

# The Design of Firms: Part 1 – Theory of the Firm

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Design theory and practice have increasingly contributed to the management literature during the past decade.<sup>1</sup> That a high-quality design creates exceptional value for firms is no longer debated. The superior financial performance reported by design-intensive companies—the exemplar being Apple—ignited industrial and scholarly interest in the attributes of a design, such as its emotional appeal, meaning, and newness, that contribute to firms' superior profitability.<sup>2</sup> With the growth of the concept of design thinking, scholarly attention quickly turned to the capabilities of design-driven firms as a precursor to the development of valuable firms.<sup>3</sup> Established firms and start-ups across industries, including firms far removed from conventional product design-oriented firms, no longer view a design as a peripheral outcome of the firm; as a result, the generation of valuable designs as a primary locus of value creation activities within a firm is not likely to go away any time soon.

Nonetheless, a critical blind spot in current management theory that borrows from design theory is that, ironically, a design has not been theorized as influencing the design of the firm. Management scholars have tended to view a design as a technical matter, an outcome of the firm.<sup>4</sup> The quality and production costs of a design in this view are determined by the attitudes of managers, the aesthetics of the firm, or a combination of the two.<sup>5</sup> In short, design theory has not been applied to the objective of explaining the economic organization of firms. Where design theory has been conceptualized as part of organizations, the theorization remains limited to the practice of, again, the organizational design attitudes of managers, the aesthetics of firms, or a combination of the two. Thus, despite the economic importance of good designs and capabilities for design, the question remains as to whether a design is simply an outcome of the existing activities of a firm, such as research and development (R&D) or asset orchestration, or whether conceptualizing firms by starting from a design could add new

- 1 Jeanne Liedtka, Andrew King, and Kevin Bennett, *Solving Problems with Design Thinking: Ten Stories of What Works* (New York: Columbia Business School Publishing, 2013); Jeanne Liedtka and Tim Ogilvie, *Designing for Growth: A Design Thinking Toolkit for Managers* (New York: Columbia Business School, 2011); Tim Brown, "Design Thinking," *Harvard Business Review* 86, no. 6 (2008): 84–92; Matthew Holloway, "How Tangible Is Your Strategy? How Design Thinking Can Turn Your Strategy into Reality," *Journal of Business Strategy* 30, no. 2/3 (2009): 50–56. doi:10.1108/02756660910942463; Roberto Verganti, "Innovation through Design," *Harvard Business Review* 84, no. 12 (2006): 114–22; and Kimberly D. Elsbach and Ileana Stigliani, "Design Thinking and Organizational Culture: A Review and Framework for Future Research," *Journal of Management* 44, no. 6 (2018): 2274–306, doi:10.1177/0149206317744252.
- 2 Julie H. Hertenstein, Marjorie B. Platt, and Robert W. Veryzer, "The Impact of Industrial Design Effectiveness on Corporate Financial Performance," *Journal of Product Innovation Management* 22, no. 1 (2005): 3–21. doi:10.1111/j.0737-6782.2005.00100.x; and Design Council, "The Impact of Design on Stock Market Performance: An Analysis of UK Quoted Companies 1994-2003," (London: Design Council, 2004). For ways in which the attributes of emotional appeal, meaning, and newness have been treated, see, respectively, Peter Boatwright and Jonathan Cagan, *Built to Love: Creating Products That Captivate Customers: The Science of Product Emotion* (San Francisco, CA: Berrett-Koehler Publishers, Inc., 2010); Verganti, "Innovation through

Design"; Ruth Mugge and Darren W. Dahl, "Seeking the Ideal Level of Design Newness: Consumer Response to Radical and Incremental Product Design," *Journal of Product Innovation Management* 30 (2013): 34–47, doi:10.1111/jpim.12062; and Katrin Talke et al., "What About Design Newness? Investigating the Relevance of a Neglected Dimension of Product Innovativeness," *ibid.* 26, no. 6 (2009): 601–15, doi:10.1111/j.1540-5885.2009.00686.x.

- 3 Brown, "Design Thinking"; Liedtka and Ogilvie, *Designing for Growth: A Design Thinking Toolkit for Managers*; Roger L. Martin, *The Design of Business: Why Design Thinking Is the Next Competitive Advantage* (Cambridge, MA: Harvard Business School Press, 2009).
- 4 Mike Hobday, Anne Boddington, and Andrew Grantham, "An Innovation Perspective on Design: Part 1," *Design Issues* 27, no. 4 (Summer 2011): 5–15, doi:10.1162/DESI\_a\_00101; "An Innovation Perspective on Design: Part 2," *Design Issues* 28, no. 1 (Winter 2012): 18–29, doi:10.1162/DESI\_a\_00137.
- 5 Aesthetic knowledge is about the summative experience of objects and situations. David Barry and Claus Rerup, "Going Mobile: Aesthetic Design Considerations from Calder and the Constructivists," *Organization Science* 17, no. 2 (2006): 262–76, doi:10.1287/orsc.1050.0165. Design attitudes refer to the urges to question whether conventions have a solid basis, and thus a progressive stance toward undermining and subverting, giving more room for novelty to have an impact. Kamil Michlewski, "Uncovering Design Attitude: Inside the Culture of Designers," *Organization Studies* 29, no. 3 (2008): 373–92, doi:10.1177/0170840607088019; John Paul Stephens and Brodie J. Boland, "The Aesthetic Knowledge Problem of Problem-Solving with Design Thinking," *Journal of Management Inquiry* 24, no. 3 (2015): 219–32, doi:10.1177/1056492614564677. Design attitudes animate aesthetic knowledge, resulting in designs with a far greater range of potential meanings. Richard J. Boland Jr. and Fred Collopy, eds., *Managing as Designing* (Stanford: Stanford University Press, 2004); Brian Leavy, "Design Thinking – a New Mental

thinking to the economic organization of firms. In short, is a design merely an economic outcome of a firm, or is a design a central object in the economic organization of firms? The extent of resources allocated and managed within the boundaries of a firm materially affects macro-economic output, making firms an essential form of economic organization and a unit of economic theorization.<sup>6</sup> As such, this is a question that design theory cannot ignore if it is to contribute seriously to the management of organizations.

