

TOWARD A “THEORETICAL TOOLBOX” FOR THE SUPPLIER-ENABLED FUZZY FRONT END OF THE NEW PRODUCT DEVELOPMENT PROCESS

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As technology life cycles have shortened in both products and processes, more research attention has been placed on the involvement of suppliers within the new product development (NPD) process. The majority of this research focuses on the *execution-oriented back-end* (production through product launch) resulting in a dearth of research centered on the *fuzzy front end* (FFE; idea generation through a production-ready product). This is surprising considering that the FFE is arguably the most important and challenging phase in the NPD process coupled with how critical suppliers may be to this phase of NPD. To provide a foundation for future inquiry in this important, but underdeveloped, research area, we describe how five promising theories can help inform future research centered on how suppliers can enhance the FFE of the NPD process. Specifically, we use: (1) resource orchestration theory; (2) real options theory; (3) tournament theory; (4) attribution theory; and (5) justice theory to help make the FFE of the NPD process become less “fuzzy” and more concrete.

Keywords: new product development; supplier; fuzzy front end; organizational theory; theory building; sourcing; supply management; procurement; supplier risk

SUPPLIER-ENABLED NEW PRODUCT DEVELOPMENT

According to a survey of 776 chief executive officers (CEOs), presidents, and chairmen, innovation is the number one challenge facing organizations (The Conference Board CEO Challenge, 2012). Yet, the notion that innovation must emerge from deep within a firm is becoming obsolete as a growing number of companies obtain process and product ideas through their

supply chain partners (Chief Executive Group, 2013). The CEO of Campbell Soup, Denise Morrison, recently highlighted this by saying, “Not every great idea needs to be Campbell-generated. It’s clear that partners and vendors and other external sources will generate innovative ideas for us” (Kirsner, 2013). Procter & Gamble has a goal of deriving half of its innovations from ideas offered by suppliers and other outsiders; a five-fold increase from the 10 percent achieved in 2001 (Slone, Dittman & Mentzer, 2010). Consequently, research and development in many firms has become a combination of technical sourcing, integration, and testing operations.

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While companies face a growing amount of pressure to develop innovative products, the new product development (NPD) process is extremely challenging. The NPD failure rate for established firms is roughly 65 percent, but exceeds 90 percent for most startup companies (Adams, 2010). The consumer products and grocery industries report failure rates around 95 and 75 percent, respectively (Linton, 2013; Nobel, 2011). In the pharmaceutical industry, 80 percent of drugs that pass the research stage fail during clinical trials and only 1 of 5,000 new drug candidates reaches market launch (Abrantes-Metz, Adams & Metz, 2005; Evans & Varaiya, 2003).

The NPD process can be partitioned into two main phases—the *fuzzy front end* (FFE; idea generation through a production-ready product) and the *execution-oriented back-end* (production through product launch; Menor, Tatikonda & Sampson, 2002). Decisions made during the FFE determine the path of the new product and, thus, play a critical role in the success or failure of the NPD effort (Wagner, 2012). As Zhang and Doll (2001, p. 95) note, “most projects do not fail at the end; they fail at the beginning.” Similarly, Hauser, Tellis and Griffin (2006, p. 702) highlight that “there is no doubt that the ‘fuzzy front end’ of the PD [product development] process has a big effect on a product’s ultimate success.”

The FFE is defined as “predevelopment stages as consisting of idea generation, product definition, and project evaluation” (Kim & Wilemon, 2002, p. 269). The FFE is experimental (by design) as firms try to generate new, creative product ideas. Firms consider a plethora of potential ideas and thus the focus of the FFE is broad and unstructured in nature. Thus, the FFE is highly flexible (ideally) due to the risks and uncertainties inherent in the process. Due to the ambiguous nature of the FFE, progress is often measured by subjective measures (e.g., strengthening of concept ideas) and decisions are based on qualitative (rather than quantitative) information. Typically, the key deliverable of the FFE is a blueprint for all products that will continue to the execution-oriented back-end of the NPD process (Kim & Wilemon, 2002).

The majority of research on the FFE has centered on how customers can enhance the NPD process (Merton, 2013). When customers are involved in the FFE, firms can gather important information about desired product features, get early feedback on product ideas, and enjoy reduced development cycle time (Song, Ming & Xu, 2013). Customers, however, “only know what they have experienced” and “cannot imagine what they don’t know about emergent technologies, new materials, and the like” (Ulwick, 2002, p. 92). As such, letting customers guide the FFE can result in “incremental, rather than bold, improvements” (Ulwick, 2002, p. 3). Furthermore, this can actually

“undermine the innovation process” because customers “merely ask for missing features that other manufacturers already offer” (Ulwick, 2002, p. 3).

Given that the FFE centers on developing creative and innovative product ideas (Kim & Wilemon, 2002), engaging suppliers may foster FFE success. Companies that partner with suppliers during the FFE phase have reported considerable improvements in their NPD process, including an 18 percent decrease in product development costs, 20 percent improvement in product quality, and 10–20 percent decrease in time-to-market (Brown, 2005). On the other hand, because roughly 80 percent of a product’s costs are fixed after the FFE phase, any enhancements suggested later by the supplier can be very costly (Brown, 2005).

