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Architectural Control Points

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Abstract

System designers and technology strategists have long recognized the concept of an *architectural control point* as a way to identify parts of a system that have particular strategic importance. Despite the vast body of work on system architecture in the engineering design literature, however, few authors have attempted to define architectural control points or study them systematically. Moreover, some industry participants have questioned whether architectural control is still a valuable or achievable goal in an era of increasingly open standards. This paper offers tentative definitions of architectural control, architectural control points, and architectural strategy. In a longer version of the paper, the utility of these concepts is demonstrated through examples drawn from the history of the personal computer industry. These examples reveal both simple and subtle interactions between system design and market competition, and suggest that architectural strategy continues to play an important role in the competitive dynamics of system-oriented industries.

1 Motivation

> "[O]perating systems no longer hold the strategic importance they once held in our industry. In a world of open standards, which is where the world is going, the operating system platforms—ours or anyone else's in the open world—are not going to be control points anymore."
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> – Louis V. Gerstner, Jr., former CEO of IBM, in a speech to financial analysts (Fried 2000).

*The concept of architectural control advanced in this paper owes much to discussions with Ralph Pollock and others at IBM from 1997–99, and with Carliss Baldwin, Barbara Feinberg and Marco Iansiti at Harvard Business School from 2000–05. The main ideas of section 3 arose in conversations with V. Sambamurthy and Ram Chellappa in 2006–07, and we are developing them in collaboration with Anandhi Bharadwaj. All errors are, of course, my own.

In a landmark *Harvard Business Review* article based on their book *Computer Wars*, Charles Ferguson and Charles Morris advanced the proposition that “architecture wins technology wars.” Specifically, they argued that “competitive success flows to the company that manages to establish proprietary architectural control over a broad, fast-moving, competitive space” (Morris and Ferguson 1993, p. 87). This claim is echoed in more recent work on platform competition (Gawer and Cusumano 2002), disruptive innovation (Christensen and Raynor 2003), and the dynamics of business ecosystems (Iansiti and Levien 2004).

However, it becomes ever harder to establish control when, as Gawer and Cusumano put it, “more and more firms want *their products* to become the foundation on which other companies build their products or offer their services” (2002, p. 6). Many technology strategists now agree that the best way to achieve this may be, counterintuitively, “to ‘let go’ of the lower levels of the platform: to open them up to adaptation and modification by a large segment of the ecosystem” (Iansiti and Levien 2004, p. 158). But although industry lore is replete with advice about which parts of an architecture to hold on to or give away at what stages of its development, we still lack a unifying theory that offers causal explanations and testable predictions.

This paper seeks to advance the development of such a theory by clarifying two of its key constructs, *architectural control* and *architectural control points*, along with the concept of *architectural strategy* more broadly. Although these concepts are familiar to practicing system designers and technology strategists, they have received surprisingly little attention in the academic literature. As a result, we still lack a clear and consistent way to say *what* is or should (or should not) be controlled, *when*, and *by whom*. We also lack a framework for distinguishing different kinds of control that may affect the evolution of a system in different ways.

The full version of the paper makes two modest contributions to addressing these deficiencies. The first, summarized in section 2, is to lay out the key concepts for a theory of architectural strategy by drawing on ideas from both engineering and economics. The second, briefly outlined in section 3, is to demonstrate the utility of these concepts by exploring their implications at the firm and industry levels through examples from the history of the personal computer industry.

2 Key concepts

According to Morris and Ferguson, firms should seek “to establish proprietary architectural control over a broad, fast-moving, competitive space” (1993, p. 89). To make sense of this advice, we need to answer some basic questions, including what is architectural control, how can it be achieved, and what is its aim? The answers will shed light on the nature of the “space” that can be controlled, and the role of architectural control points within that space.

2.1 Systems and architectures

Modern systems theory follows Ludwig von Bertalanffy's definition of a *system* as "a set of elements standing in interrelation among themselves and with the environment" (1968, p. 252). Here we are specifically interested in *engineered systems* whose elements are *components* designed by individuals or teams and realized as physical artifacts, information goods like software, or services.

A *system architecture*, according to MIT's Engineering Systems Division, is "an abstract description of the entities of a system and the relationships between those entities" (Whitney et al. 2004, p. 2). Architectures are of interest to system designers because they tend to determine important aspects of system behavior. They should be of equal interest to technology strategists because, by purposefully shaping a system's architecture, they may be able to influence the behavior of the system's stakeholders to their strategic advantage.

2.2 Design and decision rights

What gives designers—and the firms that employ them—the ability to shape a system's architecture? Put simply, they own the designs that make up the system. More specifically, they hold *decision rights* that determine, in the words of the definition above, "the entities of a system and the relationships between those entities." I will use the term *design rights* to refer to those decision rights that confer the right to create a new component or change the design of an existing one.

The allocation of decision rights in a modern economy is a complex and contentious process, but it works astonishingly well. As Jensen and Meckling (1995) note, "With minor exceptions, rights to take almost all conceivable actions with virtually all physical objects are fixed on identifiable individuals or firms at every instant of time" (p. 8). Although this is not quite as true of intellectual property, for our purposes we proceed under the assumption that every firm that participates in the design or production of a given system possesses, either by outright ownership or contractual agreement, a well-defined set of decision rights over a subset of the system's components.