First, this article seeks to explain, from a design perspective, the ways in which a design influences the existence, scale, and scope of the firm, and thereby contributes to the theory of the firm. The central thesis of this article is that firms exist because designs create and delimit choices for the internal or external exchange of resources. Our view is that a design influences and is influenced by, *inter alia*, the enforced (or communal) development and sharing of production requirements. Although we agree with the theory that firms exist as an efficient means to reduce transaction costs associated with production,<sup>7</sup> we show that designs influence *ex ante* and *ex post* transaction costs, meaning that designs create and eliminate allocation choices for the internal or external exchange of resources. Second, the paper extends the hypothesis, from the literature on the modular organization of firms, that "products design organizations," by illustrating the role of a design's formality on the internal structure of firms.<sup>8</sup> With reference to the scholarship in design studies, we will demonstrate that allocation choices between integration or open markets are both created and eliminated by designs.

### Theories of the Firm

We begin with a brief précis of theories of the firm. Given the existence of several comprehensive reviews, this review is limited to highlighting the connection between transaction costs and the most acknowledged theories of the firm.<sup>9</sup> (We return to this connection in the design-based view.) Initially, the theory of the firm arose as an economic answer to explain "why a firm emerges at all in a specialized exchange economy."<sup>10</sup> The alternative economic organization is the open market exchange of production contracts, wherein the market economizes on transaction costs.<sup>11</sup> A key starting point for formulating an answer lies in the process of exchange in a market-based economy. This process of exchange entails transaction costs, including *ex ante* transaction costs, such as the search for a resource on the market, the negotiation, and pricing of contracts, and *ex post* transaction costs, such as the execution and enforcement of contracts;<sup>12</sup> producers should seek to

Model of Value Innovation," *Strategy & Leadership* 38, no. 3 (2010): 5–14, doi:10.1108/10878571011042050.

- 6 Bengt R. Holmstrom and Jean Tirole, "The Theory of the Firm," in *Handbook of Industrial Organization*, eds. Richard Schmalensee and Robert D. Willig (Amsterdam: North-Holland, 1989), 61–133.
- 7 Ronald H. Coase, "The Nature of the Firm," *Economica* 4, no. 16 (1937): 386–405.
- 8 Ron Sanchez and Joseph T. Mahoney, "Modularity, Flexibility, and Knowledge Management in Product and Organization Design," *Strategic Management Journal* 17, Special Issue: Knowledge and the Firm (1996): 63–76.
- 9 For more comprehensive reviews, see, e.g., Holmstrom and Tirole, "The Theory of the Firm"; Pierre Garrouste and Stéphane Saussier, "Looking for a Theory of the Firm: Future Challenges," *Journal of Economic Behavior & Organization* 58, no. 2 (2005): 178–99, doi:10.1016/j.jebo.2004.09.008; and Robert Gibbons, "Four Formal(izable) Theories of the Firm?," *ibid.*: 200–45, doi:10.1016/j.jebo.2004.09.010.
- 10 Coase, "The Nature of the Firm," 390.
- 11 Oliver E. Williamson, "The Economics of Organization: The Transaction Cost Approach," *American Journal of Sociology* 87, no. 3 (1981): 548–77.
- 12 Oliver E. Williamson, "The Theory of the Firm as Governance Structure: From Choice to Contract," *The Journal of Economic Perspectives* 16, no. 3 (2002): 171–95; "The Economics of Organization: The Transaction Cost Approach."
- 13 Coase, "The Nature of the Firm," 392. See also Ronald H. Coase, "The Nature of the Firm: Influence," *The Journal of Law, Economics, and Organization* 4, no. 1 (1988): 33–47, doi:10.1093/oxford-journals.jleo.a036947.
- 14 Matthew Josefy et al., "All Things Great and Small: Organizational Size, Boundaries of the Firm, and a Changing Environment," *The Academy of Management Annals* 9, no. 1 (2015): 715–802, doi:10.1080/19416520.2015.1027086. See also Kathleen Conner, "A Historical Comparison of Resource-Based Theory and Five Schools of Thought Within Industrial Organization Economics: Do We Have a New Theory of the

minimize these costs. According to R.H. Coase, the economic organization of the firm places transaction costs under the effective control of the firm; and saving on transaction costs is a sufficient condition for the emergence of a firm.<sup>13</sup>

Subsequently, a number of other theories have emerged that either abandon the contract-based approach or offer alternative theories that argue for the existence of the firm based on activities that firms perform that markets cannot replicate. The resource-based view (RBV) argues that possessing certain valuable resources within the boundaries of the firms is advantageous over market-based ownership because the costs of coordinating these resources within a firm lowers the cost of bringing about the same result of resource coordination by market transactions.<sup>14</sup> The orchestration of valuable resources within a firm carries assumptions about the origin of transaction costs. Firms incur transaction costs through the search process for and the acquisition of co-specialized valuable resources.

The knowledge-based view (KBV) was developed to include knowledge explicitly as a valuable resource that is not readily imitated or traded through mechanisms such as contracts.<sup>15</sup> According to the KBV, firms exist because they perform better than markets in creating and sharing knowledge.<sup>16</sup> Implicit in this claim is that a firm incurs transaction costs in both internalizing knowledge and sharing knowledge associated with the production of its product. When a firm internalizes knowledge-based activities, the presumption is that it has market-tested the cost of information exchange, which carries knowledge, and determined that it was either unable to communicate such knowledge or that the costs were very high.<sup>17</sup>

The behavioral theory of the firm (BTF) opened up the economic "black box" of firms both to explain their existence and to predict the behavior and actual processes in firms.<sup>18</sup> The behavioral theory starts from the position that the purpose of firms is to make decisions related to the firm's production function, such as price, output and resource allocation.<sup>19</sup> Entrepreneurs should choose integration when the transaction costs of decisions are lower within the firm than on the open market and when firms can find the optimal production function more effectively than markets.<sup>20</sup> In addition, by creating effective organizational routines, firms reduce the costs of transactions between interdependent units of the organization, such as rework caused by activities that were performed in the wrong sequence or without necessary input from other units.<sup>21</sup>

In sum, although not all theories of the firm are grounded in transaction cost economics, transaction costs figure prominently in explaining the existence of the firm.<sup>22</sup> Different theories point to a different source of transaction costs that firms seek to minimize, as summarized in the first three columns of Table 1.