Scholars have investigated supplier involvement (defined as “integration of the capabilities that suppliers can contribute”—Johnsen, 2009, p. 187) during the NPD process (Parker, Zsidisin & Ragatz, 2008), but the majority of this research has focused on supplier involvement during back-end activities (Yan & Dooley, 2014). This has created a gap in scholarly understanding because, as Parker et al. (2008, p. 80) note, in today’s competitive marketplace “it has become almost impossible for organizations to create innovative new products on their own.” Zacharia and Mentzer (2007) highlight the need for more theorizing on supplier involvement in the product development process while Tan and Tracey (2007) call for stronger theory development on *how* firms should integrate suppliers into the NPD process. More generally, Verworn, Herstatt and Nagahira (2008) highlight that researchers lack a holistic understanding of the FFE phase in the NPD process and call for stronger theory development in order to help fill this gap.

Accordingly, the objective of this article is to shed light on supplier involvement in the FFE and to help guide future inquiry in this extremely important, yet underdeveloped research area. Specifically, we bring forth key challenges that firms encounter in the supplier-enabled FFE. As detailed below, we develop an enhanced “theoretical toolbox” matched to these challenges that culminates in a conceptual model and a series of research questions. Taken together, these elements take initial important steps toward closing the gap between *what we know* and *what we need to learn* about the supplier-enabled FFE and set the stage for subsequent researchers to make additional progress.

To help reach our objective, we drew on the expertise of executives. Specifically, we interviewed 14 supply chain executives in various industries (e.g., consumer products, medical devices, aerospace, energy, chemical) about challenges they face when involving suppliers in

the FFE to realize success.¹ Our aim was not to conduct a rigorous scientific study, but rather to leverage executives' insights to develop novel ideas about the FFE. During these discussions, we heard consistent themes about key FFE challenges. We then consulted the extant literature to identify potentially important gaps and distilled the topics that emerged during the interviews into five key challenges—three challenges centered on the design of the FFE (henceforth referred to as design challenges) and two challenges centered on the buyer–supplier relationship during the FFE (henceforth referred to as relational challenges)—that have not been systematically investigated (Table 1 and Figure 1).² For each challenge, we identified a theory that has not yet been used extensively in supply chain research (Table 2) but sheds light on the challenge.

In adopting this multi-theory perspective, we follow the suggestions of Sanders and Wagner (2011, p. 317) who state that to “advance the supply chain discipline, researchers need to consider how multidisciplinary and/or multi-method research can provide greater insight into today’s and tomorrow’s challenges and opportunities.” Similarly, Krishnan and Loch (2005, p. 439) note that the “body of work on NPD... would benefit by explicitly identifying theoretical bases used and discussing... what theories are most helpful in what contexts and for what questions.” By discussing how multiple theoretical lenses offer unique insights into a supplier-enabled FFE phase, we are able to provide a more holistic framework that outlines various research paths future scholars can explore. This also resonates with supply chain research that has centered on applying theories and conceptual contributions from other fields (Cheng & Grimm, 2006; Ketchen & Hult, 2011).

Design Challenges and Corresponding Theories

Below, we present the three design challenges that emerged during our interviews with supply chain executives and discuss how promising theories—resource orchestration theory, real options theory, and tournament theory—can shed light on these struggles (Figure 1). These challenges (and corresponding theories) center on the design and implementation of the FFE.

¹The different ways to measure FFE outcomes in Figure 1 are by no means an exhaustive list of possible measures, but rather are intended to highlight various aspects scholars should consider moving forward.

²We partitioned the challenges (and corresponding theories) into two main categories—design and relational. Both perspectives are, independently, viable and enlightening views of the FFE, yet we believe there is likely insight gained from combining them. Thus, we encourage scholars to augment each of the “relational” theories with the “design” theories (and vice versa).

Challenge #1: Supply Base Orchestration. One of the primary tasks of the FFE is to generate new, creative product ideas. In doing so, firms rely on strategic resources—i.e., resources that are valuable, rare, inimitable, and non-substitutable—in order to gain a sustained competitive advantage (Barney, 1991). However, with shrinking product life cycles, firms try to gain this competitive advantage by developing innovative product and services *faster* than their competitors which makes it increasingly difficult to endure the lengthy and costly process of developing strategic resources internally. As such, firms will often partner with suppliers who have strategic resources—yet these resources need to be managed in an efficient manner so FFE success can be realized. If a firm struggles with how to effectively coordinate its supply base and engage suppliers in the FFE, this hinders its ability to take advantage of these resources.

Resource orchestration theory is an appealing lens for examining this struggle (Tables 1 and 2) as it extends resource-based theory by explicitly considering the role of managers' actions to leverage strategic resources (Sirmon, Hitt, Ireland & Gilbert, 2011). This theory asserts that possessing resources does not guarantee superior performance; managers, instead, must effectively orchestrate a firm's resources to realize a potential advantage (Ketchen, Wowak & Craighead, 2014). Hansen, Perry and Reese (2004, p. 1280) reflect this school of thought by noting “what a firm *does* with its resources is at least as important as *which* resources it possesses.” Specifically, managers can influence FFE performance by engaging in various process-oriented managerial activities, including: *structuring* (i.e., acquiring and/or divesting resources to create a firm's resource portfolio); *bundling* (i.e., combining resources to develop capabilities); and/or *leveraging* (i.e., exploiting a firm's capabilities to capitalize on specific market opportunities; Figure 1; Sirmon et al., 2011). While each individual activity is important, it is the synchronization of these activities that creates value and thus enables firms to achieve a competitive advantage (Hansen et al., 2004).

