Strategy as Vector and the Inertia of Coevolutionary Lock-in

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To examine the consequences of a period of extraordinary success for the long-term adaptive capability of a firm's strategy-making process, this comparative longitudinal study of Andy Grove's tenure as Intel Corporation's chief executive officer (CEO) documents how he moved Intel's strategy-making process from an internal-ecology model to the classical rational-actor model during 1987–1998. His creation of a highly successful strategy vector pursued through an extremely focused induced-strategy process led to coevolutionary lock-in with the personal computer market segment, in which Intel's strategy making became increasingly tied to its existing product market. Intracompany analysis of four new business development cases highlights the inertial consequences of coevolutionary lock-in. The paper examines implications of coevolutionary lock-in in terms of its effect on balancing induced and autonomous strategy processes and exploitation and exploration in organizational learning.●

There is a vast literature ascribing the success of a company to the vision, strategy, and leadership approach of its chief executive officer (CEO). Some of these accounts put the CEO at center stage (e.g., Welch, 2001); others put him or her more modestly in the background (e.g., Collins, 2001). Organizational and strategic management researchers, however, have long highlighted the difficulties leaders encounter in aligning organizational action in the pursuit of strategic intent (e.g., Mintzberg, Ahlstrand, and Lampel, 1998). Recent work in organizational ecology (e.g., Barnett and Hansen, 1996), the behavioral theory of the firm (e.g., Levinthal and March, 1993), and neo-institutional theory (e.g., Zuckerman, 2000) continues to illuminate the external and internal limitations facing top management. Yet we still understand little about why some firms have periods of extraordinary success, what the role of the CEO is in heralding and leading the organization through such periods, and what the consequences are of such periods for strategy making thereafter. While organizational researchers are mostly concerned with ordinary states and expect regression toward the mean to wash out fluctuations over time, periods of extraordinary success have potentially important consequences for the strategy-making process as a long-term adaptive organizational capability, that is, spanning multiple generations of CEOs.

Longitudinal field-based research on strategy making at Intel Corporation during Andy Grove's tenure as CEO offered the opportunity to study a period of extraordinary corporate success and its consequences for the company's strategy-making process. Intel seemed a particularly interesting research site because it is one of the most important firms of the digital age (Gilder, 1989; Isaacson, 1997), and its evolution highlights the fundamental technological and economic forces that characterize digital industries (e.g., Arthur, 1987). The research could be used to compare Grove's strategy-making approach to that of his predecessor (Gordon Moore) and successor (Craig Barrett) and thus could examine his efficacy as CEO within the context of Intel as an evolving system over time.

Andy Grove succeeded Gordon Moore as CEO in 1987 at the time that Intel was recovering from defeat in its original semiconductor memory business and refocusing on its microprocessor business (Burgelman, 1994). He held the position until early 1998. Between 1987 and 1998, Intel became the clear winner with its microprocessors in the personal computer (PC) market segment. Intel's revenues grew from $1.9 billion to $25.1 billion—an increase of 29.4 percent per annum—and net income grew from $248 million to $6.9 billion—an increase of 39.5 percent per annum. In 1998, however, Intel's growth in the core business slowed down significantly. Also, it had become clear that new business development was relatively unsuccessful during Grove's tenure as CEO. In 1997, Craig Barrett, then Intel's chief operating officer (COO), observed that Intel's core microprocessor business had begun to resemble a creosote bush, a desert plant that poisons the ground around it, preventing other plants from growing nearby. The creosote bush metaphor raised potentially interesting questions about the strategic consequences of Intel's ability to dominate in the PC market segment. It drew attention to the phenomenon of coevolutionary lock-in: a positive feedback process that increasingly ties the previous success of a company's strategy to that of its existing product-market environment, thereby making it difficult to change strategic direction. Despite the attention given to winner-take-all competition in digital industries (e.g., Arthur, 1987) and the role of inertia in organizational and industry evolution (e.g., Hannan and Freeman, 1977, 1984), researchers have paid little attention to how coevolutionary lock-in comes about and may become a significant source of strategic inertia. This study addresses this gap. It seeks to shed light on the role of the CEO in creating a strategy-making process that leads to coevolutionary lock-in and what its implications are for organizational adaptation.

Grove described his approach as "vectoring" Intel's strategy-making process. Vector—a quantity having direction and magnitude, denoted by a line drawn from its original to its final position (*Oxford English Dictionary*)—seems an apt metaphor to describe his efforts to align strategy and action. By creating a strategy vector, Grove was able to drive Intel in the intended direction with a total force equal to all the forces at its disposition. The paper examines the long-term adaptive implications of Grove's strategic leadership approach, which seemed to approximate the classical rational-actor model (Allison and Zelikow, 1999; Bendor and Hammond, 1992), and contrasts it with that of his predecessor.

COEVOLUTIONARY LOCK-IN IN FIRM EVOLUTION

Informed by evolutionary organization theory (e.g., Aldrich, 1999; Baum and McKelvey, 1999), earlier research on Intel before Grove became CEO suggested that effective strategy making may be as much about creating an environment in which middle management makes strategic decisions as it is about strategy making in the classical sense and that the role of top management might be to recognize transitions rather than to initiate them (Burgelman, 1994). These findings were consistent with an internal ecology model of strategy making, which was conceptualized in terms of induced and

autonomous strategy processes (Burgelman, 1991). Induced strategy exploits initiatives that are within the scope of a company's current strategy and that extend it further in its current product-market environment. Autonomous strategy exploits initiatives that emerge through exploration outside of the scope of the current strategy and that provide the basis for entering into new product-market environments. Intel's strategy making before Grove became CEO resembled an internal-ecology model in which induced (memory-related) and autonomous (microprocessor-related) initiatives competed for the company's scarce resources based on their success in the external competitive environment. This paper documents how Grove's successful strategy vector created a highly focused induced-strategy process, which moved Intel's strategy making away from the internal-ecology model and closer to the rational-actor model. It shows how positive environmental feedback associated with the successful strategy vector caused coevolutionary lock-in and how this can illuminate time-paced evolution (Gersick, 1994; Brown and Eisenhardt, 1997) and the dynamics of competitive intensity (Barnett, 1997).