**Table 1 | Influence of a Design on Theories of the Firm, Sources of Transaction Costs, and Essential Capabilities**

Theory	Source of Transaction Costs	Essential Capabilities	Influence of Design
Contract view	Contract exchange	Contract negotiation	Co-determines transaction costs
Resource-based view	Search and acquisition of co-specialized resources	Resource acquisition, development, and orchestration	Determines set of co-specialized resources
Knowledge-based view	Communication (knowledge sharing)	Knowledge management	Determines exchange of production knowledge
Behavioral view	Decisions	Decision-making and routines	Coordinates decisions and (re)directs routines

### Relation Between Design and Existing Theories of the Firm

A critical blind spot in the underlying assumptions about transaction costs in these various theories of the firm is the possibility that the type and number of transactions, and therefore costs, share one common source: the design produced by the firm. We neither reject the contractual interpretation of firms nor the choice to internalize costs within the firm as being sufficient conditions for the existence of firms. Instead, we simply observe that the transaction costs posited by theories of the firm share a design as a common co-determining economic factor. A design influences the existence of (and potential benefits of and savings on) transaction costs. Transactions will not occur at all without being associated already with multiple inputs such as materials, labor, and technologies. These inputs are linked together by a design but are not yet in a firm's possession, hence causing the need to transact with external parties to obtain them. We therefore included a fourth column in Table 1 that describes the influence of a design on transactions and, by extension, the specific theory of the firm. We explain a design's influence on *ex ante* and *ex post* transaction costs in the various theories of the firm.

First, designs specify *ex ante* transaction costs. In the contract-based view, the details of what a supplier is expected to provide are described in a contract, but a design is what co-determines the contract details over which the entrepreneur transacts (or not). In the RBV, a design links distinctive resources and, in so doing, organizes the cost structure that underlies a firm's search and negotiation for needed specialized resources. For this reason, a design must necessarily precede *ex ante* transaction costs related to contracts not associated with the creation of the design itself. In the BTF, changing a design stimulates the "make-or-buy decision" because a new design establishes a different set of production parameters over which the actors must make decisions.<sup>23</sup> Decisions arise from a design.<sup>24</sup>

Firm?," *Journal of Management* 17, no. 1 (1991): 121–54.

- 15 Robert M. Grant, "Toward a Knowledge-Based Theory of the Firm," *Strategic Management Journal* 17, no. S2 (1996): 109–22, doi:10.1002/smj.4250171110.
- 16 Bruce Kogut and Udo Zander, "Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology," *Organization Science* 3, no. 3 (1992): 383–97, doi:10.1287/orsc.3.3.383.
- 17 Nicolai J. Foss, "Knowledge-Based Approaches to the Theory of the Firm: Some Critical Comments," *ibid.*, no. 5 (1996): 470–76, doi:10.1287/orsc.7.5.470.
- 18 Giovanni Gavetti, "Perspective—Toward a Behavioral Theory of Strategy," *ibid.*, no. 1 (2012): 267–85, doi:10.1287/orsc.1110.0644.
- 19 Giovanni Gavetti, Daniel Levinthal, and William Ocasio, "Perspective—Neo-Carnegie: The Carnegie School's Past, Present, and Reconstructing for the Future," *Ibid.*, no. 3 (2007): 523–36, doi:10.1287/orsc.1070.0277.
- 20 Richard M. Cyert and James G. March, *A Behavioral Theory of the Firm* (Englewood Cliffs: Prentice-Hall, Inc., 1963), Sec 2.1.
- 21 *Ibid.*, 100.
- 22 Joseph T. Mahoney, "A Resource-Based Theory of Sustainable Rents," *Journal of Management* 27, no. 6 (2001): 651–60, doi:10.1016/S0149-2063(01)00116-7.
- 23 Williamson, "The Theory of the Firm as Governance Structure: From Choice to Contract."
- 24 George Hazelrigg, "A Framework for Decision-Based Design," *ASME Journal of Mechanical Design* 120, no. 4 (1998): 653–58, doi:10.1115/1.2829328.

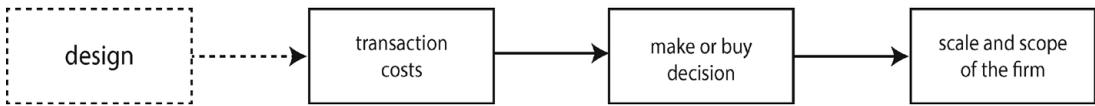


Figure 1

Conceptual model of the influence of a design on the scale and scope of the firm.

Second, designs influence the degree of *ex post* transaction costs. In the KBV, a cost is incurred to develop and share information between actors during the production of a design (execution of the contract), but this cost is not embodied in the knowledge *per se*. Rather, the cost is embodied in the structure and characteristics of the design. For example, if a design is complex and requires the integration of far-reaching knowledge from different disciplines, we expect transaction costs associated with knowledge exchange between the actors to be potentially higher.<sup>25</sup> In addition, the amount of costs to enforce contracts depends on the degree of interconnectedness of the elements exchanged across the boundary of the firm. If the elements are highly interconnected, transaction costs increase for the coordination and exertion of management authority to enforce production requirements.<sup>26</sup>

The fourth column in Table 1 can be used to generate Figure 1, which shows the relation between a design produced by the firm and the existence, scale, and scope of the firm. It shows that a direct relationship exists between a design created by the firm and the firm's transaction costs. Consequently, a design has an indirect connection with make or buy decisions and the scale and scope of the firm because designs influence transaction costs.

- 25 Paul R. Carlile and Eric S. Rebertisch, "Into the Black Box: The Knowledge Transformation Cycle," *Management Science* 49, no. 9 (2003): 1180–95, doi:10.1287/mnsc.49.9.1180.16564; Maaïke Kleinsmann, Jan Buijs, and Rianne Valkenburg, "Understanding the Complexity of Knowledge Integration in Collaborative New Product Development Teams: A Case Study," *Journal of Engineering and Technology Management* 27, no. 1–2 (2010): 20–32, doi:10.1016/j.jengtecman.2010.03.003.
- 26 Alan MacCormack, Carliss Baldwin, and John Rusnak, "Exploring the Duality between Product and Organizational Architectures: A Test of the "Mirroring" Hypothesis," *Research Policy* 41, no. 8 (2012): 1309–24, doi:10.1016/j.respol.2012.04.011.
- 27 Norbert Rozenburg and Johannes Eekels, *Product Design: Fundamentals and Methods* (Chichester: Wiley, 1995), 61–62.
- 28 Christopher Alexander, *Notes on the Synthesis of Form* (Cambridge: Harvard University Press, 1964), 1, 15.

