DEPARTMENT OF JUSTICE

LEAP-FROG AND OTHER FORMS OF INNOVATION:

Protecting the Future for High-Tech and Emerging Industries Through Merger Enforcement

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Before the

American Bar Association

Chicago, Illinois

June 10, 1999

"Ideas are the factors that lift civilization. They create revolutions. There is more dynamite in an idea than in many bombs."[1]

Introduction

Ideas. How are they created? How can we maximize their creation? How can we ensure a market structure that maximizes their creation? We're in an era of unprecedented merger activity and when we focus on high-technology and emerging growth industries, antitrust enforcement has particular relevance. Antitrust enforcement in these industries is essential because of the importance of maintaining competition for innovation, the engine of our economic growth.[2] Curtailing innovation through mergers may have serious anticompetitive consequences to consumers over the long run, and may be even more damaging to them than a price increase or a quality decrease. Even if the rapid pace of change makes analyzing market structure and the competitive dynamics of a market more difficult because of uncertainty, we still need to be vigilant to preserve innovation competition.

The Division's concern about innovation is not new, but over the last six years, with recent improvements in the economic literature on innovation and our increased experience and knowledge in the area, we are taking a harder look to see if a merger implicates innovation.[3] Today, I'd like to explain why innovation competition is so important, give you some real life examples, and then discuss some of our recent merger activity in high-tech and high-growth environments.[4]

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[1] Bishop John H. Vincent.

[2] Designed in an era of smokestack industries, the antitrust laws of our nation have a flexible, adaptable standard, as do the joint Horizontal Merger Guidelines of the Antitrust Division and the Federal Trade Commission. For an in-depth discussion of how the laws and guidelines deal with questions of innovation, see Daniel L. Rubinfeld & John Hoven, *Innovation and Antitrust Enforcement*, presented at George Mason University symposium on Dynamic Competition and Public Policy, Washington, D.C., Dec. 1998, to be published in 1999.

[3] Our increased focus on innovation in merger review began with the ZF Friedrichshafen and Allison Transmission Division merger in 1993. For a detailed review of this case see Rubinfeld & Hoven, *supra* note 2, and for a review of our earliest innovation cases, see Joel I. Klein, "The Importance of Antitrust Enforcement in the New Economy," Address Before the New York State Bar Association Antitrust Law Section Program (Jan. 29, 1998).

[4] *See also* Richard J. Gilbert & Steven C. Sunshine, *Incorporating Dynamic Efficiency Concerns in Merger Analysis: The Use of Innovation Markets*, 65 Antitrust L. J. 569 (1995); John M. Nannes, "Antitrust in an Era of High-Tech Innovation," Address Before the National Institute Representing High Technology Companies (Oct. 22, 1998); Daniel Rubinfeld, "Competition Innovation, and Antitrust Enforcement in Dynamic Network Industries,"

Recent Developments in Understanding Innovation

Traditionally, innovation has been viewed as a simple output of research and development spending; the more money that is invested in R&D, the greater the amount of innovation. Under the traditional view, all innovation is viewed as the same, no matter which firm engages in it or what the market structure is. Recent economic literature on innovation looks more closely at how innovation works, focusing on whether innovation is firm or market-specific. That is, different types of firms and different market structures create different types of innovation and at different paces. Even if two firms are attempting to achieve the same goal, they will approach this effort in different ways, making different choices along the way. Knowledge varies among firms in a market, and each firm has its own innovation strategy. Thus, the number of firms in a market will affect the number of judgments about promising innovation strategies, which in turn will affect the type and pace of innovation. Under this dynamic view, innovation is driven by the flow of ideas within a firm and between rivals, not simply by the amount of R&D spending.

Some may argue that the research and development efforts at multiple firms are redundant and inefficient. While this may be true in some circumstances, duplication often means pursuing different strategies to reach the same goal, and it can get you there sooner with greater certainty. Duplication is not necessarily or even inherently wasteful, and it can be especially useful in high-tech and emerging growth industries where the best innovation strategy is often unpredictable. Or in the words of one economist, "[g]iven uncertainty, multiple R&D efforts in competing firms may be the most effective way to explore the technology space."[5] It is a matter of judgment as to the extent that one R&D effort duplicates another, and even small differences can make one attempt successful and another a failure.

