizational slacks" (cf. Cyert, March 1963, p. 63) prevent production based on the minimum cost combination (cf. Mette 1999, p. 144; Proff 2002, p. 82). According to microeconomic theory, the minimum cost combination is the point where "slack is zero". Therefore, efficiency is inevitably lost.

With loosely associated activities, which are e.g. in a sequential relationship of interdependence (Thompson 1967, p. 54; Frese 2005, p. 54), such as the relationship of the support activities R&D or sourcing with the primary activities production, logistics and distribution, such integration costs have never really been perceived to date. This led to the conclusion that when flexibility-oriented research and development is found alongside efficient production and efficient distribution, ambidextrous management is also required (cf. e.g. Konlechner, Güttel 2006), but conflicts do not arise and therefore virtually no integration costs occur.

The line of argument up to now only considers value creation activities in *one* business unit, i.e. a business model in which the primary activities at least should be oriented towards either efficiency or flexibility.

With long-term, radical discontinuous change, however, a second, new (flexibility-oriented) business model (for electric mobility) is now developed in parallel to an existing (efficiency-oriented) business model (e.g. for combustion technology). As a result, all value creating activities are processed

in parallel. "*Dual structures*" (cf. e.g. Simsek 2009, p. 604) therefore arise, because one or more organizational units are focused on exploration, while the remainder are focused on exploitation (cf. also Benner, Tushman 2003). This is a major management challenge, because based on Jelinek and Schoonhoven (1993) "the challenges of major innovation require a dual structure that fosters both discipline and creativity". Therefore, with long-term radical discontinuous change all value-creating activities (primary and support) are in a simultaneous (and therefore restrictive) relationship of interdependence and result in the above-mentioned internal integration costs, i.e. transaction costs of ambidexterity, which have to be minimized.

Additional costs of ambidexterity also arise in the case of e*xternal* inconsistencies, i.e. conflicts between the activities pursued in a business unit or entire corporation and the management principles (centralization or decentralization) required in the business units' environment. The dynamics of the environment, i.e. the frequency and strength of changes, are taken into account here (cf. Basil, Cook 1974; Sanchez 1997; Proff 2002). External inconsistencies occur when the conduct of the corporate activity reduces the success of the management principles required in the business units' environment (cf. Rumelt 1980 on external consistency ("consonance")). External inconsistencies therefore arise when, at least in the primary value creating activities production, logistics and distribution

- an efficiency orientation is attempted in dynamic sectors such as the pharmaceuticals and computer industries or
- - as in the transition to electric mobility – a flexibility orientation is attempted in largely stable sectors like the automotive and chemical industries.

To minimize the costs of external harmonization, high environmental dynamics require decentralization as the management principle, preventing long-term optimization of the efficiency-oriented activities. In a stable environment, in contrast, centralization is needed as the management principle (cf. Lawrence, Lorsch 1967; and – referring to this - Proff 2002, p. 82).

Long-term radical discontinuous change which effects a transition from a largely stable environment (e.g. traditional automotive industry) to a dynamic environment (electric mobility), however, inevitably requires both management principles during the transition, which unavoidably leads to external integration costs.

4. Approaches to reducing the integration costs caused by ambidexterity in the transition to the new (electric) technology

Because ambidexterity leads to frictions and causes deviations from profit-maximized organizational performance, we will now attempt to explain how ambidexterity can be managed in a situation of long-term technology change (Fig. 2 in Section 2.3) as in the transition to electric mobility before, during and after the tipping point to the new technology: First, at the "ambidexterity pre-tipping point" in industrialized countries (Section 4.1), when the old technology is being further optimized and at the same time the new technology is being driven forward and new business models developed. Then at the tipping point (Section 4.2), and finally at the "ambidexterity post-tipping point", when R&D budgets at the traditional sites in the industrialized countries, particularly at the parent company, are redirected to the new technology and the traditional activities are shifted to emerging markets (Section 4.3).

4.1 Approaches to reducing the integration costs caused by ambidexterity before the tipping point to the new (electric) technology

In the first phase of the transition to the new technology (electric mobility), i.e. before the tipping point to this technology, the above-mentioned dual structures arise at the traditional locations (cf. e.g. Simsek 2009, p. 604).

The simultaneous management of exploration and exploitation is in principle "more severe", i.e. more difficult and more integration cost-intensive within one organizational unit than across units (cf. Simsek et al. 2009, p. 869) and causes a particularly low level of (structural) integration costs when companies separate the old and new technologies as strictly as possible before the tipping point. Some authors (e.g. Gupta 2006, p. 696) actually see these conflicts across different units as "non issues", since they do not lead to any costs when exploration and exploitation lie in "two different domains that are either loosely connected or connected via standardized/modular interfaces". As a consequence of the previously discussed integration costs, however, this view does not appear tenable: integration costs always arise during the simultaneous management of conflicting logics – they are only much smaller when they are structurally separated instead of contextually linked (cf. also Proff, Haberle 2010).