### A Design-Based View on Firm Existence

Since designs influence *ex ante* and *ex post* transaction costs, they delimit the choice of transactions an entrepreneur can economize. In the next sections, we discuss in greater detail the ways in which a design influences the existence, scale, and scope of the firm if the entrepreneur chooses to control transaction costs within the boundaries of a firm.

### Design-Based Factors in the Choice for Economic Integration

A design is a plan for production for an object or environment that is intentionally realized for a specific purpose.<sup>27</sup> Translated into the vernacular of business, we could call an object a (physical) product, whereas an environment is a service. However ideational this definition of a design might seem, a design is at the same time an artifact in itself, projecting the result of the plan for production as a prototype that assumes some material form (e.g., a sketch, a computer rendering, a 3D printed object, a journey map, or a service diagram). A design "display[s] new physical order, organization, form, in response to function," and it establishes a "fitness between two entities: the form in question and its context."<sup>28</sup> The design, as

plan and prototype, must have a sufficient level of structural integrity—that is, it must have a degree of coherence between the different elements to allow it to become produced, and thus materialized, as a unit for economic transaction and analysis. A design thus specifies the set of elements, their integration, and the manner in which they operate toward an intended outcome. In design theory, these three aspects are named structure (i.e., the set of elements and their architecture), behavior (i.e., the manner in which they operate), and function (i.e., the intended outcome). The degree to which the structure, behavior, and function of a design are specified as formal semantics (or even mathematical entities) determines the degree of formality of the design.<sup>29</sup> In high-formality designs, the elements of the design can have well-understood relations; the compositional logic (“know-how”) defining the execution of the design can be complete and consistent. For example, shape grammars comprise and define the elements and compositional logic of artifacts.<sup>30</sup> Because of shape grammars, for example, computers can be programmed to generate products having shapes that conform to a brand image.<sup>31</sup> Low-formality designs can have more intuitive structures, but in the design, these structures also are related to “effective actions” (i.e., the manner in which they operate) and “user values” (i.e., describing the function or intended outcome).

Because the elements of a design and the compositional logic of the elements have multiple combinations that can achieve similar or differential intended outcomes, the issue of *sets* of choices emerges for the coordination of production—rather than a single choice. By definition, a design determines the choices for production factors by specifying the way in which inputs are linked together to create the intended output. Yet, alternative designs also can have varying elements and compositional logic to achieve the same intended purpose. As a result, alternative designs create options for units of production that could be either integrated into the firm or contracted out through the open market. A design therefore influences both the number and types of choices for integration or open market contracting.

To illustrate, the design of the credit card reader by Square, Inc., provides one example of the ways in which the function, structure, and behavior of a design influence transaction costs and therefore the existence, scale, and scope of the firm. When the company formed in February 2009, it had a rudimentary design for a mobile credit card payment reader that could operate with an Apple iPhone. The design was eventually realized as a working prototype, which evidenced the structural integrity of the design. The structure and behavior of the design achieved the main functions of conventional credit card readers and influenced what

29 Function, structure, and behavior are components of an ontology to represent a design. John S. Gero, “Design Prototypes: A Knowledge Representation Schema for Design,” *AI Magazine* 11, no. 4 (1990): 26–36; John S. Gero and Udo Kannengiesser, “The Situated Function–Behaviour–Structure Framework,” *Design Studies* 25, no. 4 (2004): 373–91, doi:10.1016/j.destud.2003.10.010.

30 George Steiner, *Grammars of Creation* (New Haven: Yale University Press, 2002).

31 Jay P. McCormack, Jonathan Cagan, and Craig M. Vogel, “Speaking the Buick Language: Capturing, Understanding, and Exploring Brand Identity with Shape Grammars,” *Design Studies* 25, no. 1 (2004): 1–29, doi:10.1016/S0142-694X(03)00023-1.

would be done by entrepreneurs and what would be done outside the scope of their firm. The design of the reader thereby influenced the scale and scope of the firm. First, and foremost, the structure, behavior, and function of the design eliminated the need to exchange resources with credit card processing companies, including proprietary readers and *ex post* transaction costs associated with compliance and gateway fees, as documented by the founders on numerous occasions. The software they wrote to verify a credit card (function) and record the transaction (function) was based on Apple's (mostly free) software development language and libraries (structure). As such, their software could operate on multi-purpose mobile computing platforms (behavior), such as hand-held phones and tablets, rather than on single-purpose proprietary readers. The use of Apple's software development language and libraries (structure) eliminated the need to license the processing code (structure) from credit card processing companies. If the founders had relied on, for example, Visa's processing techniques, the design would have required that the developers license technologies from Visa because they could not own Visa or its resources (intellectual property). In addition, the founders might have needed to hire a software programmer with expertise in Visa's credit card processing techniques (thereby changing the scope of the firm) if they did not have this expertise themselves. To read data from the magnetic strip (function), their reader converts the data on the magnetic strip of a credit card into audio signal that can be transmitted over an industry-standard audio connector (behavior), thus permitting the device to work with any number of mobile computing devices (behavior). An alternative design could have specified a proprietary reader (structure) consisting of hardware from Pitney-Bowes. Instead, a simple audio jack was used, which is itself a highly formalized design, has well-known interface rules, and is easily purchased from any number of electronics suppliers. The use of the audio jack decreased the *ex ante* transaction costs associated with searching for and acquiring this resource, and the design of the reader eliminated the need for Square to exchange resources with suppliers to obtain their specialized card readers and card processors running on proprietary hardware. The overall design also eliminated the need for (future) business units within the firm to manage the inventory and external partnership agreements associated with any proprietary hardware. In addition, although the founders could have created a design that included integration with specific point-of-sale (POS) software, such as those used by restaurants, they chose to avoid this approach because this behavior of the design would have required transacting with the POS hardware manufacturers. In sum, Square's design of its reader, in terms of its structure, behavior, and function, enabled the founders to choose the factors of production within the firm. Put another

**Table 2 | A Design's Influences on Transaction Costs**

Aspects of a Design	Influence on Transaction Cost
<b>Structure</b>	Search, acquisition, and enforcement of proprietary intellectual property, embodied in a material realization of a design
<b>Behavior</b>	Knowledge transfer of “know-how” to achieve specific behaviors; communication costs associated with exchange of specifications and requirements associated with production
<b>Function</b>	Number of make-or-buy decisions increases with number of functions in a design because new functions might require non-firm-owned capabilities

way, the design “designed out” transaction costs and, in so doing, created a different kind of credit processing firm. Our point is that the *ex ante* transaction costs that are associated with the search for and negotiation of fees with credit card processors and the *ex post* transaction costs that are associated with the issuance and enforcement of payment contracts were intentionally determined by the design of the Square reader.