Address Before the Software Publishers' Association (Mar. 24, 1998).

[5] Stan Metcalf, "The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives," *in Handbook of the Economics of Innovation and Technological Change* 446 (P. Stoneman ed. 1995).

There is increasing evidence that a firm's size and position within the market affects the nature and the type of innovation it is engaged in.[6] This is because firms are differentiated by their size, position in the market, and core competencies, and because each firm will innovate so as to capitalize on its strengths. A large firm's main strengths are that it has the scale economies in research or in complementary activities, like manufacturing and distribution, to enable it to bring an invention to the marketplace, as well as having a greater ability to finance R&D. It is also more bureaucratic and stable. To utilize fully its strengths, it needs the path to innovation to be predictable. Innovation may be sweeping and fast, but it needs to be predictable.

Small firms, on the other hand, are more entrepreneurial and can respond more quickly to unexpected opportunities. At the same time, they have fewer resources to spend on R&D; are more likely to fail; and because of a lack of strong manufacturing and distribution channels are less likely to have the resources to bring the invention to the market.

There are also significant differences in the way established leaders in an industry innovate as compared to challengers. This is because leaders have different goals and strengths than challengers. Leaders tend to innovate to reinforce their positions or to enhance their core competencies. For example, they may attempt to use their innovations to maintain strict, possibly proprietary standards. Typically, market leaders focus on incremental innovation--improving their current products in a "bells and whistles" fashion, making incremental improvements to their products to cement their market dominance. These improvements can be significant, but they are not likely to change the status quo.

Market leaders are often constrained by institutional commitments to existing products or production methods that by necessity impact their innovation strategy. These commitments can be firm-specific skills, investments in complementary assets, customer expectations, patent holdings, or

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[6] *See* Michael L. Bushman & Philip Anderson, "Technological Discontinuities and Organizational Environments," 31 *Administrative Science Quarterly* 439 (1986), *reprinted in* Robert A. Burgelman & Modesto A. Maidique, *Strategic Management of Technology and Innovation* (2d ed. 1996); James M. Utterback, *Mastering the Dynamics of Innovation* (1994); F.M. Scherer & David Ross, *Industrial Market Structure and Economic Performance* (3rd ed. 1990).

even a preference for an established way of doing business. They also have to be concerned about the possibility of cannibalizing existing products. Having less to gain from a radical, new design than a challenger, they are less likely to pursue disruptive technologies or to embrace new innovations that would threaten their dominance.[7]

New firms or challengers, on the other hand, are looking for opportunities to upset the leader's position and to radically change the competitive situation, eliminating or diminishing the leader's market dominance. What they strive to do is overthrow the status quo by destroying or undercutting the leader's competence. They do this by creating new fields of technology or new skills where the leader does not have expertise or an established position. They are more willing or able to venture into completely new and untested directions because they have less of a vested interest in the current technology and are not tied to sunk investments in obsolete technologies. While they are more likely to fail, they are also more likely to provide the great technological leap forward that the dominant firm is unwilling to embrace. It is through this "leap-frog" competition that they are able to establish themselves. [8]

For instance, in the defense industry, periods of major technological innovation have permitted the transformation of a small, niche player into a market leader. In the 1940s and 1950s, the introduction of jet propulsion resulted in McDonnell--a company that had not previously developed an operational fighter or bomber--persuading the Navy to reject market leaders Grumman and Vought

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[7] Pierre Dussauge Stuart Hart & Bernard Ramanantsoa, *Strategic Technology Management* 14 (1992); Bushman & Anderson, *supra* note 6 (distinguishing competence-destroying and competence-enhancing innovations); Peter Swann & Jas Gill, *Corporate Vision and Rapid Technological Change: The Evolution of Market Structure* 15 (1993) (explaining that "[c]ompetence-enhancing innovations need not be minor, and indeed can represent 'order of magnitude' improvements in technology, but the key is that they do not render obsolete those skills that were used to develop the previous generation of technology"); Clayton M. Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (1997) (asserting that established firms find it extremely difficult to pursue a rapidly evolving "disruptive technology" that is not yet mature enough to serve current customers).