Strategic Inertia of Coevolutionary Lock-in

This paper's detailed ethnographic data also document new sources of strategic inertia that may be the unintended consequence of coevolutionary lock-in. Systemic sources of inertia associated with coevolutionary lock-in provide additional insight into structural inertia (Hannan and Freeman, 1984). They help elucidate the dynamics of the evolving relative efficiency of internal selection (Miller, 1999; Lovas and Ghoshal, 2000) and external selection (Sorenson, 2000), as a company's product-market environment matures, and of the rate and direction of innovation relative to environmental evolution as firms grow large (Sørensen and Stuart, 2000). Study of the psychological sources of inertia associated with coevolutionary lock-in can be used to assess Prahalad and Bettis's (1986) contention that executives become ingrained with beliefs about causes and effects that may not hold after the environment changes. And they help sort out Audia, Locke, and Smith's (2000) argument that success tends to increase decision makers' feelings of self-efficacy from that of Miller and Chen (1994), who suggest that it causes complacency, understood as drifting without further attempts at improvement. These psychological sources of strategic inertia draw attention to the potential limitations of evolution guided by the strategic intent of the CEO (Lovas and Ghoshal, 2000). Most important for the purposes of this paper, the various sources of strategic inertia associated with coevolutionary lock-in have implications for maintaining a balance between induced and autonomous strategy processes and between exploitation and exploration in organizational learning. They help connect these ideas, which are rooted in evolutionary organization theory (Burgelman, 1991; March, 1991), with related ideas of the modern economic theory of the firm (Rotemberg and Saloner, 1994, 2000).

RESEARCH METHOD

The research reported in this paper is part of a longitudinal multistage, nested case study design (e.g., Yin, 1984; Leonard-Barton, 1990) focused on major periods of Intel's history (Burgelman, 2002). These include Epoch I: Intel the memory company (1968–1985); Epoch II: Intel the micro-processor company (1985–1998); and Epoch III: Intel the Internet building-block company (beyond 1998). These three epochs correspond roughly to the tenure of Gordon Moore, Andy Grove, and Craig Barrett as Intel's CEOs.

Data Collection

Interview data. For this paper, which focuses on Intel's Epoch II, I used data from 63 informants, collected mostly through interviews I and/or a research associate conducted and through informal interactions. Informal interactions some-times involved a research associate. Others took place in the strategic long-range planning sessions I observed, executive education sessions I taught for senior Intel executives, and working with Intel staff in preparing for executive education sessions. I also had access to transcripts of interviews con-ducted and tape-recorded by Intel consultants. The list of these informants and their position in the organization is pro-vided in table 1. Managers from different levels, different functional groups, and different businesses were involved. Throughout the research period, I used informal discussions with many current and former Intel employees to corroborate data obtained from the formal interviews. Most interviews lasted between one and two hours and focused on key events, people, and issues. Key events involved, for instance, the introduction of successive generations of microproces-sors. Key people were individuals or groups from different functional areas or different hierarchical levels who made crit-ical decisions or made proposals that, while not necessarily implemented, triggered high-level reconsideration of strategic issues. Key issues included, for instance, how to allocate resources to different businesses, how to resolve internal competition between different microprocessor architectures, and how to enter into new businesses. Most interviews were not tape-recorded (exceptions are listed in table 1, below), but the interviewers made extensive notes. Many of the interviews were done together with research associates. Transcripts of the research associates' notes showed agree-ment on the substantive content of the interviews. This pro-vided some confidence that the data were valid and reliable.

Archival data. Archival data, such as documents describing the company's history, annual reports, and reports to financial analysts, were obtained from Intel. Additional archival data were obtained from outside sources, such as industry publi-cations and financial analysts' reports and business press arti-cles about Intel and the semiconductor and computer indus-tries. The archival data could be juxtaposed to the interview data to check for potential systematic biases in retrospective accounts of past strategy.

Case teaching as a data source. The interview and archival data were used to write several case studies about the role of strategy making in Intel's evolution during the period that

Table 1

Informants Providing Data Concerning Epoch II (1988–1998)