Although contracts are a sufficient condition for the existence of firms, designs are a necessary condition for contracts. Indeed, we can readily find examples of firms that started with only a design and then contracted all the other resources necessary to fulfill the design (e.g., ARM Holdings, the fabless microchip company). In other words, having a design is a necessary condition to cause transactions to flow to and from the firm. A firm’s contracts delineate ownership and control over the design, but a design—that is, the structure, behavior, and function of a design—already determine the firm’s set of choices for the integration of economic activities within the firm or in an open market. When the structure, behavior, or function of a design requires capabilities beyond the boundaries of the firm, the firm incurs transaction costs, such as searching for companies that offer the requisite capabilities. Table 2 summarizes the ways in which the structure, behavior, and function of a design can influence transaction costs. The summary shows that transaction costs are a consequence of designs and not constituent elements of a design. Therefore, designs influence the existence of the firm because designs influence the existence and types of transaction costs entrepreneurs might seek to minimize or manage through the internal and external coordination of production.

### Designs and the Structure of Firms

In the previous section, we described the ways in which a design influences the existence of the firm because a design brings together transactions in a way so that value can be delivered either through a firm or the open market. The effect of a design on firm

transaction costs implies that a design provides a path to specify options for the relationship between the structure of a design and the structure of the firm. In other words, a design can influence both the boundary of the firm and its internal structure. The degree of formality and complexity of a design influences the boundary of the firm because of the relation between formality, complexity, and asset specificity. Asset specificity refers to the extent to which investments that support a particular transaction have a higher value to that transaction than to any other purpose for which they might be deployed. As Oliver E. Williamson points out, the cost differences between markets and firms increase with asset specificity: The cost advantage of firms exceeds the advantage of markets as asset specificity becomes high.<sup>32</sup> Complex designs with interdependent functions, structures, and behaviors increase asset specificity because complex designs increase the need for investments that support transactions relevant to the production of the design. High-formality designs have well-defined relationships between structure, behavior, and function. By formalizing a design into discrete units of production, firms can contract for the production in the open market at a low transaction cost based on the formality of the specifications. In contrast, low-formality designs, by definition, have a more complex structure; they include behaviors and functions that cannot be derived from a summation of the constituent parts, and therefore they demand more coordination. In addition, complex designs make determining the optimal boundary of the firm more challenging. The cross-over point between internalization and open markets can shift as the complexity of the design causes distortions in the calculus in determining whether the market exhibits a cost advantage over the firm, such that the market seems to exhibit a cost advantage even when it does not.

Firms with extremely complex designs, such as civil aviation, have a poor track record of making optimal decisions with respect to the boundaries of their firm because firms cannot predict *ex ante* how components will interact and produce transactions, such as knowledge exchange, that cross firm boundaries.<sup>33</sup> Empirical evidence on the reintegration of outsourced activities stemming from unrealized transaction cost savings based on high asset specificity suggests that such distortions occur regularly.<sup>34</sup> Bureaucratic costs associated with taking the transaction out of the market might appear less attractive than they actually are because of the complexity of the design. In essence, theorizing about the boundary of the firm without acknowledging the existence of complex couplings between product structure, behavior, and function is likely to lead to sub-standard assessments regarding the boundaries of the firm.

32 Williamson, "The Theory of the Firm as Governance Structure: From Choice to Contract," 176.

33 Suresh Kotha and Kannan Srikanth, "Managing a Global Partnership Model: Lessons from the Boeing 787 'Dreamliner' Program," *Global Strategy Journal* 3, no. 1 (2013): 41–66, doi:10.1111/j.2042-5805.2012.01050.x.

34 Sandro Cabral, Bertrand Quelin, and Walmir Maia, "Outsourcing Failure and Reintegration: The Influence of Contractual and External Factors," *Long Range Planning* 47, no. 6 (2014): 365–78, doi:10.1016/j.lrp.2013.08.005.

Designs also influence the internal structure of the firm, reflecting the design's formality. When transaction costs have been seen as impinging on a design, the direction of causality has historically been theorized such that the boundaries of the firm specify the design and the functional considerations specify the design architecture.<sup>35</sup> However, theorists in the area of the modular organization of firms note that the arrow of causality goes both ways because coordinating divisions (e.g., departments) in a firm entails information costs to communicate policies and directives. To understand the effect of the structure of a design on information costs, we turn to the key observation that the "coordination tasks implicit in specific product designs largely determine the feasible organization designs for developing and producing those products."<sup>36</sup> The idea that a congruence ought to exist between the structure of a design and the structure of the firm has been called the "mirroring hypothesis." The mirroring hypothesis claims that the internal structure of the firm influences the structure of the design, and, in turn, the structure of the design can influence the internal structure of the firm.<sup>37</sup> Multiple studies have shown an increase in intra-organization transaction costs when the organizational and design structures are not aligned.<sup>38</sup> The extension we propose is that the formality of a design establishes a division between the value of the internal units of a firm or of its external trading partners. This division between the coherence of a design and its established value through a (trade) context also has long been acknowledged in design theory and can be traced back to early design theorists from the 1950s and 1960s.<sup>39</sup> Firms tend to create standardized modules in parts of their design that are not subject to performance gains through innovation.<sup>40</sup> The establishment of these modules requires that firms formalize their designs—that is, that they specify rules pertaining to the coherence between structure, behavior, function, and value. The effect of these rules is to decrease the likelihood that some units will remain within the firm because the unit's value is lower than the cost savings the firm can achieve by internalizing the transaction costs. Although an argument might be made against a design's direct and immediate influence on the structure of the firm (especially in cases of large-scale production, where the design is highly formalized and firm structure represents vested interests), a design nevertheless imposes, an organizational structure, even if indirectly and as a slow evolution. A design lays down both the scale and scope of the firm and its internal structure.