Resource orchestration theory suggests that these managerial activities are affected by three key elements: *breadth* (i.e., resource orchestration across the scope of the firm); *depth* (i.e., resource orchestration across levels of the firm); and *life cycle* (i.e., resource orchestration at various stages of firm maturity; Figure 1; Sirmon et al., 2011). Each element individually (as well as collectively) influences *how* managers should orchestrate the firm's resources during the FFE. For example, collaborating with suppliers during the FFE could involve several functions (e.g., procurement, engineering, marketing, operations) at various levels of the firm (e.g., top, middle, and operational). If managers do not take advantage of complementarity

TABLE 1

Overview of What We Know and What We Need to Learn About the Fuzzy Front End (FFE)

Key Challenges	Promising Theories	What Do We Know?	What Don't We Know?	Research Questions
Supply base orchestration	Resource Orchestration Theory	Supplier resources and capabilities are important in the FFE	How can firms orchestrate their internal resources to more effectively coordinate their supply base and engage suppliers in the FFE?	<ul style="list-style-type: none"> • How does breadth, depth, and life cycle impact FFE success? • Is there a certain extreme point where orchestrating a firm's resources too much could hinder FFE success? Perhaps FFE success is undermined at extremely high levels of resource orchestration. • How is a firm's ability to orchestrate resources affected by time pressures inherent in the FFE process?
New product development real options	Real Options Theory	The failure rate for new products is extremely high	How can firms manage the FFE to create real options that they can exercise under uncertainty?	<ul style="list-style-type: none"> • Is the value of real options during the FFE homogenous? Perhaps certain real options are more valuable in regard to FFE success than others. • Does supplier involvement in the FFE change the portfolio of available real options for firms? • Do managers undervalue new products during the FFE due to their difficulty in recognizing embedded real options? • Is net present value the best indication of successful ideas in unstructured environments, such as the FFE, where creativity and innovation are key drivers?

(continued)

TABLE 1 (continued)

Key Challenges	Promising Theories	What Do We Know?	What Don't We Know?	Research Questions
Supply tournaments	Tournament Theory	The FFE process can be extremely competitive	How can firms more effectively manage supplier competition?	<ul style="list-style-type: none"> • What tournament design and prize spread help firms more effectively manage competition among suppliers during the FFE? • The supplier selection process can foster more aggressive and competitive behavior among suppliers so how can firms ensure suppliers are not overselling their capabilities in order to “win” the tournament? • How many entities (i.e., suppliers) should compete in a tournament? Is there an extreme point where too many contestants reduce the efficiency of the tournament? What contextual issues affect both of these questions?
Causal attributions	Attribution Theory	Firms often face intellectual property issues when suppliers are involved in the FFE	How can firms more effectively acknowledge the value suppliers bring to the FFE?	<ul style="list-style-type: none"> • Do firms assign a greater amount of causality to internal or external supplier attributions during the FFE? • What contextual factors impact the extent to which firms acknowledge the value of suppliers? Perhaps firms are more willing to acknowledge the value of local suppliers more than geographically distant suppliers.

(continued)

TABLE 1 (continued)

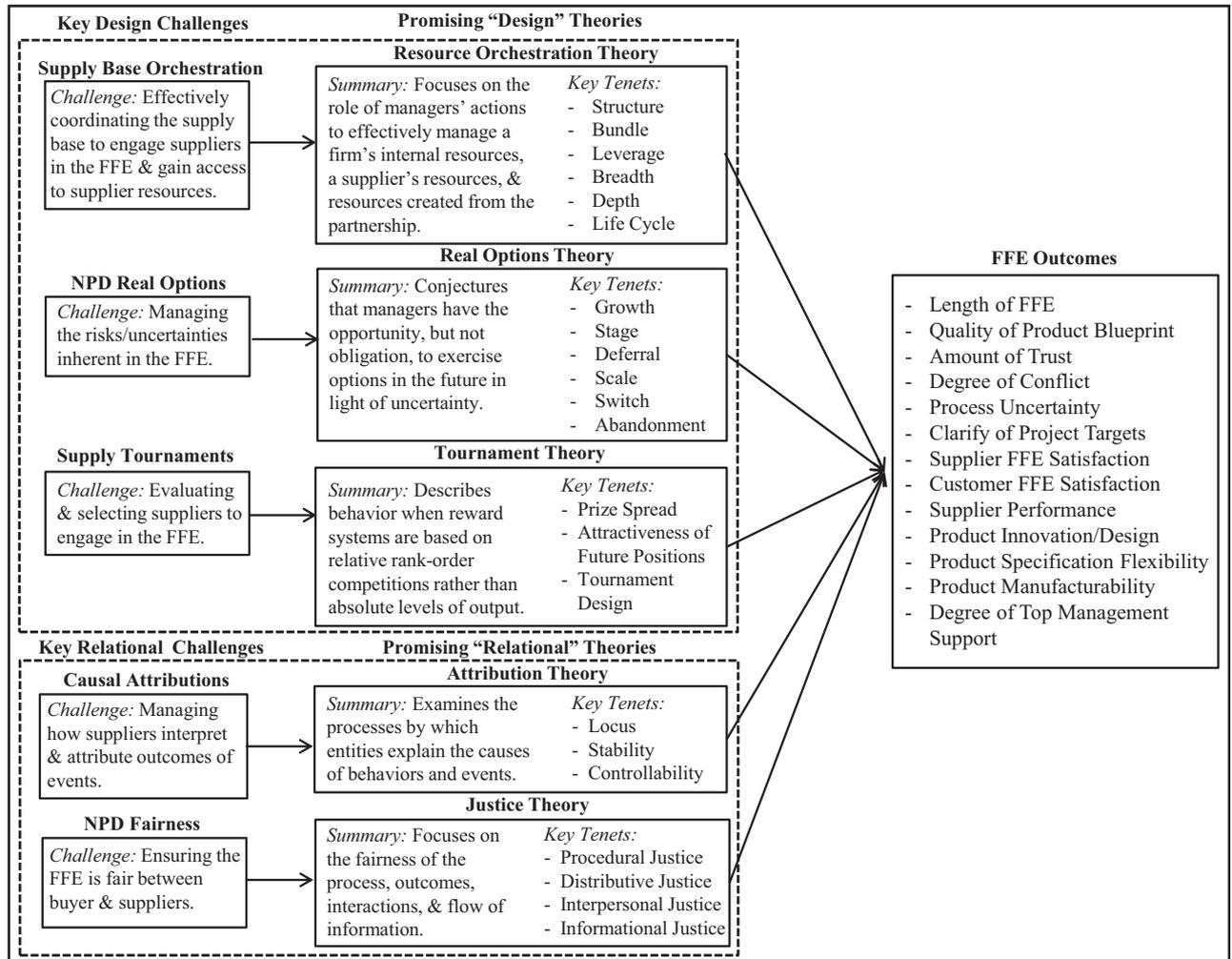
Key Challenges	Promising Theories	What Do We Know?	What Don't We Know?	Research Questions
New product development fairness	Justice Theory	Suppliers and buyers both make investments in the FFE	How can firms create fairness in the risks and rewards when suppliers are involved in the FFE?	<ul style="list-style-type: none"> • How does a firm's interpretation of events change over time? In other words, do previous performance outcomes (e.g., NPD success or failure) impact how firms interpret future events or actions on behalf of suppliers during the FFE? • To what extent does procedural, interpersonal, informational, and distributive justice impact FFE success when suppliers are involved in the process? Perhaps certain types of justice are more important than other types of justice. • When suppliers are involved during the FFE, are firms more concerned that the outcomes of the process are fair than that actual success of NPD ventures? • Should there always be equality between buyers and suppliers in the FFE?