Since, however, in the transition to the new (electric) technology the goal is being pursued of superseding the old technology of a previously stable sector with the new technology at some point, i.e. developing an entirely new business model, which demands close harmonization of parallel activities not only by top

management but by other people as well over a protracted period, developers of traditional internal combustion engines, for example, have to be involved in the development of electric vehicles so as to connect to the vehicle tradition of the company and transfer the company and product image to the new vehicle. The change therefore cannot simply be achieved by only the top management team having a mastery of contextual ambidexterity, while the other employees initially have to deal with the old technology, and after a punctuating abrupt change with the new one (e.g. Vermeulen/Barkema 2001; Burgelmann 2002; Siggelkow/Levinthal 2003 on the idea of "punctuated equilibrium" in Section 2.2). Instead, long-term radical discontinuous change that penetrates deep into the business units demands the management of a contextual and structural ambiguity in a long transitional phase.

Structural and therefore also contextual ambidexterity can only be reduced by optimizing the inevitable "dual structures", i.e. considering in detail which activities have to be carried out separately for the traditional and new technologies and which can be done together for both. Consideration of the consistency requirements as related to the interdependencies between organizational units (Section 3.2) leads to the following conclusions:

- That the primary activities production, logistics and distribution, which are in a restrictive relationship of interdependence, should be separated for the old and new technologies which show very strong differences in their efficiency and flexibility orientation and in the dynamics of their environments,
- While the support activities sourcing and human resources – but also value creating activities in the corporate infrastructure, such as management accounting or brand management (branding) – which are in a (very) loose, relationship of interdependence with production, logistics and distribution, should be carried out together for the old and new technologies in order to retain a holistic view of the technologies.
- Research and development, which was also previously regarded as a support activity and as being in a loose, sequential relationship of interdependence with production, logistics and distribution because they preceded these activities, is carried out simultaneously with production in the long-term radical discontinuous change to a new (electric) technology and should therefore be separated for the old and new technologies.
- For both the old and the new technology, the above-mentioned functional unit activities in the new technology must be harmonized in cross-functional development teams, in the same way as was done previously for the old technology (simultaneous engineering), in order to process the complexity in the product development process and be able to manufacture a company-specific product.

These considerations form the basis of four hypotheses:

Hypothesis 1: Production, logistics and distribution activities should be carried out separately for the old and new technologies in order to reduce the integration costs arising from ambidexterity.

Hypothesis 2: Sourcing, human resources, management accounting and branding activities should be carried out jointly for the old and new technologies in order to minimize integration costs.

Hypothesis 3: R&D activities should be separated for the old and new technologies to reduce integration costs.

Hypothesis 4: For the new technology, cross-functional development should be aimed for through simultaneous engineering in order to reduce the integration costs arising from ambidexterity.

4.2 Approaches to reducing integration costs arising from ambidexterity at the tipping point to the new (electric) technology

The tipping point from which the R&D budgets are redirected to the new technology, i.e. the tipping point between the "ambidexterity pre-tipping point" and the "ambidexterity post-tipping point" in Fig. 2, should lie at a market share for pure electric vehicles of around 5 percent, which will be achieved between 2020 and 2025. This point should be determined as accurately as possible: in view of the major technology leap, the very scare resources must not be misallocated. For this purpose, the expected value of the investment in R&D resources for the old and new technologies as the mean of the possible results weighted by the probabilities of their occurrence (cf. e.g. Schmidt, Terberger 1997) must be weighed up. Since an investment in R&D in the automotive industry sometimes does not produce economic results until six or eight years have passed, such ROI analyses are essential in order to determine the point at which an investment in the old technology will no longer be worthwhile, so that investments should be made in the new (electric) technology. At that time, the ratio of resources invested in the new and old technologies has to be reversed. The faster this reversal takes place, the lower will be the costs. Two further hypotheses result from this:

Hypothesis 5: The tipping point to the new technology must be precisely determined by a comparison of the expected values for investments in the old and new technologies in order to reduce the integration costs caused by ambidexterity.

Hypothesis 6: At the tipping point, the ratio of the resources invested in the new and old technologies will be reversed. The faster this reversal takes place, the lower will be the integration costs caused by ambidexterity.