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- 35 For the former, see, e.g., Oliver E. Williamson, *Markets and Hierarchies, Analysis and Antitrust Implications: A Study in the Economics of Internal Organization* (New York: Free Press, 1975).
- 36 Sanchez and Mahoney, "Modularity, Flexibility, and Knowledge Management in Product and Organization Design," 64.
- 37 Lyra J. Colfer and Carliss Y. Baldwin, "The Mirroring Hypothesis: Theory, Evidence, and Exceptions," *Industrial and Corporate Change* 25, no. 5 (2016): 709–38, doi:10.1093/icc/dtw027.
- 38 Manuel E. Sosa et al., "Factors That Influence Technical Communication in Distributed Product Development: An Empirical Study in the Telecommunications Industry," *IEEE Transactions on Engineering Management* 49, no. 1 (2002): 45–58, doi:10.1109/17.985747; Manuel E. Sosa, Steven D. Eppinger, and Craig M. Rowles, "The Misalignment of Product Architecture and Organizational Structure in Complex Product Development," *Management Science* 50, no. 12 (2004): 1674–89, doi:10.1287/mnsc.1040.0289; "Identifying Modular and Integrative Systems and Their Impact on Design Team Interactions," *Journal of Mechanical Design* 125, no. 2 (2003): 240–52, doi:10.1115/1.1564074.
- 39 Alexander, *Notes on the Synthesis of Form*; Tomás Maldonado, "New Developments in the Industry and the Training of the Product Designer," *ULM 2* (1958): 25–40.
- 40 Sendil K. Ethiraj, Daniel Levinthal, and Rishi R. Roy, "The Dual Role of Modularity: Innovation and Imitation," *Management Science* 54, no. 5 (2008): 939–55, doi:10.1287/mnsc.1070.0775.

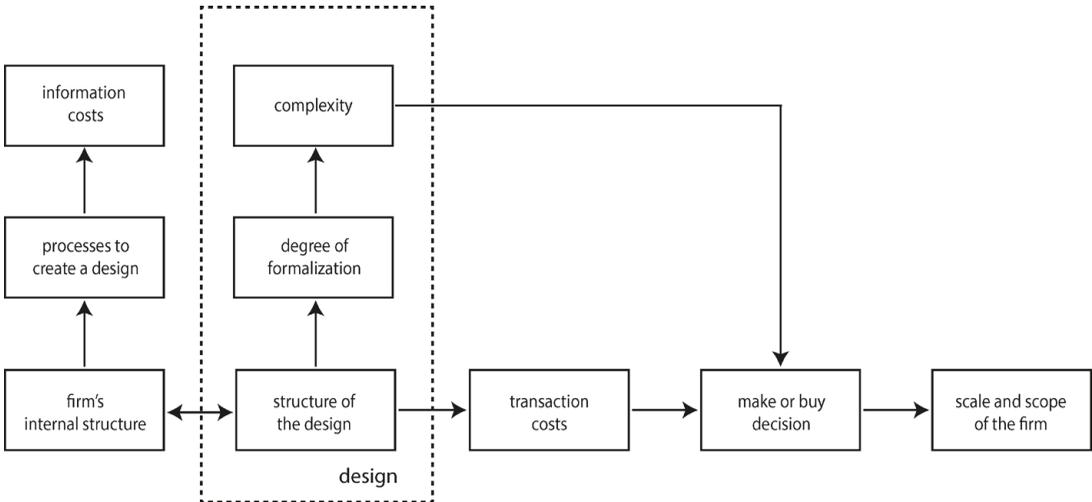


Figure 2  
Detailed conceptual model of a design's influence on a firm.

### Toward a Design-Based View on Theories of the Firm

Thus far, we have provided an explanation grounded in design theory for the ways in which a design influences the sets of transaction costs, giving entrepreneurs various choices for structuring the firm. Although our exposition, like others, is aiming toward a theory of the firm, our practical goal is to point out the promise that designs owned by firms hold as a vehicle for productive change—and particularly in ways that open markets cannot achieve. Around the world, a growing proportion of the population is creating new firms—an endeavor undertaken by as many as 50 million firms per year, according to estimates by the World Bank.<sup>41</sup> Unfortunately, a large majority of these firms will fail. Theories that can explain why a firm might be born but fails to explain what keeps it alive is a cynical form of economics. Fortunately, each theory of the firm settles on a set of principles for thriving firms that managers should follow—from negotiating best-priced contracts, to seeking or recombining valuable resources, to making optimal decisions. Based on our previous section, this section provides a conceptual model that forms the foundation for a design-based view on the theory of the firm (see Figure 2).

As we have described, one of the most complex questions firms face is how to produce a design that optimizes product-market fit while also economizing on transaction costs. By carefully balancing these two considerations, a design determines the firm's set of choices on transaction costs, the ensuing make-or-buy decisions, and, depending on these decisions, the scale and scope of the firm (as illustrated outside the right part of the dashed-line box in Figure 2). The formality of the design holds the key to the optimality of the make-or-buy decisions that ultimately affect the boundaries of the firm. The structure of a design incorporates a certain complexity, which sets the extent to which elements of a design can be formally specified into units of production that can

41 See <https://www.doingbusiness.org/en/data/exploretopics/entrepreneurship>.

then be contracted on the open market. Thus, complexity influences the formality of a design, which in turn directly influences the make-or-buy decisions of a firm. Figure 2 shows these relations between transaction costs and the structure of a design. It illustrates that the complexity of a design and its accompanying degree of formalization could (sub-optimally) shift the make-or-buy decisions of the firm.

However, the influence of designs on transaction costs, make-or-buy decisions, and the scale and scope of the firm is only one part of the detailed conceptual model of the design-based view of the firm shown in Figure 2. The left side of the model demonstrates that a design also influences the internal structure of the firm. Processes to create a design drive the information costs, and consequently, the internal structure of the firm should minimize the costs associated with the task of coordinating factors of production.

### Conclusions

This article models firms as products of their designs because a design influences the sets of decisions associated with the firms' choice to control the factors of production in-house or to purchase them from the open market. The contract is a sufficient condition for firms to exist, but contracting for resources not held together by a coherent design seems to be a waste of economic activity, undermining the cost advantage of a firm, its capability to set its boundaries, and ultimately its (legal) structure. This implies that a design is a first-order principle for firms. We have explicated the ways in which a design influences the transaction costs addressed or implied in original and later theories of the firm: in terms of search, negotiation, resource coordination, knowledge sharing, and directing make-or-buy decisions. In doing so, we have demonstrated the importance of a design as necessary in optimizing the transaction costs of firms.