[8] Numerous economic studies document that leap-frog innovations are most often created by niche players or by firms attempting to upset the dominant firms. In an analysis of 46 case studies in industries with shattering innovations, James M. Utterback found that most of the leap-frog innovations came from new firms. *See* Utterback, *supra* note 6; *see also* Scherer & Ross, *supra* note 6 (listing historical examples where new challengers, without ties to old or accepted technology, were responsible for revolutionary products/processes).

and to take a chance on a hungry new company. The result was the FH-1 Phantom, the Navy's first successful jet fighter, which made McDonnell, by the late 1950s, the leading fighter developer for the Navy and, two decades later, the leader for the country.[9] Similarly, the innovations of niche player Lockheed were critical to the success of the rapid and ground-breaking introduction of stealth technology designed to enable an aircraft to avoid detection, which has so radically changed our military aircraft. Let me tell you more about how that happened, as the Lockheed stealth story is illustrative of the impact that differently structured firms have on innovation competition.

Lockheed and the Stealth Revolution

In the 1950s, Lockheed was a relatively minor player in conventional fighters and bombers; its major product was the F-104, sold to the Air Force. After the F-104, Lockheed continued to try to get mainstream development contracts for conventional military aircraft, but for more than two decades, it failed. Meanwhile, Lockheed started to focus on developing top-secret, highly specialized, reconnaissance aircraft. Eventually, it developed the SR-71Blackbird spy plane using stealth technology. Throughout the '60s, it continued to develop its expertise in covert reconnaissance aircraft using stealth technology.

Starting in the 1970s, the Air Force and the Department of Defense became increasingly interested in stealth technology for use in a broader range of combat aircraft. In 1974, competitive study contracts to develop design concepts for a stealthy combat aircraft were sent to Northrop, McDonnell-Douglas, General Dynamics, Fairchild, and Grumman. All but Fairchild responded. Lockheed was originally omitted from the competition because Pentagon officials were not aware of certain work Lockheed had done on a classified CIA project.

[9] Mark A. Lorrell, *Bomber R&D Since 1949: The Role of Experience,* MR-670-AF, RAND Corporation (1995); Mark A. Lorrell, *The Cutting Edge: A Half Century of Fighter Aircraft R&D,* MR-939-AF, RAND Corporation (1998).

After joining the competition, Lockheed's engineers submitted an extremely unconventional design nicknamed the "Hopeless Diamond." McDonnell-Douglas, one of the dominant manufacturers of combat aircraft at the time, produced a variant of one of its previous designs. Pentagon officials realized that Lockheed's design was a revolutionary one with the potential to produce an aircraft with unparalleled stealthiness. Lockheed and Northrop (also a small niche, stealth player which gained its experience in stealth technology through in-house study efforts launched in the 1960s, and used that experience in technology for lightweight export fighters) were the two contractors selected to develop the ideas further. Lockheed was awarded a full-scale development contract for the subsonic stealth fighter-attack aircraft later designated the F-117. This aircraft was used to great effect in Desert Storm and is currently being used over Kosovo.

The design for the successful F-117 was a gigantic leap forward in technological innovation. The design was so revolutionary and so risky that a dominant firm most likely would not have attempted it; only a firm hoping to break into the market would have taken such risks. Even within Lockheed, some counseled that the revolutionary design was too risky. Walter J. Boyne, in his book *Beyond the Horizons: The Lockheed Story*, explains that Lockheed's chairman, Bob Haack, "...would have to think long and hard about funding a costly project that might not prove out." But, as Boyne concluded,

> By scraping the financial cupboard almost bare, they managed to provide [the money for the design], at a time when Lockheed's finances were near their lowest ebb. This showed remarkable insight and courage on the part of upper management, just recovering from the long siege of anti-Lockheed publicity. They took grave risks when utter conservatism was a safer choice; and they did so because they knew Lockheed needed to begin selling aircraft to the government again.