of functions and/or coordinate their efforts across levels, the FFE could be lethargic and/or lead to inferior products. Thus, effectively structuring and bundling resources across functions (i.e., breadth) and levels (i.e., depth) within a firm is important—given the tight timelines of the FFE, effective resource orchestration could be paramount.

Resource orchestration during the FFE also has to transcend firm boundaries to help manage supplier efforts as well as supplier resources. Indeed, the need for scholars to focus more on resource management

between firms was highlighted in a recent *Journal of Supply Chain Management* editorial (Crook & Esper, 2014). Although interfirm resource management is important in supply chain management research in general, it may be especially vital during the FFE when suppliers have key resources that can enhance product design and functionality. An aerospace organization, for example, that is developing a new product could have to orchestrate hundreds of suppliers during the FFE. Each supplier possesses valuable resources that can enhance the FFE and contribute to a superior

FIGURE 1
A Conceptual Map of Key Challenges, Promising Theories, and Outcomes



product. In order for the firm to take advantage of these resources, it must gain access to the supplier's resources that are most valuable to the FFE (i.e., structuring), strategically coordinate its resources with the supplier's resources to create capabilities (i.e., bundling), and move quickly to take advantage of specific market opportunities (i.e., leveraging). As highlighted in Table 1, resource orchestration theory can help shed light on this multi-faceted challenge and thereby help close gaps in the literature.

When firms engage suppliers in the FFE, they not only gain access to supplier resources, but they may gain access to resources that are created *because of the partnership*. Indeed, in a recent *Journal of Supply Chain Management* editorial, Esper and Crook (2014, p. 4) note, "interfirm relationships that create value streams that would be impossible for the individual firms to create independently." In sum, to maximize

FFE success, firms have to effectively orchestrate their own internal resources, supplier resources, and resources that are created from the partnership.

There are at least three other theories that could help address, in a standalone or complementary manner, the supply base orchestration challenge. First, social network theory, which views systems (e.g., supply chains) as a collection of interrelated nodes that are connected via ties (Granovetter, 1983), could shed light on how the strength of the buyer-supplier relationship affects FFE outcomes. Social network theory draws attention to the differences between *weak ties* (e.g., supplier seldom used) and *strong ties* (e.g., long-term supplier). Although strong ties are obviously important, weak ties are a better source of flexibility and creativity. During the FFE, firms might want to look more frequently to suppliers with whom they have weak ties in order to access novel ideas.

TABLE 2

Promising Theories and Their Implications for Key Challenges in Fuzzy Front End (FFE) Research

Key Challenges	Promising Theories	Key Premises of the Theories	How Can Each Theoretical Lens Help Guide Future Research?
Supply base orchestration	Resource Orchestration Theory	Resource orchestration theory focuses on the role of managers' actions to effectively manage a firm's internal resources	Resource orchestration theory can shed light on how firms can orchestrate: (1) internal resources; (2) supplier resources; and (3) resources that are created as a result of the partnership to more effectively engage and coordinate their supply base during the FFE.
New product development real options	Real Options Theory	Real options theory conjectures that managers have the opportunity, but not obligation, to exercise options in the future in light of uncertainty	Real options theory can shed light on how firms should manage their portfolio of projects in the FFE to minimize risk and enhance their return on investment. It also provides guidance on how firms can "hedge their bets" when investing in a plethora of project ideas.
Supply tournaments	Tournament Theory	Tournament theory helps describe behavior when reward systems are based on relative rank-order competitions rather than absolute levels of output	Tournament theory can shed light on multiple perspectives of the FFE, including: (1) how firms can manage supply base competition during the FFE in general and during the supplier selection portion in particular; (2) how suppliers can determine which firms they should partner with during the FFE; and (3) how firms can select the <i>right technology</i> for a new product rather than the <i>right supplier</i> for the process.
Causal attributions	Attribution Theory	Attribution theory examines the processes by which entities explain the causes of behaviors and events	Attribution theory can shed light on how firms interpret information to explain events and supplier actions during the FFE. It also provides guidance on which entity gets "credit" for FFE successes and which entity gets "blamed" for failures.
New product development fairness	Justice Theory	Justice theory focuses on the fairness of the process (procedural justice), fairness of interpersonal interactions (interpersonal justice), fairness in regard to open communication of information (informational justice), and fairness of outcomes (distributive justice)	Justice theory can shed light on how firms can interact fairly with suppliers during the FFE. Decisions made during the FFE are often based on subjective metrics and qualitative data and thus it is easy for a decision maker's biases to influence the process. Justice theory ensures that both entities are treated fairly.