Name and most relevant job during Epoch II	Interview	Informal Interaction
1. Gordon Moore, chairman	X	X
2. Andy Grove, CEO	X	X
3. Craig Barrett, COO	X	X
4. Gerry Parker, executive VP, Technology and Mfg. Group	X	X
5. Paul Otellini, executive VP, Intel Architecture Business Group	X	X
6. Frank Gill, executive VP, Intel Products Group, gen. mgr. Networking	X	X
7. Les Vadasz, senior VP, Corporate Business Development Group	X	X
8. Albert Yu, senior VP, Microprocessor Products Group	X	X
9. Ron Whittier, senior VP, Intel Architecture Labs, Content Group	X	X
10. Andy Bryant, senior VP and CFO	X	
11. Sean Maloney, senior VP, Sales and Marketing Group		X
12. Dennis Carter, VP, Corporate Marketing Group	X	X
13. Ron Smith, VP, gen. mgr. Chipsets	X	X
14. Patrick Gelsinger, VP, gen. mgr. ProShare	X	X
15. Mike Aymar, VP, Desktop Products Group, Hood River	X	X
16. Mark Christensen, VP, gen. mgr. Networking (late 1990s)	X	X
17. John Miner, VP, Enterprise Server Group		X
18. Hans Geyer, VP, gen. mgr. Flash Products Division		X
19. Patty Murray, VP, Human Resources		X
20. Harold Hughes , VP and CFO mid-1990s	X	X
21. John Davies, VP, Consumer Marketing Desktop Prod. Grp., Hood River	X	
22. Avram Miller, VP, Corporate Development Group, Hood River	X	
23. Jim Johnson, gen. mgr. PC Enhancement Organization (late 1980s)	X	X
24. Claude Leglise, Marketing Director i860 (late 1980s)	X	X
25. Steve McGeady, gen. mgr. Home Media Lab (mid-1990s)	X	X
26. Scott Darling, gen. mgr. Busin. Com. Prod. Grp., ProShare (late 1990s)	X	X
27. Sandra Morris, manager Intel Prod. Grp. (mid-1990s)	X	X
28. Tom Yan, mgr. development OEM Prod. and Syst. Div., Hood River	X	
29. Dick Pashley, gen. mgr. Flash Memory Division (early 1990s)	X	X
30. Warren Evans, Business Process Network, Planning	X	X
31. Renee James, technical assistant to Andy Grove (mid-1990s)	X	X
32. Katherine Yetts, technical assistant to Craig Barrett (mid-1990s)	X	X
33. Michael Bruck, program manager Content Group	X	X
34. Vin Dham, program manager Pentium processor (early 1990s)	X	X
35. Richard Wirt, director Software, IAL	X	X
36. Les Kohn, technical manager, i860 processor (late 1980s)	X	
37. Bruce McCormick, manager, Flash (mid-1980s)	X	
38. Sally Fundakowski, manager, CMG (early 1990s)	X	
39. Tom Macdonald, marketing director for 386 and 486 processors	X	
40. Jim Yasso, mgr. in Desktop Prd. Grp. and Microp. Prd. Grp. (mid-1990s)	X	
41. Don Whiteside, gen. mgr., Digital Imaging and Video Division	X	
43. Lori Wigle, strat. mkting. dir. Digital Imaging and Video Division	X	
43. Tom Willis, manager in Corporate Business Development Group	X	
44. Dave Williams, director Home Media Lab	X	
45. Dave Cobbley, director Home Media Lab	X	
46. Rob Siegel, program manager Hood River	X	X
47. Ganesh Moorthy, mgr., Appliance and Comp. Div. (Deskt. Prod. Grp.)	X	
48. Krish Bandura, engineer, Hood River	X	
49. Roy Coppinger, product mgr. OEM Prod. and Syst. Div., Hood River	X	
50. Eric Mentzer, marketing manager, Chipsets	X*	X
51. Andy Wilhelm, technical manager, Chipsets	X*	
52. Andy Beran, finance manager, Chipsets	X*	
53. Tom Bruegel, finance manager, Networking (mid-1990s)	X*	
54. Dan Sweeney, marketing program mgr., Networking (mid-1990s)	X*	
55. Steve Cassell, engineering mgr., Networking (early 1990s)	X*	
56. Kirby Dyess, marketing mgr., PC Enhancemt. Org. (late 1980s)	X*	X
57. Susan Studd, human res. mgr., PC Enhancemt. Org. (late 1980s)	X*	X
58. Gerry Greve, marketing director ProShare (mid-1990s)	X*	
60. Laura Finney, finance manager ProShare (mid-1990s)	X*	
61. Taymoor Arshi, engineering manager, ProShare (mid-1990s)	X*	
62. Mark Olson, product marketing manager Microproc. Prod. Grp.		X
63. John Sutherland, manager, Systems Management Division		X

* These interviews were tape recorded by Intel consultants, and transcripts of the raw recorded interview data were made available to this author.

Grove was CEO (Cogan and Burgelman, 1991; Steere and Burgelman, 1993a, 1993b; Fine and Burgelman, 1997; Bamford and Burgelman, 1997a, 1997b; Bamford and Burgelman, 1998; Suzuki and Burgelman, 1998; Burgelman, Carter, and Bamford, 1999). Lengthy discussions with the research associates involved in writing these cases provided me with an opportunity at each writing to check whether they thought my interpretation of the data was consistent with theirs, providing an additional check on internal validity (e.g., Dyck and Starke, 1999). Grove taught these cases in Stanford Business School's Master's of Business Administration (MBA) program throughout the research period. This yielded rich additional data as he reflected on Intel's strategic situation in class. It provided a window into the mind of the CEO as strategic thinker that has rarely been matched in previous studies.

Multilevel Comparative Analyses

I adopted the methodology of grounded theorizing (Glaser and Strauss, 1967) to analyze the field data. While grounded theorizing requires care not to use data simply as illustrations of preconceived theoretical ideas, analysis is only possible within a theoretical perspective. With this in mind, I used three interrelated conceptual frameworks generated through grounded theorizing in earlier work. Together, these frameworks form an evolutionary research lens to perform a multilevel comparative analysis of Intel's strategy making during Andy Grove's tenure as CEO. At the company level, the analysis is comparative with respect to time. I examined Intel's strategy making during Epoch II with a framework including induced and autonomous strategy processes (Burgelman, 1991) and compared it with Epoch I. At the company-environment interface level, the analysis is also comparative with respect to time. I examined the coevolution of Intel's strategy with the PC industry during Epoch II, leading to lock-in, with a framework of internal and external forces driving company evolution (Burgelman, 1994) and compared it with Epoch I. The forces taken into account in this framework include the basis of competitive advantage in the industry, the firm's distinctive competencies, its official corporate strategy, its strategic actions, and its internal selection environment. At the intracompany level, the analysis compares new business development efforts during Epoch II. The process model of internal corporate venturing (Burgelman, 1983), which identifies the interlocking key activities of multiple levels of management involved in internal new business development, helped in examining the behavioral details of the development of four cases in the context of Intel's strategy-making process.

Strengths and Limitations of the Research

By concentrating on one firm and tracking one CEO throughout his tenure, I had access to sources with intimate knowledge of the details of the company's strategy making. It also allowed me to become familiar with "the manager's temporal and contextual frame of reference" (Van de Ven, 1992: 181). Because I had virtually unlimited research access to the company throughout the twelve-year research period, I was able to obtain input from different levels of management, which

provided a basis for triangulation and made it possible to maintain an appropriate level of distance and neutrality, while capitalizing on the teaching collaboration with Andy Grove. Nevertheless, the research has several limitations. First, it focused on a single high-tech company run by one of the founding team members. Also, during Grove's tenure as CEO, the PC industry expanded enormously, and fortuitous circumstances contributed to giving Intel the opportunity to become a driving force. Finally, during the study, I kept track of the evolving fortunes of Intel's competitors, but it would have been fruitful to study these other organizations systematically if time and access had permitted it.