Without Lockheed's innovative design, a strategy designed to move the company out of its niche, the stealth revolution would not have been nearly as successful.

Having established itself as a player, what happened to Lockheed? At the request of the Air Force, and because of the extensive knowledge and experience it had with stealth technologies, it went

on to build the F-22 Stealth Air Superiority Fighter. Building upon and refining its work on the F-117 plane, Lockheed teamed up with General Dynamics and Boeing and was selected in April 1991 for full-scale development of the aircraft. The F-22 is expected to be the premier Air Force air-superiority fighter well into the 21st century, partly because of its design and partly because of the high-quality industrial team.

So, at the beginning of the stealth revolution, when Lockheed was a niche player, it took a huge risk with its "leap-frog" innovation, which resulted in the radical design of the F-117. Later, as Lockheed became one of the market leaders in stealth technology, it focused on improving its core skills of stealth technology and developed the incrementally innovative F-22 design. Both planes were innovative, but in different fashions. The success of the F-117 radically altered the status quo. It undercut the previous market leaders' dominance and made their expertise in certain fields irrelevant. The F-22, while also innovative, reinforced Lockheed's position as the market leader in advanced combat aircraft.

Lockheed's story illustrates the importance of diversity in innovations and the principle that "the most fertile soil for innovation is a rich loam of differently situated firms."[10] Indeed, diversity and variety are the key to maintaining and promoting innovation in a market. While I've focused here on size of firms and market position, other forms of diversity exist that can enrich the generation of

[10] John Hoven, "Innovation Effects in Merger Policy," mimeo, Economic Analysis Group, Antitrust Division, U.S. Department of Justice (1998).

innovation, such as R&D joint ventures, vertical relationships, and collaborations between large and small firms.

Merger Innovation Analysis

So where does the Antitrust Division fit in? In evaluating a merger, innovation questions arise in the definition of product market, the identification of firms participating in the relevant market, and the analysis of market concentration, entry, and competitive effects.[11] Though it is possible to have coordinated effects, we most often expect to see some type of unilateral effect: either the merging firms are each other's next best substitute or the merger will affect diversity by eliminating an independent innovator.

When we're determining if innovation competition will be harmed, we first attempt to understand what drives the innovation. Does it come from existing players? Customers? Component suppliers? Collaborators? How has the innovation occurred? Do each of the players have an equal role? Are some leaders and others followers? In other words, we look for the market-specific, firm-specific facts about innovation. To do that, we consider the current market structure; the pace, predictability, and history of innovation in the market, as well as the historical innovation role of each firm; the relative capabilities of the merging firms; and the effect of the loss of variety. We learn this

[11] In merger analysis, a reduction in innovation is usually considered a competitive effect in a downstream product market, or as an element of potential competition. But in some cases, a separate innovation market may be appropriate. *See* U.S. Department of Justice and Federal Trade Commission, *Antitrust Guidelines for the Licensing of Intellectual Property* (1995); Gilbert & Sunshine, *supra* note 4.

through interviews with competitors, potential entrants, and other industry experts. We also look to see if innovation requires specific and unique assets that are not easily acquired, but can nonetheless be reliably identified. Specialized assets will vary across industries but can include key physical assets, experience, production ability, or even, as in many high-tech industries, intellectual property.

After determining the likely source of innovation, we then attempt to answer the following questions: Does the merger affect incentives to perform R&D? Will overall R&D spending decrease? What will happen to the efficiency of the R&D effort? Will the merger affect the diversity of likely innovations? Does the merger result in vertical integration giving the merged firm an incentive to exercise an in-house bias? In other words, we strive to define whether the merger changes the rate or type of innovation.

Many mergers that enhance efficiency can enhance innovation by creating a more effective innovator. There are some instances where R&D truly is redundant and, after a merger, some of those resources could be put to better use in other fields. It's also possible that other merger efficiencies could free up resources to be used for R&D. Combining innovators also may be beneficial when either the different innovation strategies being pursued are complementary, so that a combination of the two would create a better final product, or when the firms have complementary core competencies, such as a merger between a company with strengths in marketing and distribution and a firm strong in innovative design. These pro-innovation mergers generally occur in situations where the innovation path is predictable, where the merging firms pursue similar strategies, and where there are few fringe players.