Second, agency theory posits that an organization faces a dilemma when delegating responsibility to act on its behalf—its agent may act in ways that benefit the agent, not the organization (Eisenhardt, 1989). A firm incurs two types of costs—monitoring and control costs—when overseeing suppliers (agents) during the FFE to ensure that the agents behave in desired ways. Given that the FFE is often quite unstructured (Kim & Wilemon, 2002), how can buying firms best deploy monitoring and controlling mechanisms (thus incurring costs) that deter opportunistic behavior while fostering supplier creativity (Wang, Li, Ross & Craighead, 2013)?

Finally, resource dependence theory stresses the importance of acquiring important inputs for organizational survival (Pfeffer & Salancik, 1978). During some FFE efforts, the buyer could be heavily dependent on the supplier due to its unique capabilities, thus creating power asymmetry. A critical decision for the buyer is whether to tolerate this power imbalance or to address the asymmetry via acquiring the supplier (Casciaro & Piskorski, 2005), building an alliance with the supplier (Shook, Adams, Ketchen & Craighead, 2009) or some other strategy.

Challenge #2: New Product Development Real Options. As discussed above, the failure rate for new products is particularly high. Although the FFE is the most influential part of the NPD process (Zhang & Doll, 2001), it is also the most unstructured portion, which makes it inherently riskier and more difficult to manage than the execution-oriented back-end (Kim & Wilemon, 2002). Real options theory provides insight about how firms can manage uncertainty and thus is an intuitive theoretical perspective to help shed light on this challenge (Tables 1 and 2). Real options exist when managers have the right, but not obligation, to take certain actions in the future (Hult, Craighead & Ketchen, 2010). As shown in Figure 1, firms can use six real options, including *growth* options,³ which allow firms to make follow-on investments to develop future capabilities; *stage* options, which allow firms to complete a project incrementally; *deferral* options, which allow firms to postpone or defer an investment until a later point in time; *scale* options, which allow firms to expand investments and/or projects; *switch* options, which allow firms to redeploy their investments; and *abandonment* options, which allow firms to terminate investments and/or projects and thereby redeploy the remaining resources elsewhere (Hult et al., 2010). Real options provide firms with the flexibility to alter their actions in uncertain contexts—such as the FFE—based on new information acquired over time as events unfold (Dixit & Pindyck, 1994).

³Extant research also refers to a growth option as an unlocking option (cf., Hult et al., 2010).

Decisions managers make during the FFE often have a high degree of uncertainty and require managers to consider fragmented information in their decision making. Uncertainties can be reduced over time, however, and thus real options theory highlights the value of waiting (Tiwana, Wang, Keil & Ahluwalia, 2007). While waiting, managers acquire new information, which, in turn, reduces the degree of uncertainty and allows them to make more informed decisions relative to their FFE strategy (i.e., which product or portfolio of products to continue developing). According to Chatterjee, Lubatkin and Schulze (1999, p. 560) “strategy is about making resource commitments before the relationship between these commitments and their potential performance outcomes are fully understood.” Real options, therefore, are a mechanism through which managers can reduce the risk of making commitments during the FFE.

Each real option, in its own way, allows managers to delay investment decisions until they have more information. Having a stage option, for example, can be particularly attractive during the FFE because it allows firms to incrementally commit to a new project through a series of smaller investments. When a stage option exists, the project is partitioned into a series of sub-projects. After each sub-project is completed, the firm has the option to terminate the project if faced with adverse conditions or continue to the subsequent sub-project if conditions are favorable. Real options can also avail opportunities in the FFE that would be otherwise unavailable. Having a growth option, for example, allows firms to unlock or foster suppliers’ FFE development capabilities. Unlocked capabilities could, in turn, create avenues for technology shifts and culminate in a portfolio of new products. In essence, the growth option invests in future FFE capabilities, which can enhance FFE success (Figure 1). Conversely, a deferral option allows a firm to rely on a “wait and see” strategy by deferring investments until it has more information without foregoing the FFE opportunity (Miller & Folta, 2002).

Leveraging real options theory can enhance FFE success because the theory allows managers to assess products based on the real options created by a project in addition to the product’s net present value (NPV; Tiwana et al., 2007). Specifically, a product’s option-adjusted NPV equals its traditional NPV plus the value of the real options. It is important to note that the value of real options is not uniform, but varies depending on the degree of uncertainty in the environment (i.e., real options are more valuable when there is ample uncertainty surrounding a new product). Consequently, we encourage managers to use an “option lens” when evaluating products during the FFE (Bowman & Hurry, 1993). In sum, we believe

future research should unpack the value of real options in the context of the FFE in the NPD process (Table 1 and Figure 1).

Because the NPD real options challenge centers on how to manage uncertainty, there are at least three additional perspectives that could provide insight. First, organizational learning focuses on how firms leverage experience and greater insights over time to make improvements. *Single-loop learning* involves detecting a problem and taking corrective action whereas *double-loop learning* involves calling into question why the organization is pursuing its current goals and actions (Argyris, 1976). The FFE may operate well in the short-run based on single-loop learning, but long-term success likely depends on asking the deep questions about current assumptions and practices that lead to double-loop learning.