COEVOLUTIONARY LOCK-IN OF STRATEGY AND ENVIRONMENT

Grove's Strategy Vector

During Epoch II, Gordon Moore remained as chairman and Craig Barrett served as chief operating officer (COO). Looking back in 1999, Andy Grove pointed out that "At no point in Intel's history has it been a solo show. It's never been only one person leading the organization. Our tradition is somewhat of a shared power structure." Nevertheless, many insiders confirmed that Andy Grove drove strategy making during Epoch II. Table 2 provides a chronology of selected key instances throughout Epoch II, when it was clear that Grove made the difference in how Intel took strategic action in the core microprocessor business.

The data presented in table 2 show that Grove's role in driving Intel's strategy making relied more on strategic recognition than on foresight. Intel had been lucky to invent the microprocessor and even more lucky to obtain the design win for the IBM PC. But it was ex post facto strategic recognition of the importance of these fortuitous events that set Intel on its highly successful course. An article in the *New York Times* in 1988 pointed out that it was "irksome to competitors . . . that there is a fair amount of luck involved in all of this [Intel's success]." Responding to this, Andy Grove was quoted as saying, "There is such a thing as luck and then you grab it and exploit it" (Pollack, 1988). Grove sometimes also called it "earned luck" (Schlender, 1989). Table 2 indicates that the ability to get the organization to follow up on the mandates that he imposed based on his strategic recognition was another defining characteristic of Grove's leadership. Contrasting Grove's strengths to those of co-founder Robert Noyce and his own, Gordon Moore said, "Andy is a true manager. He is very detail oriented. He has strong follow-up—he never trusted that anyone would do what they were asked unless there was follow-up—and he is strongly data driven."

Focusing Intel on the microprocessor business. Table 2 indicates that toward the end of Epoch I, then-COO Grove recognized that Intel's future lay in microprocessors rather than memory products. To make sure that the organization would be committed to the new microprocessor-focused strategy when he became CEO, Grove made major changes in Intel's senior management. He recalled:

Table 2

Company Level of Analysis: Andy Grove's Impact on Intel's Strategy Making during Epoch II*

Selected key instances	Strategic recognition	Strategic action

Transition to Epoch II: Focusing Intel on microprocessors as chief operating officer (mid-1980s)

Selected key instances	Strategic recognition	Strategic action
Ed Gelbach (sales VP and director)[†]: "In board meetings the question of DRAM would often come up. I would support them from a market perspective, and Gordon [Moore] would support them because they were our technology driver. Andy [Grove] kept quiet on the subject."	*COO Andy Grove:* "I stayed quiet because I didn't know what to do, initially."	Grove removes Carsten as GM Components Division in summer 1985.
	COO Andy Grove: "It's not always clear why you do certain things. You do a lot of things instinctively, without knowing why you're doing it. I knew we had to get out of DRAMs and put all our brightest on microprocessors."	Grove moves Sunlin Chou and the DRAM Technology Development Group to microprocessors.
Jack Carsten (GM Components Division)[†]: "Grove said: 'Don't worry about the memory business, it is not important to our future.'"		Grove goes to Oregon in October 1985 and tells the organization: "Welcome to the mainstream of Intel."
Another senior executive[†]: "Grove has been preaching: 'Make the tough decisions! Don't do tomorrow something because you did it today.'"	*COO Andy Grove:* "I recall going to see Gordon (Moore) and asking him what a new management would do if we were replaced. The answer was clear: Get out of DRAMs. So, I suggested to Gordon that we go through the revolving door, come back in, and just do it ourselves."	

Resolving the battle between i860 (RISC) and x86 (CISC) microprocessors within Intel (1991)

Selected key instances	Strategic recognition	Strategic action
Dennis Carter (VP Corporate Marketing): "In the end, Andy [Grove] resolved the debate. He essentially did a compromise that favored CISC."	*Andy Grove in February 1991:* "The strategy process reflects the company's culture. You can look at it positively or negatively. Positively, it looks like a Darwinian process: we let the best ideas win; we adapt by ruthlessly exiting business; we provide autonomy, and top management is the referee who waits to see who wins and then rearticulates the strategy; we match evolving skills with evolving opportunities. Negatively, it looks like we have no strategy; we have no staying power, we are reactive, try and move somewhere else if we fail; we lack focus."	Grove did not allow the planned introduction of both 486c and 486r processors that would have signaled a planned transition path from CISC to RISC. The i860 business was to continue by that name and was soon halted in early 1991.
		Andy Grove in November 1992: "It was a confusing period for Intel. . . . The i860 was a very successful renegade product that could have destroyed the virtuous circle enjoyed by the Intel Architecture. . . . Intel was helping RISC by legitimizing it. . . ."

Identifying the magnitude of capital investment as Intel's new differentiator (1993)

Selected key instances	Strategic recognition	Strategic action
Direct observation during SLRP 1993: In his kick-off presentation, Grove identified Intel's successive key strategic differentiators throughout its evolution: Silicon technology competence (1970s), design competence (mid-1980s), intellectual property (late 1980s), and brand preference (early 1990s). He then suggested that the increasingly large capital investments necessary for next-generation processors had become the new differentiator for the next several years.	*Andy Grove:* Pointing to the great uncertainty associated with these capital investments, Grove posited that they would provide Intel with a new competitive advantage. He asked, rhetorically, "Who is going to invest \$5 billion on speculation?"	Grove was willing to make these large bets. During the remaining 4 years of his tenure as CEO, Intel invested \$13.5 billion in plant, property, and equipment.
		In 1997, Craig Barrett said, "It's a risk to go out and spend billions of dollars on these manufacturing plants. But if we didn't, we couldn't possibly reap the benefits. We're going down the road at 150 miles per hour, and we know there's a brick wall someplace, but the worst thing we can do is stop too soon and let someone else pass us" (Reinhardt, Sager, and Burrows, 1997: 71).