Other mergers that reduce duplication can diminish innovation and have social costs. By reducing the number of firms, you reduce the likelihood of achieving the most efficient outcome. The more attempts there are, the greater the chance that someone will get it right. Determining what the effect will be is the difficult and challenging task of the antitrust enforcer.

Now, having identified some of the issues for merger analysis, let me talk about two recent cases that we've worked on.

Halliburton/Dresser

The Division's complaint challenging the Halliburton/Dresser merger alleged that the merger would result in increased prices and decreased quality for logging-while-drilling ("LWD") tools and services for oil and natural gas drilling projects, as well as in decreased competition in the development and improvement of LWD tools. LWD services provide information to oil and gas companies about the formations through which the companies are drilling, whether there is oil in the formation, and the ease with which oil can be extracted. Total worldwide revenues for LWD services in 1997 exceeded $500 million.

The LWD market is characterized by a few dominant companies, known as the Big Four (Schlumberger, Halliburton, Dresser, and Baker Hughes), and a number of smaller fringe players. Historically, the pattern of innovation has been that one of the Big Four (or its predecessor) has developed a new LWD tool, improvements for that tool, and then an even more advanced model.

After these innovations, the smaller companies would either buy an older generation of the tool from one of the Big Four, or they would spend several years attempting to create their own versions of the tool. By the time the smaller companies had created their own versions, the Big Four had created something new. In the history of the LWD market, no firm outside the Big Four had entered the LWD market with a major innovation. Under these facts, it was clear that the Big Four had specialized innovation assets that no other firm possessed, and the merger would have combined two of the only four major innovators.

Even though the firms promised to increase R&D spending if allowed to merge, we believed there was a significant anticompetitive problem for two main reasons. First, there was no single innovator among the Big Four. The breakthrough innovations were spread out among the group, so that all four of the companies had recent significant innovations. Second, and more importantly, Dresser and Halliburton had two very different innovation strategies. They approached R&D in significantly different ways. Dresser did little or no pure research (in the sense of expending funds purely to gain knowledge and not to develop a commercial product) and was less concerned about being the first to market with a new innovation. It preferred to learn from the mistakes of others. Halliburton, on the other hand, did more pure research and was more concerned about being the first one in the market. The merger threatened to eliminate one of these approaches, decreasing the chance of successful innovation. It also would have reduced the incentive for the merged firm to innovate and to improve similar, competing tools that the merged firm might deem redundant since it owned both.

Our relief addressed innovation. We required Halliburton to sell its entire LWD business, including its manufacturing, research and development, sales, and service capabilities. The divestiture focused on the specialized assets that were required for innovation. By creating a company with these specialized assets--a wide scope of tools with the capability to operate on a worldwide scale--the divestiture allowed another firm to enter the competition for innovation, ensuring competition in this high-tech industry.

Lockheed Martin/Northrop Grumman

The Division's challenge to the $11.6 billion proposed acquisition of Northrop Grumman by Lockheed Martin was the largest merger ever challenged by the federal government. In the complaint, we alleged that the merger would have resulted in unprecedented vertical and horizontal concentration in the defense industry, which would have substantially lessened, and in several cases eliminated, competition in major product markets critical to the national defense. Lockheed and Northrop were two of the leading suppliers of military aircraft and electronic systems in the United States. The merger would have resulted in Lockheed's obtaining a monopoly in airborne early warning radar, electro-optical missile warning systems, directed infrared countermeasures systems, the SQQ-89 antisubmarine warfare combat system, and fiber-optic towed decoys. It would have reduced the number of competitors from three to two in high-performance fixed-wing military airplanes, on-board radio-frequency counter measures, stealth technology, and remote mine-hunting systems. And it would have had vertical effects in numerous projects, such as the combination of Lockheed's airframe with Northrop's fire-control radar. While the complaint alleged significant price effects, I think it's fair to

say the principal driver of our challenge was the merger's effect on innovation. As the Attorney General indicated when the case was filed, a loss of innovation can literally have life and death implications for our servicemen and women.