The behavioral theory of the firm (Cyert & March, 1963), suggests that decision makers evaluate important outcomes (e.g., their firm's level of FFE success) in juxtaposition with an aspiration level (defined as "the smallest outcome that would be deemed satisfactory by the decision maker"—Schneider, 1992, p. 1053) and search for solutions (e.g., switch suppliers, terminate products) when below the threshold level. This calls attention to the need to carefully manage aspiration levels. If the people involved with the FFE seem to be growing complacent, for example, increasing the desired benchmarks can lead to positive change. However, aspiration levels should not be set so high that they are impossible to reach and thus become demoralizing.

Finally, the literature on risk management could be used to assess and manage the various dangers that lie beyond the typical uncertainties of the FFE. For example, a critical supplier's plant burning down would be very disruptive with potentially severe consequences (Blackhurst, Dunn and Craighead, 2011; Craighead, Blackhurst, Rungtusanatham & Handfield, 2007). Thus, various risk mitigation mechanisms, such as buffering (actions that help firms establish safeguards, which protect them from disruptions in inter-firm exchanges—cf. Bode, Wagner, Petersen & Ellram, 2011) and bridging (actions used to reduce uncertainty in "boundary-spanning" exchanges—cf. Bode et al., 2011, p. 834) could be used to enhance the FFE process.

Challenge #3: Supply Tournaments. Selecting the right supplier is of utmost importance during the FFE as it can significantly enhance the probability of FFE success. However, competition among suppliers can be fierce and in some cases involve exaggeration and deception. For example, suppliers may overstate their capabilities in an attempt to be selected during the FFE, which can hinder product design and contribute to FFE demise (Figure 1). Thus, firms often struggle with how to effectively evaluate suppliers

and manage supply base competition during the FFE supplier selection process.

Tournament theory provides insights about how entities are evaluated, selected, and rewarded in contests wherein monitoring is difficult or costly (Lazear & Rosen, 1981) and thus is an appealing lens for examining the FFE supplier selection process. Tournament theory focuses on designing contests (i.e., tournaments) that promote effective competition among participants (Lin, Yeh & Shih, 2013). Unlike other compensation schemes, tournament theory applies to situations wherein rewards are based on rank-order rather than absolute levels of output (Lazear & Rosen, 1981). In the context of the FFE, suppliers vying to be selected can be viewed as competing in a tournament, wherein the prize (e.g., being selected to participate in the later stages of NPD) is determined not on the absolute level of performance of the contestants, but on how well they do in relation to other competitors (e.g., suppliers; Conyon, Peck & Sadler, 2001). The outcome of the tournament is rank-order because the margin of winning between Supplier A and Supplier B does not affect earnings.⁴

Tournament theory rests on three key elements (Lin et al., 2013): (1) the winner (i.e., the supplier(s) selected to participate in the later stages of NPD) is uncertain when the tournament is in progress; (2) the outcome of the tournament is dependent on the performance of the contestants within the FFE; and (3) the winner gets a bonus, and this bonus, in turn, becomes the pay gap between the winner and the loser (i.e., suppliers who are not selected to continue). In other words, the winner of the FFE tournament is promoted (i.e., integrated into the later stages of NPD) and receives higher pay while the losers remain in their current position and at their current compensation level (Lazear & Rosen, 1981). All firms have a finite amount of resources so the supplier selection process can be thought of as a zero-sum game: increased financial resources allocated to Supplier A impose limits on the resources that can be allocated to Supplier B, which results in only one supplier being selected.

At the beginning of the tournament, each contestant (i.e., supplier) decides how much effort it is going to expend during the tournament; this decision is based on two factors. The first is the size of the pay gap, which is also known as the *prize spread* (defined as the spread between the winning and losing prize; Lazear & Rosen, 1981). The buyer must set the prize spread at a level that maximizes a supplier's expected utility,

⁴For simplicity, we discuss an example where only two suppliers (i.e., Supplier A and Supplier B) participate in the tournament. However, the underlying rationale can be generalized to any number of contestants in the tournament (cf., Lazear & Rosen, 1981).

subject to a zero-profit constraint by the buyer (Connelly, Tihanyi, Crook & Gangloff, 2014). Specifically, the effort expended by suppliers increases as the prize spread increases (and vice versa when the prize spread decreases). Studies have shown that there is a positive relationship between the pay gap and the number of contestants (Bognanno, 2001); consequently, to motivate more suppliers to compete in a tournament, buyers will often widen the prize spread. There is a point of diminishing return, however; firms that have too large of a prize spread can create tournament inefficiencies as it induces excessive effort on behalf of the suppliers, for which they must be compensated (Lazear & Rosen, 1981). Conversely, if the prize spread is too small, suppliers are not incentivized to compete as the losing prize may not be sufficient to offset their investments and effort expended during the tournament. This is, in essence, a “Goldilocks” situation (cf., Fields, Craighead & Ketchen, 2015) where the prize spread has to be large enough to incentivize suppliers to participate, but small enough to circumvent tournament inefficiencies.

The second factor is attractiveness of future positions (e.g., future FFE collaborations; Lin et al., 2013). Consequently, the value of winning can be thought of as the prize received at the end of the tournament as well as the possibility to compete for future positions that may result in larger prizes (Chen, Ezzamel & Cai, 2011). These factors individually, as well as collectively, play a role in the effort suppliers expend during the tournament and thus the effectiveness of the tournament design.