Continued

Table 2 *(Continued)*

Resolving conflict around "Intel Inside" between Corporate Marketing and Intel Products Group

Direct observation during SLRP 1993: At the end of SLRP the objectives as stated in 1992 were revisited in light of the discussion during the 1993 SLRP. The third objective in 1992 was "Manage the Intel and Intel Inside brands for significant return and long-term advantage." Grove felt that this objective had to be restated in light of the intense conflicts that had broken into the open between CM (Dennis Carter) and IPG (Frank Gill) during the SLRP 1993 discussions.

Andy Grove: "This is a lame statement. And yet it is the inflection point—[similar] to what happened with the transition from memories to microprocessors. This involves a dialectic. It is a move from a single space to a dual one. This duality is all over the place. It is a continuation of the change from OEM to a distribution channel."

Grove decides: "Dennis [Carter] and Frank [Gill] must rephrase this. It must be words that will affect hundreds of people that work for them and are fighting over it. The new words [must make sure] we get credit for what we do for our [end-user] customers: ease-of-use, richness, upgradability; and who our customers *could* be."

Supporting Intel's motherboard business in the face of organizational resistance (mid-1990s)

Harold Hughes (former CFO): "Andy was always brilliant at identifying threats to our business. For example, on the motherboards business, Andy and I clashed. I said that we were never going to make any money on motherboards. But they did push adoption of our microprocessors. Our motherboard business allowed the little [OEMs] to stay competitive."

Andy Grove: "I have been rabid about four things in my career at Intel: motherboards, Intel Inside, chipsets, and videoconferencing."

Grove supported the development of the motherboard business in spite of strong opposition of the microprocessor division, whose OEM customers complained vigorously about Intel's vertical integration strategy, and in the face of reservations on the part of the CFO.

Supporting the chipset business to drive industry adoption of Intel technology (mid-1990s)

Several executives pointed out that Andy Grove initially did not support the development of the chipset business based on the new Peripheral Component Interconnect (PCI) bus technology but, rather, wanted to introduce the new technology as an enabling technology into the PC industry with a consortium-based effort.

After the chipset business became very successful, Andy Grove changed his mind about chipsets as a strategic business for Intel.

Grove then began to view the chipset business as an important tool for supporting the corporate strategy. Andy Bryant (CFO) said, "At a time when motherboard pricing was extremely competitive, the motherboard division decided not to use Intel's chipsets because they were more costly than third-party alternatives—even though they provided superior performance. . . . Grove ruled that the long-term interests of the company required moving advanced technology into the marketplace and that we should forgo short-term returns for the long-term benefits."

Driving Intel to meet the threat of the growth of the low-end of the PC market segment (1997)

Direct observation during SLRP in September 1997: Grove was very concerned about recent developments in the PC market segment. He felt that Intel's top management was failing to see the strategic implications of the rapid growth in demand for below-$1,000 PCs.

Andy Grove during his SLRP kick off: "We say we have a top-to-bottom strategy. But we don't act top-to-bottom, because Intel has low-end phobia. . . . But the low end is not going away. . . . The data about desktop sales at the retail, reseller, and direct level all show a downward trend in price: $500 in about a year! I have not seen that before, And the volumes at the low end are up. So, the good news about segment zero is that we have it on our road map. The bad news is that we don't have an engineered product."

Grove articulated a new mandate, requiring the assignment of a large number of engineers to the task of developing a microprocessor specifically for the low-end market segment

In about six months the team developed a new product called the Celeron processor, which made it possible for Intel to regain market segment share against AMD in the low end by early 1999.

In early 1999, Paul Otellini observed, "We've made a lot of progress on the low end. One year ago in the sub-$1,000 market our share was about 38 percent. We then lost some ground, but we have regained share, so we're at about 38 percent again."

Continued

Table 2 *(Continued)*

Looking back: Grove's influence on the PC industry during Epoch II

Gordon Moore (chairman emeritus) in 1999: "When he became CEO, he really jumped on the opportunity to organize the industry. I wasn't so inclined to do this. He likes public exposure more than I did, and he has a stronger feeling about where he fits in. . . . Andy has had a tremendous impact on what's going on outside."

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* Abbreviations and terms used in this table are as follows: DRAM = dynamic random access memory; RISC = reduced instruction set computing; CISC = complex instruction set computing; and SLRP = strategic long-range planning. The motherboard is the main integrated circuit board in a PC; it contains the microprocessor, the memory, and other support chips. A chipset is the set of support chips for the microprocessor, for example, a chip that controls computer graphics. Bus refers to the set of electrical connections between a microprocessor and the other chips on an integrated circuit board. The speed of communication allowed by the bus affects PC performance. The PCI bus architecture increased speed significantly over the previous bus standard.
† Executive interviewed for Epoch I Study, not listed in table 1.

The Grove leadership approach consisted of trying to persuade and sell the new strategic approach to the management team. . . . After some period of time, the new strategy had traction with some managers and it did not have traction with some others. The people who did not get traction—they may have provided lip service to the new strategy, but their actions were not so supportive—the approach was to remove these people from positions where they could choke progress. We moved them around to other positions where they couldn't impede progress. This worked for a period of time. But when it became obvious that they were in a position that was not so important or influential, several of them left. We didn't actually have to fire anyone, nor were we happy that they left. But they were not happy being in a non-core activity.

Intel's new corporate strategy reflected key lessons that top management had learned from the DRAM (dynamic random access memory) exit. In the context of a case discussion in an MBA class in the early 1990s, Grove said:

We learned that we had to get around the companies that had subjugated us in DRAM. We learned that high market share was critical for success and that to get market share we had to be willing to invest in manufacturing capacity. Such investments involve big bets because they have to be made in advance of actual demand. We learned that commodity businesses are unattractive, so we didn't want to license out our intellectual property anymore.

