

# Connecting the Cloud to Theory: Applying Carr and Christensen to advance the strategic understanding of cloud computing

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## Abstract

Cloud computing has become an important part of MIS education and is beginning to alter our discipline and curriculum in significant ways. In this paper we outline two important sets of ideas that emerged from the Harvard Business School that can be used to situate cloud discussions and projects in a deeper set of theoretically based ideas. Specifically, this paper discusses key ideas and concepts derived from the work of Nick Carr and Clayton Christensen. This approach has been employed at the undergraduate and graduate levels with great success.

**Keywords:** Cloud computing, theory, sustaining innovation, disruptive innovation, proprietary technology, infrastructural technology

## 1. INTRODUCTION

Cloud computing has emerged as an important business technology that has the potential to fundamentally transform the manner in which firms deploy, manage and innovate with information technology. The nature of the technology and the possibility it represents has captured our students' imagination as well as the interest of the broader society. In turn, cloud computing has become an important part of MIS education and, for many of us, has enriched discussions, projects and labs within our classes.

The aim of this paper is to propose ways in which the discussions around cloud computing taking place in our classrooms can be coupled with important theoretical ideas, thereby enriching our students' perspective and understanding. Specifically, we identify two important sets of ideas that emerged from the Harvard Business School that can help provide students with enduring perspectives that will be

relevant to understanding technology throughout their careers. The ideas described in this paper have been successfully utilized in a course in our undergraduate MIS program as well a required MBA course. In fact, these two courses have consistently been rated among the top courses in our business school.

The theoretical basis that we suggest can supplement discussions of cloud computing are derived from two important books that have profoundly impacted discussions of technology, strategy and innovation. The first is Nicholas G. Carr's *Does IT Matter?: Information Technology and the Corrosion of Competitive Advantage*. The second is Clayton Christensen's *The Innovator's Dilemma*. These can serve as assigned texts for courses, or simply support material for developing lectures.

The remainder of this paper proceeds as follows. In the next section we will provide an overview of Carr's argument and his key concepts. We will

then transition into an examination of Christensen's notion of the Innovator's Dilemma. Once a foundation in both works has been established we will suggest ways in which these two works can be used to complement and extend our students understanding of cloud computing.

## 2. NICK CARR, DOES IT MATTER?

In 2004, Nick Carr ignited a firestorm with the publication of his controversial book, *Does IT Matter?: Information Technology and the Corrosion of Competitive Advantage* which was published by the Harvard Business School Press. Carr, the former Executive Editor of the Harvard Business Review, argued against blind investment in information technology and suggested that investments in technology rarely provided a firm with a competitive advantage. Carr's argument is often misunderstood as one that advances the notion that information technology does not matter. In fact, early in his work he recognizes the importance of technology, but argues that we need a more sophisticated and rigorous approach to assessing IT's strategic importance.

Carr's provocative argument stands out for a couple of important reasons. First, when published it stood in stark contrast to the dominant technologically deterministic perspective that suggests that investments in technology are the foundation of a firm's strategy. In addition, Carr carefully approached the discussion of the effect of powerful technologies that were transforming global economic and social life by drawing upon an historical analogy. Specifically, he compared the emergence of information technology to the evolution and diffusion of the national rail system and electrical generative capabilities that dominated the early part of the 20th century. At its most basic form, Carr's argument suggests that modern information technology will follow a pattern similar to that of electrical generation, which is to say that it is destined to be provided as a *utility*.

Carr argues that in order to talk effectively about information technology and strategy we need to refine the language and terms we use. Accordingly, Carr suggests that when we speak of technology we need to be clear as to whether we are talking about *proprietary technology* or *infrastructural technology*.

"Proprietary technologies can be owned, actually or effectively, by a single company" which "can be the basis for long-term strategic advantages, enabling companies to reap higher profits than their rivals" (Carr 2004). Carr maintains that as long as a firm can protect these technologies and processes, a firm can enjoy a competitive advantage. Examples of proprietary technologies include key components of the iPhone's mobile operating system as well as pharmaceuticals protected by patents. The key characteristic when thinking about *proprietary technologies* is that these technologies enjoy some type of protection from adoption by competitors.

Carr contrasts *proprietary technologies* with *infrastructural technologies*. He states that infrastructural technologies "offer far more value when shared than when used in isolation" (Carr 2004). Because of standardization and ease of interoperability, infrastructural technology in part derives its benefit from being widely shared. Furthermore, best practices surrounding the deployment and use of this type of technology help to spur its diffusion. Carr contends that when technology becomes infrastructural in nature that is the point at which tremendous benefits and efficiencies accrue to the broader economic environment, but do not favor individual firms. Accordingly, more often than not the technology we employ in our organizations is *infrastructural* in nature and "is a cost of doing business that must be paid by all but provides distinction to none" (Carr 2004).