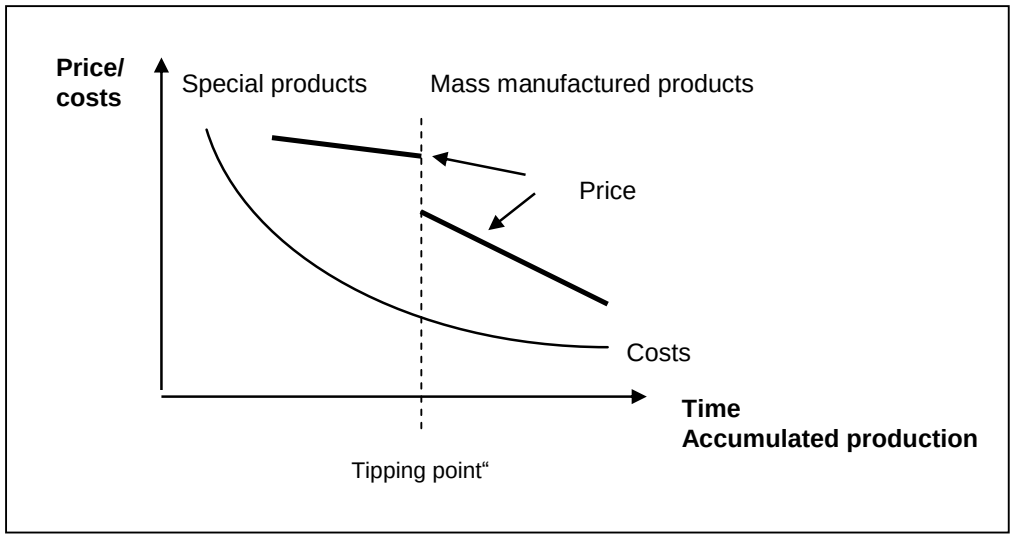
4.3 Approaches to reducing the integration costs caused by ambidexterity after the tipping point to the new (electric) technology

When the research and development budget has been redirected to the new technology after the tipping point to electric mobility, the industrialized countries will concentrate very strongly on it. Due to cost considerations apart from anything else, (automotive) companies should think then (at the latest) about shifting their traditional technology to emerging markets. There are two reasons in favor of this:

(1) The cost pressure in electric vehicles will increase in line with their shift from special products manufactured as one-offs to scale-produced mass goods (cf. Fig 4).

(2) The "dual structures" (cf. Simsek 2009) could be optimized by separating activities focused on resource exploitation and those focused on resource renewal very sharply from one another geographically. The considerations relating to the "dual structures" of Duncan (1976) und Tushmann, O´Reilly (1996) can be transferred to internationally operating subsidiaries. The resource renewing organizational units driving the new technology (e.g. at the parent company and in other industrialized countries) can then be characterized by a creative innovation culture which is not overlaid or even overwhelmed by the culture of efficiency-oriented resource exploitation in other organizational units (in the emerging markets). Conversely, the resource exploiting subsidiaries in emerging markets, i.e. those which are operating with traditional technologies, can concentrate entirely on resource improvement. The structural ambidexterity created as a result is more cost-effective than contextual ambidexterity through pursuing both technologies ambidextrously worldwide.

Fig. 4: Transition from special to mass products



Hypothesis 7: After the transition to the new (electric) technology, the new technology should be concentrated in the industrialized countries and the old technology shifted to emerging markets in order to reduce the integration costs caused by ambidexterity.

Nevertheless, not only a structural, but to some extent also a contextual ambidexterity will remain, since global activities will have to be harmonized centrally from both the marketing and the financial point of view.

In addition, the question arises as to whether the traditional technology should be concentrated at one or a small number of locations (e.g. with low factor costs such as China). Levinthal and March (1993, p. 105) emphasize, for example, that entire organizations have to make an effort to maintain, their current viability on the one hand through satisfactory exploitation of the traditional resources, and sufficient energy for the exploration of the new resources on the other hand to safeguard future viability, because "survival requires a balance, and the precise mix of exploitation and exploration that is optimal is hard to specify".

Since the improvement and exploitation of traditional technologies in individual subsidiaries (here: in emerging markets) has to finance the development of the new innovation at the parent companies and at subsidiaries in key industrialized countries, the traditional technology, especially since it will initially account for the largest share of sales by far, cannot be concentrated on a few, cost-minimized locations, but has to be spread over various countries and regions in order to distribute risks (including the loss of intellectual property).

In order at that point to reduce costs at the stable locations selected on the grounds of risk (in the automotive industry, e.g., in addition to China also Brazil as a stable market with very good standard technology), scale advantages have to be achieved in those countries which cannot be reached without exports even in large domestic markets such as Brazil (sales of 4 million vehicles are expected there in 2014). For this reason, such countries will have to develop after the tipping point as bases for the export of traditional technologies to other emerging markets, but also to industrialized countries and the parent company's domestic market.