General-purpose microprocessors were a disruptive technology (Christensen and Bower, 1996). Microprocessor development was subject to Moore's Law, which posits that computing power doubles every 18 months and is available at the same price. Andy Grove was among the first to recognize that, in contrast to the vertically integrated mainframe and minicomputer industries, the PC industry followed a "horizontal" model in which a component manufacturer's products needed to be able to work with other component manufacturers' products (Grove, 1993, 1996). Grove's "vertical" and "horizontal" were a precursor to what economists call "closed" and "open" models of industry organization (Farrell, Monroe, and Saloner, 1998: 144). Success in the horizontal PC industry was governed by increasing returns to adoption,

a new economic force (e.g., Arthur, 1987) that was initially not well understood by most industry participants. Increasing returns to adoption meant that a technological platform, like Intel's x86 microprocessors, became increasingly valuable the more people were using it. Achieving a high installed base was key to creating a virtuous circle. While economies of scale and economies of learning were important determinants of the relative success of different industry participants competing within the same microprocessor architecture, increasing returns to adoption strongly affected competition between different architectures.

Resolving the internal battle between CISC and RISC. The x86 architecture was based on complex instruction set computing (CISC). During the mid-1980s, however, Intel's autonomous strategy process generated the development of a microprocessor (the i860) based on a new architecture called reduced instruction set computing (RISC). Internal champions of the i860 had been able to generate support from workstation original equipment manufacturers (OEMs), which were new customers for Intel. During 1989–90, the autonomous and somewhat surreptitious development of the i860 and its initial market success looked like a potentially adaptive variation (Burgelman, 1991). But the new microprocessor soon created significant confusion inside the company that reflected external confusion about the importance of the RISC architecture for the future development of the PC. The internal confusion manifested itself in the emergence of two warring camps within Intel's microprocessor development group (MPG). Each camp had its external supporters. Andy Grove said that Microsoft supported the i860. Compaq, however, strongly supported the x86 architecture. According to Grove, within a short period of time, the RISC camp had been able to claim about 50 percent of the microprocessor development resources because there was no clear corporate strategy regarding RISC (personal communication). Some within Intel proposed to create a transition path from the x86 architecture to the RISC architecture by bringing out two versions of the i486, one called i486c and the other i486r, but this proposal ran into strong resistance from Dennis Carter, Intel's senior marketing executive during most of Epoch II, who feared that it would undermine Intel's brand identity. In part motivated by the negative consequences that a similar battle between CISC and RISC was having within rival Motorola (Tredennick, 1991), Grove eventually resolved the situation. Table 2 quotes Dennis Carter on how Grove decided the issue. It also reports Grove's growing concerns about Intel's strategy-making process. The episode strengthened his determination to fully exploit Intel's favorable strategic position with the x86 architecture. He said, "The commitment to the x86 architecture vectorized everybody at Intel in the same direction."

Effectively driving strategy making in the core business. The significance of the rise and fall of the i860 microprocessor lies primarily in the effect it had on Grove's efforts to further strengthen Intel's induced strategy process. Table 2 shows that Grove had come to the conclusion that Intel's Darwinian strategy process was perhaps a guise for lack of a clear strategy. His efforts to vectorize everybody at Intel in

the same direction in 1991 created an induced strategy process superbly suited for exploiting the rich opportunities in the PC market segment of the microprocessor industry. Several entries in table 2 describe how Grove drove Intel's strategy making in the core business during the remainder of Epoch II. He showed keen insight in the successive strategic differentiators that had formed the basis of Intel's competitive advantage in the past and emphasized the importance of large capital investments for competitive advantage for the remainder of the 1990s. He forced senior executives to resolve the frictions that were emerging between corporate marketing's concerns about protecting the Intel brand and the needs of businesses outside the core microprocessor business. He forced the motherboard business to adopt Intel's more advanced but also more expensive PCI chipset technology in the face of resistance of both the motherboard managers and the finance organization. Toward the end of Epoch II, Grove forced the microprocessor business to face up to the dangerous threat posed by the rapidly growing low end of the PC market. He recognized that Intel's "low-end phobia" was preventing it from meeting the challenge posed by this major environmental shift and directed Intel to engage in a crash effort to develop the Celeron processor to meet it. Finally, as Gordon Moore observed, Grove's strategy vector gave Intel the opportunity to drive its external environment, that is, the development of the PC market segment.

Intel's Narrow Business Strategy

Already in 1989, then-chairman Gordon Moore had observed that CEO Andy Grove had significantly narrowed Intel's strategic focus, but he also predicted that the growth potential of the microprocessor business would not make that a problem in the next twelve years (Burgelman, 1991). Looking back in 1998 and comparing Intel's strategy during Epoch II and Epoch I, Grove said, "The most significant thing was the transformation of the company from a broadly positioned, across-the-board semiconductor supplier that did OK to a highly focused, highly tuned producer of microprocessors, which did better than OK" (Kawamoto and Galante, 1998). Many senior executives confirmed that Grove forced a distinct shift in the strategy-making process toward a narrow business strategy focused on microprocessors for the PC market segment. Table 3 provides evidence of this shift. The views expressed in table 3 touch on various aspects of the strategic leadership approach Grove used to focus Intel's induced strategy process narrowly on the microprocessor business. They include setting clear objectives and establishing a structural context (Bower, 1970; Burgelman, 1983), including strategic planning, organization structure, and resource allocation, to align strategy and action.

Unambiguous strategic objectives. Intel's strategic focus became ingrained in the strategy-making process through the setting of clear and consistent objectives. Intel's number-one objective was to strengthen the position of Intel microprocessors in the evolving computer industry. A related objective was to "make the PC it," which became somewhat of a rallying cry. Grove viewed the PC as the ideal tool for computing as well as for communications, and even for entertainment.

Table 3

Company Level of Analysis: Views on Intel's Narrow Business Strategy during Epoch II

Gordon Moore (1989):
"Over time . . . Intel has narrowed and narrowed its technological interests. Andy [Grove] has been instrumental in this. . . . We can do variations on present businesses very well. But doing something new is more difficult."

Gerry Parker (1989):
"We could now manufacture everything in one and one-half plants. That's obscene. You need a broad product base—EPROM [electrically programmable read-only memory] is a natural. . . ."

Les Vadasz (1988):
"The system [strategic long-range planning] is now [in the late 1980s] more top-down. A high-level group sets the corporate strategy, and business units operate within that focus. Business units must focus on a few things and do them right. . . . Some managers complain that their 'sandbox' is too well defined."