Tournament theory can also shed light on the converse perspective—namely, when customers compete for a supplier’s resources and capabilities during the FFE. In this scenario, suppliers design the tournament (e.g., prize spread) and manufacturers are the contestants. A recent example of tournament theory from this unique perspective is in regard to major automakers (e.g., General Motors, Ford, Toyota, Daimler, and Volkswagen) competing for new technology from Apple or Google to be used in their cars (Korosec, 2015). In this context, tournament theory can be used to help suppliers rank-order the contestants (automakers) to determine which manufacturer they should partner with during the FFE; yet could also simultaneously help auto manufactures select the *right technology*.

Designing tournaments and determining the optimal prize spread can be a challenging endeavor when manufacturers are selecting suppliers and vice versa. We suspect that the optimal tournament design will vary significantly depending on the buyer–supplier context, which entity is designing the tournament (manufacturer or supplier), product characteristics, industry, and competitive landscape. As shown in Table 1, tournament theory can give rise to important

research questions built around the concepts of optimal tournament design and prize spread.

Relational Challenges and Corresponding Theories

Below, we discuss the relational challenges that emerged during our interviews and suggest two promising theories—attribution theory and justice theory—that can help guide future research efforts (Figure 1). These challenges center on the buyer–supplier relationship or the social fabric of the FFE.

Challenge #4: Causal Attributions. During the FFE, both the firm and its suppliers put forth product ideas. Some of these ideas are rejected while others evolve during the FFE. Because both entities are actively engaged in the idea generation and refinement process, it can be difficult to attribute specific ideas to certain entities. This may be a critical problem with FFE successes (e.g., who gets credit) and with FFE failures (e.g., who gets blamed)—either of which can fracture the buyer–supplier relationship.

Attribution theory focuses on how entities interpret events (such as FFE activities) and attribute outcomes of the events to various causes (Heider, 1958). Attribution theory rests on three causal dimensions (Bettman & Weitz, 1983). The first is *locus* of causality, which can be internal (e.g., ability, effort) or external (e.g., task difficulty, luck, environmental constraints). The second is causal *stability*, which refers to the temporal nature of the causes. Causes can be permanent and unchanging (e.g., ability) or temporary and unstable (e.g., luck). The third is *controllability* of the cause or the extent to which a firm has power to change or alter the cause.

The outcome of the FFE (i.e., success or failure) can have potential consequences for the firm as well as for the buyer–supplier relationship. How managers interpret these outcomes is important because different interpretations can lead to different strategic responses (e.g., ending a relationship with a supplier or continuing to work with the supplier), which may impact FFE success (Figure 1; Gooding & Kinicki, 1995; Oflaç, Sullivan & Baltacıoğlu, 2012). For example, if a firm enjoys FFE success, it will likely try to reinstate the prior causal network (e.g., use the same supplier in the FFE; Weiner, 2000). Conversely, if a firm was unsuccessful, it will, most likely, adjust the causal network (e.g., select a new supplier or integrate the old supplier in a new way) in an effort to produce a different outcome (Weiner, 2000).

Managers, however, are far from perfect judges of causality and they often gravitate toward explanations that make themselves and their firms look good. In particular, managers are subject to a “self-serving bias” wherein they attribute positive outcomes (i.e., FFE success) to internal factors and negative outcomes

(i.e., FFE failure) to external factors⁵ (Bettman & Weitz, 1983). As a result, when firms realize FFE and/or NPD “home runs,” managers will likely attribute them to their own expertise and effort (internal and controllable), but FFE failures are likely to be blamed on suppliers’ shortcomings (external and uncontrollable).

The willingness of a firm to escape these natural biases when making attributions may affect its short- and long-term relationship with suppliers during the FFE. Specifically, a buyer’s willingness to attribute (at least partially) the success of a new product to a supplier may build valuable social capital and encourage suppliers to join in future FFE efforts. Likewise, a buyer’s willingness to share in the blame for failed FFE efforts will enhance supplier trust. Broadly, attribution theory can be used to examine “who” or “what” gets credit/blame for value creation/destruction within the FFE (Table 2).

The behavioral theory of the firm (Cyert & March, 1963) may also provide insight into this challenge. Specifically, when performance is below aspirations, decision makers will engage in “problemistic search” for solutions to the problems that contribute to unmet aspirations (Cyert & March, 1963). How decision makers interpret outcomes of the FFE may bias their search process. If decision makers blame suppliers for an FFE failure they may consider certain solutions (e.g., switch supplier), but may consider other alternatives (e.g., alter product design) if they take responsibility for the outcome.

Challenge #5: New Product Development Fairness. The FFE can be particularly complex (Wagner, 2012) and often requires buyers and suppliers to make considerable investments of time, money, and effort. When both entities make investments during the FFE, each wants a fair payoff at the end. However, as noted above, decision making during the FFE is often based on qualitative information and subjective metrics. As such, managers could be influenced by biases that result in them making decisions that benefit their firm as opposed to decisions that are mutually beneficial for both entities. Similarly, what may be fair in the buyer’s eyes may not be fair in the supplier’s eyes and vice versa. While scholars have examined fairness in buyer–supplier relationships (Griffith, Harvey & Lusch, 2006; Wagner, Coley & Lindemann, 2011), research on fairness in the FFE and how it affects FFE success is scant.