Interestingly, the firms that often enjoy the benefits of infrastructural technologies are typically the suppliers and not the end users. A good example of this is Microsoft's dominance in providing computer operating systems and productivity applications for most of the corporate world. These tools developed by Microsoft do not provide the individual firms with a *proprietary technology*, which is to say that an individual firm controls, instead we can view these tools as *infrastructural* in nature. It is clear that these tools are considered crucial to operations because they provide a standardized environment that lends itself to connectivity and efficient management.

Another important concept in Carr's work is what he calls the *technology replication cycle* (TRC). The TRC reflects the notion that most innovative features and functions within a given technology are often built into the broader infrastructure in

a short period of time. Carr writes, "As the performance of hardware and software improves, as their cost falls, and as knowledge about them spreads, competitors become able to match the capabilities and performance of new systems at an ever faster clip (Carr 2004). Accordingly, distinct uses that provide an organization with an advantage are often short lived because of the rapidity in which these functions and capabilities are adopted by competitors. In addition, expert consultants who often help firms deploy, integrate and refine organizational processes around new technologies taking the experience and best practices with them to the next consulting engagement.

### Conclusion on Carr

Carr's contribution, and, its relevance in IS education, comes largely from his insistence on linking discussions on information technology to a more sophisticated and nuanced examination of IT and business strategy. By differentiating and identifying the properties and characteristics of both *proprietary* and *infrastructural technologies*, he provides us with the foundations of a useful taxonomy. This taxonomy and its application enable students to begin the process of analyzing technology and its role in a firm's strategy. Furthermore, by taking an historical perspective he shows students that technological evolution often follows a somewhat predictable pattern that a keen observer can discern.

While Carr's work provides a model and a more rigorous way of thinking about technology and organizational strategy, it does fall short in at least one important way. Specifically, he views general purpose infrastructural technologies as a stable and standardized set of technologies that do not benefit individual firms, but provide benefit to all who possess it. However, as we will later see, there are instances when a special type of innovation occurs that has as its basis widely available infrastructural technologies. In fact, these innovations often disrupt entire markets and reshape industries. In order to understand this phenomenon we will now turn to the work of Clayton Christensen and *The Innovator's Dilemma*. Later we will see how Carr's ideas, coupled with Christensen's notion of disruptive technologies provides a strong foundation for discussing cloud computing and its implications.

### 3. CLAYTON CHRISTENSEN AND THE INNOVATOR'S DILEMMA

Clayton Christensen's seminal work, *The Innovator's Dilemma*, is arguably one of the most influential business books ever published and is regularly recognized as such by active corporate CEOs (Murray 2010). *The Innovator's Dilemma*, which emerged from Christensen's doctoral work at the Harvard Business School, examines why great companies fail. Through a careful analysis of the history of the disk drive industry, his research revealed some startling insight that can be generalized across industries. His work suggests that certain types of technologies, which he calls *disruptive technologies*, are often the reason great companies eventually lose dominance and sometimes fail.

Similar to Carr, Christensen insists that if we are to advance our understanding of technological based innovation we must begin the process by developing a language that helps us carefully examine the innovation process. Specifically we must determine whether we are talking about *sustaining technologies* or *disruptive technologies*. Of *sustaining technologies* he writes, "What all sustaining technologies have in common is that they improve the performance of established products, along the dimensions of performance that mainstream customers in major markets have historically valued. Most technological advances in a given industry are sustaining in character (Christensen 1997)." An example of a *sustaining innovation* is the continual improvements we regularly observe in computer chip performance. We are not surprised when the next generation of Intel mobile chip possesses more processing power and runs at lower temperatures. Typically these advances are the result of years of expensive R and D and often represent the leading edge in engineering and chip design.

Leading companies often enjoy dominance in their industries because they excel at developing *sustaining technologies*. However, Christensen argues that while the dominant firms often lead the way with *sustaining technologies* the same firms often fall victim to what he terms *disruptive technologies*. "Products based on disruptive technologies are typically cheaper, simpler, smaller, and, frequently, more convenient to use (Christensen 1997)." In addition, "...a disruptive technology is initially embraced by the least profitable customers in a

market (Christensen 1997).” Since disruptive technologies initially appeal to less sophisticated customers and are embedded in lower margin products, they are often ignored by leading firms.

The choice for leading firms to disregard *disruptive technologies* is rationalized by the fact that from a performance perspective these technologies are often inferior to the leading products on the market. Correspondingly the economics surrounding disruptive technologies are often inferior to the leading edge products with higher margins. It is because of these facts that management can appear to be making the right decisions when confronting *disruptive technologies*.