A senior executive (1995):
"Intel may be too focused too soon. We have narrowed our range of experimentation too fast from 360 degrees to 180 and then to 90. The code words are: You don't have a business plan; your strategy is vague."
"We must narrow down from a 360 degree scan to 20, but even so we still have 20 things to do. Andy [Grove], however, wants a 'laser shot.'"

Frank Gill (1997):
"In 1994–95, Andy [Grove] would tell me 'Frank, I make a billion dollars in profit per quarter and you make a billion dollars in revenue per year. This is all distraction, so focus on Job 1.'"

Another senior executive (1998):
". . . a lot . . . is driven from Job 1, because every six months we have a SLRP [strategic long-range planning meeting]. Andy [Grove] stands up and says . . . here is a problem. And everyone says . . . we can go do wonderful things to solve that problem."

Craig Barrett (1999):
"[During the second epoch] we became much more verticalized behind IA and related businesses. Now we are more broad. . . . This requires less top down management and more P&L and line management."

A third senior executive (1999):
"Barrett is very different from Grove. First, he's encouraging new ideas. . . . Andy wouldn't have let that happen. Craig made it happen. . . . Second is behavior. If you have a good idea, overwhelm it with resources: What do you need? Do what it takes. Come back with a prize. . . . That's a different style."

A fourth senior executive (1999):
"But I am more concerned about Andy [Grove] because of his singular focus. Andy says that PCs are becoming a commodity. So, we must focus on servers and not let Sun [Microsystems] capture this. It is like going back to the old days."
"Barrett at some point will be expected to set the corporate strategy; and if he doesn't, Andy [Grove] will."

Intel also made a distinction between "Job 1" and "Job 2." Job 1 encompassed everything that had to do with making the Intel architecture more successful. Job 2 involved the development of new businesses around the core business.

CEO-driven strategic planning. Grove said that he had used changes in the company's strategic long-range planning process (SLRP) to redefine the content of the new corporate strategy and get the organization to execute it:

In 1987, we blew up the SLRP process. Formerly it had been a very bottom-up process, but there was no strategic framework. Each of the different groups was supposed to come up with the strategy for

their group, and then we would try to piece them together like a jig-saw puzzle. By '87, I was so frustrated with the whole thing that I started the process of turning the SLRP process on its head. I said, 'I'm going to tell you what the strategy is.' I started with a detailed discussion of the environmental issues, which led to a series of strategic mandates. I did not consult the organization. I did this myself, along with the help of my technical assistant at the time, Dennis Carter . . . I became very directive in prescribing the strategic direction from the top down. This defined the strategy for all of the groups, and it provided a strategic framework for different groups at different levels of management. It's very hard to reach through several layers of management to communicate the strategy and the vision. SLRP became a tool for doing that.

Typically, Grove's SLRP kickoff speech was followed by a two-hour presentation in which he addressed Intel's strategic challenges, presented his vision of what was happening in the industry, and identified high-level trends. The remainder of the three-day meeting involved presentations by Intel's senior executives concerning specific issues and topics. They worked across product and functional groups to put their presentation together, with the help of a staff member. These executives had been given their assignment without knowing in advance what Grove was going to present. Dennis Carter pointed out that this was viewed as a tough assignment, dreaded by some, and that instances of strategic dissonance surfaced immediately.

Centralized organization structure. During Grove's tenure as CEO, Intel's organization structure became highly centralized. In the words of one senior executive, "Intel was organized around funneling things up to Gordon, Andy, and Craig." Intel was structured as a matrix, with various corpo-

Table 4

Company-environment-interface Level of Analysis: Highlights of Coevolution of Intel's Narrow Business Strategy

'81–84	'85	'86	'87	'88	'89	'90	'91	'92
					PC market segment			
IBM introduces PC/XT/AT with an Intel chip and Microsoft operating system.	Large installed base for IBM PC/XT/AT; Compaq has emerged as a viable competitor; Intel and Microsoft are the fortuitous beneficiaries of a "virtuous circle."	Compaq first with 386 PC; IBM follows.			Clone PC manufacturers are gaining share.			
							Intel strategy	
8088 and 80286 chips for IBM PCs; cross-license other chip manufacturers; Intel initially not fully aware of importance of PC for its future.	Decision to be sole source for new 80386 processor and to maintain product leadership; "Red X" end-user marketing campaign.	Court battle with AMD about intellectual property rights for x86 microprocessors prevents AMD from entering the 386 market for 4 years; same for 486.			Intel is sole source for i486 processor; "Intel Inside" end-user marketing campaign; Intel develops an ecosystem; i860 battle resolved; Intel creates IAL to enable the PC industry.			
Revenue ($Billion)	1.4	1.3	1.9	2.9	3.1	3.9	4.8	5.8
Profits ($B)	0.0	−0.2	0.2	0.5	0.4	0.7	0.8	1.1
Cap. Invest. ($B)	0.24	0.15	0.3	0.5	0.4	0.7	0.9	1.2
R&D exp. ($B)	0.19	0.23	0.3	0.3	0.4	0.5	0.6	0.8

rate functions on one side and various product groups on the other. Each product group carried profit and loss responsibility for its respective market, but no product group controlled all of the functional resources needed to execute its strategy. The functional groups were responsible for supporting the product groups and for cultivating necessary expertise across the organization. The functional groups were highly stable so as to develop capabilities, while the product groups were constantly redefined in order to match the evolving product-market environment. Given the importance of microprocessors in Intel's new corporate strategy, and the relentless pace with which new product generations needed to be developed, manufactured, and marketed, coordination among all the groups was critical.

Tightly managed resource allocation. The resource allocation process strongly favored Intel's core microprocessor business. As one executive observed in 1999:

> Virtually every single quarter, the requests outweigh the willingness to spend. We would end up ZBB-ing [zero-based budgeting] the lower ROI projects. The larger ROI projects were almost always related to the mainstream CPU [microprocessor] business. Therefore, if you were not part of the mainstream business, you needed to be very spirited and very perseverant to drive your projects through that process every quarter. I knew they were great businesses by any other metric, just not compared to the microprocessor business. . . . If you were in a non-core business, it was tough.