Highlighting the importance of a design has a number of managerial implications. First, the emphasis leads to a strategic shift in managerial focus—away from coordinating resources and toward producing differentiated designs. While the conventional RBV of the firm has tended to concentrate on the problems of managing existing resources, our arguments point toward the need to create valuable, differentiated designs (which in turn can produce valuable, differentiated firms) in a way that reduces the firm's dependence on any endowments it might have. Second, the emphasis heightens the importance of the designs created by the firm for delineating the space of feasible alternatives for the firm's organizational structure. Our argument is that an alignment between the structure of the design and the structure of the organization is a fundamental managerial activity. From this perspective, design theory adds to the classical theorization of the firm based on

transaction economics. Third, and from a more activist perspective, our insights should be able to help new firms in their efforts to be more frugal from a transaction cost perspective, thereby helping them to start up and sustain themselves.

This article concentrated on firm existence, structure, and behavior, and by doing so touched on some ideas about the various way in which firms differ based on the influence of a design. Clearly, a more comprehensive theory would describe more completely the capabilities through which a firm creates different designs.

## References

- Alexander, Christopher. *Notes on the Synthesis of Form*. Cambridge: Harvard University Press, 1964.
- Barry, David, and Claus Rerup. "Going Mobile: Aesthetic Design Considerations from Calder and the Constructivists." *Organization Science* 17, no. 2 (2006): 262–76. doi:10.1287/orsc.1050.0165.
- Boatwright, Peter, and Jonathan Cagan. *Built to Love: Creating Products That Captivate Customers, the Science of Product Emotion*. San Francisco: Berrett-Koehler Publishers, Inc., 2010.
- Boland Jr., Richard J., and Fred Collopy, eds. *Managing as Designing*. Stanford: Stanford University Press, 2004.
- Brown, Tim. "Design Thinking." *Harvard Business Review* 86, no. 6 (2008): 84–92.
- Cabral, Sandro, Bertrand Quelin, and Walmir Maia. "Outsourcing Failure and Reintegration: The Influence of Contractual and External Factors." *Long Range Planning* 47, no. 6 (2014): 365–78. doi:10.1016/j.lrp.2013.08.005.
- Carlile, Paul R., and Eric S. Rebentisch. "Into the Black Box: The Knowledge Transformation Cycle." *Management Science* 49, no. 9 (2003): 1180–95. doi:10.1287/mnsc.49.9.1180.16564.
- Coase, Ronald H. "The Nature of the Firm." *Economica* 4, no. 16 (1937): 386–405.
- . "The Nature of the Firm: Influence." *The Journal of Law, Economics, and Organization* 4, no. 1 (1988): 33–47. doi:10.1093/oxfordjournals.jleo.a036947.
- Colfer, Lyra J., and Carliss Y. Baldwin. "The Mirroring Hypothesis: Theory, Evidence, and Exceptions." *Industrial and Corporate Change* 25, no. 5 (2016): 709–38. doi:10.1093/icc/dtw027.
- Cyert, Richard M., and James G. March. *A Behavioral Theory of the Firm*. Englewood Cliffs: Prentice-Hall, Inc., 1963.
- Design Council. "The Impact of Design on Stock Market Performance: An Analysis of UK Quoted Companies 1994–2003." London: Design Council, 2004.

- Elsbach, Kimberly D., and Ileana Stigliani. "Design Thinking and Organizational Culture: A Review and Framework for Future Research." *Journal of Management* 44, no. 6 (2018): 2274–306. doi:10.1177/0149206317744252.
- Ethiraj, Sendil K., Daniel Levinthal, and Rishi R. Roy. "The Dual Role of Modularity: Innovation and Imitation." *Management Science* 54, no. 5 (2008): 939–55. doi:10.1287/mnsc.1070.0775.
- Foss, Nicolai J. "Knowledge-Based Approaches to the Theory of the Firm: Some Critical Comments." *Organization Science* 7, no. 5 (1996): 470–76. doi:10.1287/orsc.7.5.470.
- Garrouste, Pierre, and Stéphane Saussier. "Looking for a Theory of the Firm: Future Challenges." *Journal of Economic Behavior & Organization* 58, no. 2 (2005): 178–99. doi:10.1016/j.jebo.2004.09.008.
- Gavetti, Giovanni. "Perspective—Toward a Behavioral Theory of Strategy." *Organization Science* 23, no. 1 (2012): 267–85. doi:10.1287/orsc.1110.0644.
- Gavetti, Giovanni, Daniel Levinthal, and William Ocasio. "Perspective—Neo—Carnegie: The Carnegie School's Past, Present, and Reconstructing for the Future." *Organization Science* 18, no. 3 (2007): 523–36. doi:10.1287/orsc.1070.0277.
- Gero, John S. "Design Prototypes: A Knowledge Representation Schema for Design." *AI Magazine* 11, no. 4 (Winter 1990): 26–36.
- Gero, John S., and Udo Kannengiesser. "The Situated Function–Behaviour–Structure Framework." *Design Studies* 25, no. 4 (2004): 373–91. doi:10.1016/j.destud.2003.10.010.
- Gibbons, Robert. "Four Formal(Izable) Theories of the Firm?." *Journal of Economic Behavior & Organization* 58, no. 2 (2005): 200–45. doi:10.1016/j.jebo.2004.09.010.
- Grant, Robert M. "Toward a Knowledge-Based Theory of the Firm." *Strategic Management Journal* 17, no. S2 (1996): 109–22. doi:10.1002/smj.4250171110.
- Hazelrigg, George. "A Framework for Decision-Based Design." *ASME Journal of Mechanical Design* 120, no. 4 (1998): 653–58. doi:10.1115/1.2829328.
- Hertenstein, Julie H., Marjorie B. Platt, and Robert W. Veryzer. "The Impact of Industrial Design Effectiveness on Corporate Financial Performance." *Journal of Product Innovation Management* 22, no. 1 (2005): 3–21. doi:10.1111/j.0737-6782.2005.00100.x.
- Hobday, Mike, Anne Boddington, and Andrew Grantham. "An Innovation Perspective on Design: Part 1." *Design Issues* 27, no. 4 (Summer 2011): 5–15. doi:10.1162/DESI\_a\_00101.