Justice theory focuses on the perceived fairness of organizational processes (Rawls, 1971), and, thus, can help shed light on how buyers and suppliers can create fairness in the risks and rewards during the FFE (Tables 1 and 2). Justice theory rests on four primary

elements (Figure 1). *Procedural justice* refers to the perceived fairness of the process (Thibaut & Walker, 1975). If a supplier believes the FFE process is biased, unethical, and/or inaccurate, for example, the supplier will perceive the process to be unfair and may be less likely to fully engage in the FFE and/or accept responsibility for its role in FFE failures (Leventhal, Karuza & Fry, 1980). Anger and/or resentment may also arise as a result of procedural injustice, which, in turn, could result in the supplier retaliating in future FFE collaborations by padding quotes to increase its profits (Skarlicki & Folger, 1997). Conversely, a process that is fair to both parties increases the probability of FFE success (Figure 1) as both entities are fully engaged and willing to share responsibility for failures and/or problems during the process.

Distributive justice centers on the equitable allocation of rewards based on each entity’s contribution to an outcome (Narasimhan, Narayanan & Srinivasan, 2013). The performance outcomes of the FFE are deemed fair for both parties if there is a balance between the inputs each contributes (e.g., resources, effort) and the outcomes each receives (e.g., revenue; Cowherd & Levine, 1992). Inequity distribution of rewards leads to increased conflict and decreased trust (Wang, Craighead & Li, 2014); this can create an unstable partnership and thus increases the FFE failure rate.

The third and fourth elements—*interpersonal justice* or fairness of interpersonal interactions (Tyler & Bies, 1990) and *informational justice* or fairness in regard to open communication of information (Bies & Moag, 1986)—are drawn from the idea of social exchange. The former refers to fairness about how parties treat each other in regard to dignity, politeness, and respect (Luo, 2007). If the buyer, for example, is curt or disrespectful to the supplier during the FFE, the supplier could view this as interpersonal injustice and may be more likely to take nefarious actions in future NPD efforts (Luo, 2007). The latter refers to the extent to which knowledge about why certain decisions are made are shared between the buyer and supplier (Narasimhan et al., 2013). Given the high degree of uncertainty and risk inherent in the FFE, informational justice may play a key role in the success of FFE efforts. Both of these types of fairness highlight that justice does not necessarily have to center on the “destination” (i.e., outcome), but could also encapsulate the “journey” (i.e., interactions between the buyer and supplier during the FFE). In Table 1, we highlight several research questions we believe could be particularly fruitful.

Once again, we believe the behavioral theory of the firm (Cyert & March, 1963) can provide guidance on this challenge. Similar to how decision makers evaluate performance levels relative to aspirations, decision

⁵This bias is also known as “hedonic” or “motivational” attributions (cf., Bettman & Weitz, 1983; Schaffer, 2002).

makers may evaluate the fairness of FFE outcomes relative to aspiration levels. Specifically, if the rewards they receive match their aspirations, the decision maker may view the process as fair. However, if the outcome is lower than the decision maker's aspirations, they may view the process as unjust. The decision makers' aspirations in regard to fairness may not be consistent over time, but may vary depending on certain factors (e.g., buyer with whom they are working). Thus, decision makers may have different aspirations about fairness for each of their supply chain partnerships.

THE TOOLBOX AND TYPE OF INNOVATION

These promising theories can shed new light on a supplier-enabled FFE, which in turn, could increase FFE success (Figure 1). Yet, we encourage scholars to consider the type of innovation (radical versus incremental) when designing studies and integrating these overarching theoretical perspectives into their research. For example, both relational theories—attribution theory and justice theory—are centered on the buyer-supplier relationship and thus are relevant for radical, bold innovations as well as minor improvements. Similarly, tournament theory can provide guidance on either type of innovation as it is less focused on the product and more focused on the entities involved in the process.

Other theories, however, may be more valuable relative to the type of innovation. Real options theory focuses on reducing risks and uncertainties and thus may be more valuable for studies examining radical innovations, which are significantly riskier than incremental innovations. A stage option, for instance, may be particularly valuable with radical innovations as it allows firms to complete a project incrementally depending on a project's success at various milestones. Similarly, radical innovations may require more resource orchestration across various functions and levels of the firm than incremental innovations. Thus, while resource orchestration theory can be used to help guide research on both radical and incremental innovations, it may provide the most value to the former (implicit in this conjecture is a suggestion of moderation). Thus, we believe that no matter which theory is used, scholars should consider the type of innovation as an important factor, perhaps even as a moderator—at a minimum, the type of innovation should be used as a control.

MAKING THE FFE LESS "FUZZY"

Only a small percentage of potential new products survive and even fewer thrive. The linchpin of NPD success is centered on the FFE phase. We aspired to

depart from the extant literature and advance understanding of the FFE in at least three important ways. First, we focused exclusively on the supplier-enabled FFE while the majority of research in this area has centered on customer involvement. Novel and innovative product ideas are often gleaned from suppliers (as opposed to customers) as the latter may in fact "undermine the innovation process" (Ulwick, 2002, p. 3). By examining supplier involvement in the FFE, we provide rich insights into a nascent, yet important aspect of the FFE. Second, by engaging industry experts, we identified novel FFE challenges. Past scholars have examined the FFE process, but we dove deeper by investigating emergent challenges firms struggle with during the process. Third, we shed light on these challenges by applying promising theories that are well-established in other research domains (e.g., management, psychology, and business ethics), but that have been underutilized in FFE research and in supply chain management in general.

Looking to the future, customer expectations are growing for new, innovative products and stakeholder pressure to avoid NPD failures is mounting. This will likely intensify the burden on firms to realize FFE success. We believe that the ideas we presented can meaningfully guide inquiry centered on supplier involvement in the FFE phase of the NPD process. More broadly, we hope this article serves as a catalyst for future research such that our understanding of the FFE becomes less "fuzzy" and more concrete.

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