Innovation was the key for several reasons. First, due to the Pentagon's weapons acquisitions cycle, most of the critical competitive events occur at a very early stage, when costs and prices are extremely uncertain. What is competitively significant is the quality of the design (or the inventiveness of the idea) and the likely success of its implementation.[12] Second, innovation is often achieved in response to external military threats that change rapidly and are unpredictable, requiring that we maintain a number of firms with the capability of innovating to meet future national security challenges. Third, maintaining diversity of firms is also critical, since maintaining our strategically important technological lead over other countries requires, in part, cutting-edge innovations that incumbents are less likely to encourage.

Since I've been talking a great deal about aircraft today, let me focus specifically on that part of this case. Without even looking at vertical integration issues (which were significant), think for a minute about the implications for our country five, ten, even twenty years from now. Just nine years ago, we had eight military aircraft companies. Today there are only three. Boeing and Lockheed are the giants, while Northrop is considerably smaller. Lockheed and Northrop have the most stealth experience. All three of the firms have experience and capabilities in building a variety of aircraft, and

[12] Office of the Under Secretary of Defense for Acquisition & Technology, U.S. Department of Defense, "Report of the Defense Science Board Task Force on Antitrust Aspects of the Defense Industry Consolidation," at 28 (Apr. 1994)

all three are profitable. Each has bid in recent competitions, although Northrop claimed to have made an internal decision not to bid as a prime contractor in the future. Barriers to entry are extremely high because of Defense Department regulations, the importance of reputation, and the difficulty in obtaining the critical and highly complex skills necessary to win a defense contract. Moreover, weapons programs can span decades, and once capability is lost it is incredibly difficult and slow to recreate it.

Should we have only two? One thing to consider is the amount of teaming in the industry. Had this acquisition been consummated, the resulting firm would have been the prime contractor for thirteen aircraft platforms out of nineteen, and would have participated with its only competitor in virtually every aircraft in production. For example, on the F-22 Lockheed controls 67% of the platform, and Boeing the remaining 33%. On the F/A-18, Boeing controls 60% and, after the merger, Lockheed would have controlled of the rest.

What made the most sense for ensuring that competition exists for the future? Letting the merger go through and ending up with a duopoly of two fairly equal firms which share a large numbers of joint projects, or maintaining three players with different strengths and capabilities? While there is obviously a high degree of uncertainty with any attempt to predict the future, the anticompetitive harm that would have resulted from the merger would have lasted for a very long time, perhaps indefinitely.

And think about the one "technology market"[13] alleged in the complaint--stealth. This merger would have combined the two stealth leaders and the only two companies to have produced stealth aircraft. That has implications that can cut across different products. Indeed, we had seen that Northrop had made a surprising bid for the Arsenal Ship--a stealthy ship which Northrop intended as a stepping stone into competition for the DD21 destroyer--even though it had never built or integrated a ship. In the words of J.S. Gordon of Lockheed's Skunk Works division, through the Northrop acquisition, "Lockheed Martin would consolidate its dominance of stealth-related technology." (Complaint ¶ 82).

These facts--coupled with the other factors I mentioned--led us to conclude the merger had to be challenged: To a large extent, we wanted to preserve innovation competition.

Conclusion

While I've only focused on innovation, I hope I've demonstrated that merger enforcement is extremely relevant to high-tech and emerging growth environments because of the importance of innovation. As you can see, innovation analysis is challenging, but protecting variety in innovation is critically important. We at the Antitrust Department are not trying to direct evolution, we're trying to protect it.

[13] "Technology markets consist of the intellectual property that is licensed... and its close substitutes--that is, the technologies or goods that are close enough substitutes significantly to constrain the exercise of market power with respect to the intellectual property that is licensed." *Antitrust Guidelines* § 3.2.2; *see also* Dussuage et al., *supra* note 7, at 106, 111 (discussing "technology clusters").