- . “An Innovation Perspective on Design: Part 2.” *Design Issues* 28, no. 1 (Winter 2012): 18–29. doi:10.1162/DESI\_a\_00137.
- Holloway, Matthew. “How Tangible Is Your Strategy? How Design Thinking Can Turn Your Strategy into Reality.” *Journal of Business Strategy* 30, no. 2/3 (2009): 50–56. doi:10.1108/02756660910942463.
- Holmstrom, Bengt R., and Jean Tirole. “The Theory of the Firm.” Chap. 2 In *Handbook of Industrial Organization*, edited by Richard Schmalensee and Robert D. Willig, 61–133. Amsterdam: North-Holland, 1989.
- Josefy, Matthew, Scott Kuban, R. Duane Ireland, and Michael A. Hitt. “All Things Great and Small: Organizational Size, Boundaries of the Firm, and a Changing Environment.” *The Academy of Management Annals* 9, no. 1 (2015): 715–802. doi:10.1080/19416520.2015.1027086.
- Kleinsmann, Maaïke, Jan Buijs, and Rianne Valkenburg. “Understanding the Complexity of Knowledge Integration in Collaborative New Product Development Teams: A Case Study.” *Journal of Engineering and Technology Management* 27, no. 1–2 (2010): 20–32. doi:10.1016/j.jengtecman.2010.03.003.
- Kogut, Bruce, and Udo Zander. “Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology.” *Organization Science* 3, no. 3 (1992): 383–97. doi:10.1287/orsc.3.3.383.
- Kotha, Suresh, and Kannan Srikanth. “Managing a Global Partnership Model: Lessons from the Boeing 787 ‘Dreamliner’ Program.” *Global Strategy Journal* 3, no. 1 (2013): 41–66. doi:10.1111/j.2042-5805.2012.01050.x.
- Leavy, Brian. “Design Thinking – a New Mental Model of Value Innovation.” *Strategy & Leadership* 38, no. 3 (2010): 5–14. doi:10.1108/10878571011042050.
- Liedtka, Jeanne, Andrew King, and Kevin Bennett. *Solving Problems with Design Thinking: Ten Stories of What Works*. New York: Columbia Business School Publishing, 2013.
- Liedtka, Jeanne, and Tim Ogilvie. *Designing for Growth: A Design Thinking Toolkit for Managers*. New York: Columbia Business School, 2011.
- MacCormack, Alan, Carliss Baldwin, and John Rusnak. “Exploring the Duality between Product and Organizational Architectures: A Test of the “Mirroring” Hypothesis.” *Research Policy* 41, no. 8 (2012): 1309–24. doi:10.1016/j.respol.2012.04.011.
- Mahoney, Joseph T. “A Resource-Based Theory of Sustainable Rents.” *Journal of Management* 27, no. 6 (2001): 651–60. doi:10.1016/S0149-2063(01)00116-7.

- Maldonado, Tomás. "New Developments in the Industry and the Training of the Product Designer." *ULM* 2 (1958): 25–40.
- Martin, Roger L. *The Design of Business: Why Design Thinking Is the Next Competitive Advantage*. Cambridge, MA: Harvard Business School Press, 2009.
- McCormack, Jay P., Jonathan Cagan, and Craig M. Vogel. "Speaking the Buick Language: Capturing, Understanding, and Exploring Brand Identity with Shape Grammars." *Design Studies* 25, no. 1 (2004): 1–29. doi:10.1016/S0142-694X(03)00023-1.
- Michlewski, Kamil. "Uncovering Design Attitude: Inside the Culture of Designers." *Organization Studies* 29, no. 3 (March 1, 2008 2008): 373–92. doi:10.1177/0170840607088019.
- Mugge, Ruth, and Darren W. Dahl. "Seeking the Ideal Level of Design Newness: Consumer Response to Radical and Incremental Product Design." *Journal of Product Innovation Management* 30 (2013): 34–47. doi:10.1111/jpim.12062.
- Roozenburg, Norbert, and J Eekels. *Product Design: Fundamentals and Methods*. Chichester: Wiley, 1995.
- Sanchez, Ron, and Joseph T. Mahoney. "Modularity, Flexibility, and Knowledge Management in Product and Organization Design." *Strategic Management Journal* 17, no. Special Issue: Knowledge and the Firm (1996): 63–76.
- Sosa, Manuel E. , Steven D. Eppinger, Michael Pich, David G. McKendrick, and Suzanne K. Stout. "Factors That Influence Technical Communication in Distributed Product Development: An Empirical Study in the Telecommunications Industry." *IEEE Transactions on Engineering Management* 49, no. 1 (2002): 45–58. doi:10.1109/17.985747.
- Sosa, Manuel E., Steven D. Eppinger, and Craig M. Rowles. "Identifying Modular and Integrative Systems and Their Impact on Design Team Interactions." *Journal of Mechanical Design* 125, no. 2 (2003): 240–52. doi:10.1115/1.1564074.
- . "The Misalignment of Product Architecture and Organizational Structure in Complex Product Development." *Management Science* 50, no. 12 (2004): 1674–89. doi:10.1287/mnsc.1040.0289.
- Steiner, George. *Grammars of Creation*. New Haven: Yale University Press, 2002.
- Stephens, John Paul, and Brodie J. Boland. "The Aesthetic Knowledge Problem of Problem-Solving with Design Thinking." *Journal of Management Inquiry* 24, no. 3 (2015): 219–32. doi:10.1177/1056492614564677.

- Talke, Katrin, Sören Salomo, Jaap E. Wieringa, and Antje Lutz. "What About Design Newness? Investigating the Relevance of a Neglected Dimension of Product Innovativeness." *Journal of Product Innovation Management* 26, no. 6 (2009): 601–15. doi:10.1111/j.1540-5885.2009.00686.x.
- Verganti, Roberto. "Innovation through Design." *Harvard Business Review* 84, no. 12 (2006): 114–22.
- Williamson, Oliver E. "The Economics of Organization: The Transaction Cost Approach." *American Journal of Sociology* 87, no. 3 (1981): 548–77.
- . *Markets and Hierarchies, Analysis and Antitrust Implications: A Study in the Economics of Internal Organization*. New York: Free Press, 1975.
- . "The Theory of the Firm as Governance Structure: From Choice to Contract." *The Journal of Economic Perspectives* 16, no. 3 (2002): 171–95.