2.3 Architectural control

Because the elements of a system are by definition interrelated, the decision rights associated with them will frequently overlap: one firm's decisions may have both a *direct* impact on the design of some components (through the exercise of design rights), and an *indirect* impact on many others. This indirect influence on design is precisely what Ferguson and Morris call architectural control. I propose a more formal definition that will, in turn, help clarify the concept of an architectural control point:

Definition *Architectural control* is the capacity to enable or constrain the design of a system component (or set of components) without exercising design rights over it directly.

Architectural control can vary widely in strength and scope. A firm can wield strong control over a small part of a system, or weaker control over a larger part. Architectural control also has an important dynamic dimension: it can wax and wane over time, shifting among firms while varying in strength with respect to the system as a whole.

2.4 Architectural control points

The central concept of the paper follows immediately from architectural control:

Definition An *architectural control point* is a system component whose decision rights confer architectural control over other components.

In other words, if holding decision rights with respect to a particular component allows the holder of those rights to enable or constrain the design of other components, then the component in question is an architectural control point.

2.5 Architectural strategy

To put the foregoing definitions to use, we need to connect the means of design with the ends. Consider the goals of a typical design project. Product or system designers typically try to *create value* by meeting the needs of customers, clients, or other stakeholders. For designers operating in firms, these needs are usually translated into "requirements" and communicated to technical staff by product or project managers. Project success is measured primarily by the extent to which the product or project meets the stated requirements within the time and budget allocated. From a firm's point of view, however, what Morris and Ferguson called "competitive success" is more properly measured by ability to *capture value* as financial returns. Designs are the ultimate source of this value, whose magnitude may bear little relationship to the success of the project in engineering terms (Baldwin and Clark 2000).

When one firm's design decisions affect the ability of *other* firms to capture value from a system, tensions arise between the size of the profit "pie" available to the firms collectively, and the size of the slice claimed by each through product market competition. These situations require *strategic thinking*, defined by Dixit and Nalebuff (1991, p. ix) as "the art of outdoing an adversary, knowing that the adversary is trying to do the same to you." Our final definition applies this concept to system architecture:

Definition *Architectural strategy* is the application of strategic thinking with the aim of capturing economic value through architectural control.

Although some of the most successful engineers in history have been skillful strategic thinkers (consider Bill Gates as a paradigmatic example), formal training in engineering design tends to ignore strategic tensions or insist that they be translated into design requirements by external stakeholders. In contrast, I assert that the strategic analysis of design decisions lies properly within the scope of engineering design itself.

3 Playing the game

A useful theory of architectural strategy must explain how "architecture wins technology wars," if indeed it still does. To do this, we need to identify the elements of such a strategy and think about how firms string them together to capture value through architectural control. These issues are discussed in a longer version of this paper, which focuses on the strategic use of *design moves* and *contract moves* by firms such as IBM, Microsoft, Intel, Apple, and Google.

In a design move, an individual or firm invokes a design right to create a new component or change the design of an existing one. A contract move reallocates decision rights among individuals or firms. At a higher level of analysis, firms adopt differing *strategic postures* with respect to architectural control. I classify strategic postures based on the extent to which the firm seeks *horizontal* and *vertical* control over complementary and substitute components, respectively. Strategic postures also evolve over time, tracing out *architectural trajectories* in a design space.

Taken together, the concepts presented in the paper provide a way to reason about architecture and strategy in the same analytical framework. Design science researchers are well positioned to apply these ideas to yield insights about system industries such as music and mobile communications that are converging with the traditional sphere of information technology.

References

Baldwin, C. Y., and K. B. Clark. 2000. *Design Rules, Vol. 1: The Power of Modularity.* MIT Press.

Bertalanffy, L. v. 1968. *General System Theory: Foundations, Development, Applications.* Revised ed., Braziller, 1976.

Christensen, C. M., and M. E. Raynor. 2003. *The Innovator's Solution: Creating and Sustaining Successful Growth.* Harvard Business School Press.

Dixit, A. K., and B. Nalebuff. 1991. *Thinking Strategically: The Competitive Edge in Business, Politics and Everyday Life.* W. W. Norton.

Fried, I. 2000. IBM chief admits failures, sees better times ahead. *CNET News.com*, May 10. `http://www.news.com/2100-1001-240320.html`.

Gawer, A., and M. A. Cusumano. 2002. *Platform Leadership: How Intel, Microsoft, and Cisco Drive Industry Innovation.* Harvard Business School Press.

Iansiti, M., and R. Levien. 2004. *The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability.* Harvard Business School Press.

Jensen, M. C., and W. H. Meckling. 1995. Specific and general knowledge, and organizational structure. *Journal of Applied Corporate Finance* 8(2):4–18.

Morris, C. R., and C. H. Ferguson. 1993. How architecture wins technology wars. *Harvard Business Review* 71(3):86–95.

Whitney, D., E. Crawley, O. de Weck, S. Eppinger, C. Magee, J. Moses, W. Seering, J. Schindall, and D. Wallace. 2004. The influence of architecture in engineering systems. Engineering Systems Monograph, MIT Engineering Systems Division.