Hypothesis 8: After the transition to the new (electric) technology, the old technology should be distributed over a variety of emerging markets to spread risks and secure the financing of investments in the new technology.

There is, however, the danger that "dual structures" within the same organization will lead to isolation and the individual units will no longer be in a position to combine their activities productively. Therefore, structural ambidexterity among international subsidiaries has to be managed very actively so that the new technology does not become entirely autonomous and, e.g., lose the image anchor of the old technology.

Many examples of active management of conflicting logics are cited in the ambidexterity literature. For example, contextual conditions have to be set up, i.e. interpersonal and cultural frameworks that encourage ambidextrous behavior in individuals and the collective (Ghoshal, Bartlett 2004; Birkinshaw, Gibson 2004). According to Gibson, Birkinshaw (2004, p. 213; referring to Ghoshal, Bartlett 1994) such contextual attributes are: first, *discipline* to achieve individual and superordinate goals. This can be supported by clear communication and transparent controls. Second, *readiness to transcend one's capabilities* by agreeing on above-average objectives and creating an aspirational culture. Third, *support* from superior managers through the provision of resources and training in order to enable people to take the initiative independently at the decentral level. Fourth, *trust*, particularly through codetermination rights and transparent, objective decisions. Güttel and Konlechner (2009) highlight in addition the relevance of ambidextrously oriented systems for agreeing on objectives (MbO) and flexibility-oriented structures (e.g. partly structured processes, simple rules, flexible project structures). They also point out the importance of shared cultural values and norms and an employee policy that supports the principles of exploration and exploitation in recruitment and human resources development.

From the structural point of view in particular, diffusion of information between differentiated units must also be enabled with the help of formal and informal integration mechanisms (Gilbert 2006; Westerman et al. 2006). The formation of paradoxical cognition structures at superordinate hierarchical levels is absolutely essential (Smith, Tushman 2005). Ambidextrously oriented managers therefore have to be able to handle conflicts and contrasts (Tushman, O`Reilly 1996; Floyd, Lane 2000; Smith, Tushman 2005), initiate paradoxical analysis processes (Gibson, Birkinshaw 2004; Smith, Tushman 2005) and assess the potential of conflicting goals (O`Reilly, Tushman 2004). This is dependent on a regular expansion and renewal of their knowledge (Floyd, Lane 2000). They should have an equally short-term and long-term orientation (O`Reilly, Tushman 2004) and take both current and future market opportunities into account (Burgelman 2002; Tushman, O`Reilly 1996).

Hypothesis 9: The structural ambidexterity between international subsidiaries has to be actively managed by the top management team to minimize integration costs.

5. First indications of the importance of the previously defined approaches to reduce integration costs arising from ambidexterity in the transition to electric mobility

As a first step in long term research, the nine hpotheses established above as approaches to reducing integration costs caused by ambidexterity before and after the tipping point to electric mobility were discussed with 15 German and American automotive manufacturers and suppliers at their parent companies and foreign subsidiaries in the autumn of 2008 and the spring of 2009.

The results show that so far companies are thinking about the first phase – if any - of ambidexterity, the "ambidexterity pre-tipping point", and in some cases are actually already deploying initial development teams specifically for electric mobility, i.e. separated from the R&D for internal combustion technology (hypothesis 3) in order to reduce ambidexterity costs.

The production and therefore the logistics and distribution, but also sourcing, management accounting and branding (hypotheses 1 and 2) of electric vehicles has not yet begun in any of the companies surveyed – it is still too early to test hypotheses 1 and 2.

In internal combustion technology, almost all of the companies surveyed are attempting cross-functional development with dual simultaneous engineering teams (hypothesis 4) and are also aiming to use this for future activities in electrical engineering in order to reduce the integration costs caused by ambidexterity (hypothesis 2).

The companies surveyed have not so far actively defined the tipping point to electrical technology (hypotheses 5 and 6), but are so far only superimposing the various forecasts. They are not yet concerning themselves with the period after this tipping point (hypotheses 7 to 9).

All respondents realize the necessity of addressing (ambidextrous) management of the transition to electric mobility, since they see a need to take decisions soon in order to overcome the present crisis, as well as in view of the long lead times in the automotive industry. This shows the importance of further research into ambidextrous management in the transition to electric mobility, which, however, has to be conducted through experiments (simulation of decision-making behavior of automotive managers).

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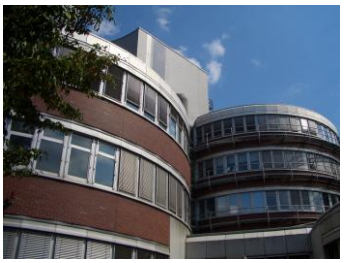

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