Sophisticated managers have been trained to pursue the best economic opportunities for the firm by developing high performance products that meet the needs of the most demanding customers. In addition to the prestige associated with being the market leader, the firms who lead with sustaining innovations often enjoy higher margins derived from performance based differentiation. Accordingly, market leaders continue to innovate and advance the *sustaining technologies* that have served as the basis for the current success.

However, over time *disruptive technologies* evolve and often see significant improvements in performance and capabilities. Eventually, Christensen argues, these improvements advance to the point to where the needs of most customers’ can be met by this technology. Essentially, what was once considered to be an inferior technology with bad economics supplants what had historically been the dominant technologies and products. Further contributing to the emergence of *disruptive technologies* is the fact that the established firms through improvements in *sustaining technologies* eventually overshoot the needs and requirements of most customers.

Once the established products begin to overshoot and the formerly inferior products improve to such a degree that most customers’ needs can be met, the table is set for the once dominant firms to begin their decline. Christensen shows that when the established firms are confronted with the effects of the *disruptive innovations* it is very difficult for the firms to change course. He shows that for historical and often cultural reasons, established companies often fail to adapt to the changing

environment which gives rise to the firm’s demise.

### Conclusion on Christensen

Christensen’s work supplies important insight for leaders of established companies as well as for startups. Chief among the many reasons CEOs have recognized The Innovator’s Dilemma importance is that it helps assess the broader competitive landscape and identify disruptive threats. Furthermore, some of his greatest insight relates to the importance of organizational culture which can enable and constrain innovation. Entrepreneurs find inspiration in his work as it illuminates the difficult path of introducing new products that can eventually compete with and exceed the dominant designs and products.

### 3. Linking Carr, Christensen and the Cloud

Now that we have provided an overview of Carr and Christensen’s ideas it is easy to see how we can situate these influential works into a more sophisticated understanding of the strategic implications of cloud computing. Beginning with Carr, we see that cloud computing closely approximates the historic utility model he draws upon in *Does IT Matter?*. For example, when we discuss environments such as Amazon Web Services or the Google Apps Business environment we see that these are consistent with our understanding of utility services. Furthermore, we can recognize that many of the cloud services fall under what he considers to be *infrastructural technologies* which derive their benefit from being broadly shared but do not favor a particular adopter of the technology.

On the surface this advancement, a utility service that provides the foundation for infrastructural technologies, belies the profound significance this advancement holds for business and society. Perhaps Carr’s greatest contribution is to show us that the emergence of the cloud represents the continuation of a pattern of advancement that stretches back to the agrarian revolution, through the industrial revolution and into the present day. We see that when crucial societal resources such as the production of food, industrial manufacturing and computing resources begin to be produced in a centralized environment, extraordinary benefits accrue to the broader economy. This conception of the cloud reveals much, but it falls short in providing a way for business leaders to frame its

significance as both a threat and opportunity. By linking Carr to Christensen we can establish a foundation that is stronger than what one set of ideas alone can provide.

A more nuanced and powerful conception of the cloud is that it represents an important set of infrastructural technologies that serve as a platform upon which disruptive innovations are created, nurtured and diffuse. This is precisely why the cloud has captured the imagination of our students and society. For many, it represents a canvas upon which they can experiment and create innovative new products and services. The cloud also represents a relatively flexible infrastructure that can be adapted and innovative upon in limitless ways. For example, the innovation we see in the mobile app environment is the beneficiary of the power of the cloud. Of equal importance, the cloud has stripped away once formidable barriers to entry as these tools are ubiquitous. In addition, to being widely available, cloud resources are often inexpensive because of the utility economic model that has emerged.

#### **4. CONCLUSION**

It is not a stretch to characterize the current as well as the foreseeable economic landscape as one driven by disruptive technologies and business models. In short, we live in an age of disruption. Of course, this disruption is multifaceted as it seriously challenges many established ways of doing business and utilizing technology, but it also represents opportunity and great possibilities for our students.

The aforementioned challenges and opportunities also extend into our classrooms. We as IS educators aspire to provide enduring models and frameworks that our students can take with them in an ever changing technological environment. Carr and Christensen provide us with the basis to help our students formulate a perspective that can be generalized across the innovation landscape that cloud computing has given rise to.

This paper has sketched out the broad ideas associated with each author and shown how they can enrich our discussions around cloud computing. Our experience has been that bringing these books into the classroom as supplementary material or as part of the assigned readings has delivered significant rewards and we believe it can do the same for our colleagues around the world.

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