Complementary Strategic Thrusts

Comparing Epoch II with Epoch I, Craig Barrett said in 1999, "We became the industry driving force." Table 4 identifies

and PC Market Segment, Epoch II

'93	'94	'95	'96	'97	'98
Commoditization of PCs: intense margin pressure for PC OEMs; threat from IBM-Apple-Motorola RISC alliance does not materialize.		Internet emerges: threat of the network computer (NC).		Growth in demand for below-$1,000 PC is a real threat to Intel; NC threat does not materialize.	AMD [Advanced Micro Devices] gains market segment share on the low end.
Intel is sole source for new Pentium processor; Intel vertically integrates into motherboards and chipsets, which are decisively helpful in Pentium launch; Pentium flaw crisis and resolution.		Intel introduces Pentium Pro for workstations with Windows NT; AMD litigation for 386 and 486 settled; Microsoft pressures Intel to stop its native signal processing (NSP) project.		Intel introduces Pentium with MMX and later in the year Pentium II.	Intel introduces Celeron processor to combat AMD on the low end; Pentium II Xeon for workstations/ servers.
8.8	11.5	16.2	20.8	25.1	26.3
2.3	2.3	3.6	5.2	6.9	6.1
1.9	2.4	3.6	3.0	4.5	4.0
1.0	1.1	1.3	1.8	2.3	2.7

key dynamics of the PC market segment between the early 1980s and 1998. It also identifies several complementary strategic thrusts, briefly discussed below, that made it possible for Intel to drive the PC market segment. These complementary thrusts did not reflect a comprehensive ex ante formulated strategic plan to take control of the PC market segment. Rather, Grove's successful narrow business strategy set in motion a positive feedback process that extended the number and magnitude of strategic responsibilities that Intel needed to take on to sustain its position as driver of the PC market segment. These, in turn, reinforced the induced strategy process.

Sole-source supplier. The installed base of x86 microprocessors created by IBM's success in the PC market segment (with Intel's 8088 and 80286 microprocessors) had significantly and fortuitously shifted bargaining power in Intel's favor. Understanding the implications of increasing returns to adoption offered Intel the opportunity to become sole-source supplier of microprocessors for the PC market segment as of the 80386 microprocessor generation. Nevertheless, this was a bold move given IBM's still very powerful position in the industry. Looking back, Grove said, "What good is the 386 if IBM doesn't adopt it? . . . We were chewing our nails until 1986, when Compaq adopted the 386. IBM adopted it the next year." Intel was able to keep rival AMD tied up in the courts over intellectual property rights disputes, which allowed it to remain the sole source for the 386 processor for four years. The 386 microprocessor was succeeded by the i486, which was introduced in April 1989. It again took four years (until the summer of 1993) before AMD was able to launch its first 486-compatible processors.

Investing in manufacturing. One of the imperatives associated with the sole-source strategy was that Intel needed to become a world-class manufacturer. Table 4 shows the large and rapidly increasing capital investments Intel made during Epoch II. Intel's new manufacturing prowess depended on a new distinctive competence: close integration of the Microprocessor Group's chip designs and process technology and manufacturing competencies within the Technology and Manufacturing Group. Intel became renowned for its ability to optimize the manufacturing process of a new chip design and then to roll out that process to Intel's other plants using the "copy exact" principle.

Pacing the race through product leadership. Table 4 shows the rapid pace of product introductions between 1993 and early 1998: Pentium (1993), Pentium Pro (1995), Pentium MMX (1997), Pentium II (1997), and the Celeron (1998) processors. This time-driven product introduction strategy, however, reflected deep intuition for the feasible pace of development of the PC industry. In an MBA class in fall 1994, Andy Grove revealed that he had learned from studying the data that the peak-to-peak production across microprocessor generations for 386 and 486 microprocessors had been about three years and would be the same for the Pentium processor. Based on this, Grove assumed that the next generation microprocessor, the P6, would follow the same adoption

cycle, which informed the timing of Intel's next major capital investment decisions.

Building brand with end users. In April 1990, Intel launched its first "Intel Inside" campaign. Aimed directly at end users, rather than Intel's traditional PC OEM customers, the campaign sought to influence customers to ask for Intel microprocessors specifically when they purchased a PC. Major OEMs such as Compaq and IBM initially refused to participate in some elements because they felt that Intel Inside decreased their ability to differentiate their products from the competition, but eventually all of them carried the Intel Inside logo on their products, in part, because Intel engaged in massive co-marketing campaigns with the OEMs. From 1990 to 1993, Intel invested more than $500 million in end-user marketing campaigns. Paradoxically, the Pentium flaw crisis of November-December 1994, which according to Grove, "shook Intel to its core," in some ways indicated the powerful impact of Intel's branding strategy on end users.

Introducing industry-enabling technologies. Increased competition among a growing number of PC OEMs created intense pressure on their profit margins. Combined with its successful sole-source strategy, this gave Intel the ability to appropriate a large part of the available profits in the PC market segment. This created a positive feedback loop, which increasingly shifted the center of industry influence from the PC OEMs to Intel (and to Microsoft) during the 1990s. Only the largest PC OEM customers could afford to do much research and development (R&D). Other OEMs became increasingly dependent on Intel for technological innovation. Intel created the Intel Architecture Labs (IAL) for the purpose of developing new technologies that would remove technological bottlenecks preventing PCs from taking full advantage of the increased processing power of new-generation microprocessors. These technologies were offered to the OEM customers for free or for nominal royalty payments.

Cultivating an ecosystem of complementors. The most important complementary product for Intel's microprocessors was Microsoft's Windows operating system software. Andy Grove described the relationship between Microsoft and Intel as "two companies joined at the hip." While constantly vying for perceived leadership of the PC industry and jealously guarding their own spheres of influence (software for Microsoft and hardware for Intel), most of the time the two companies were able to maintain their symbiotic relationship throughout Grove's tenure as CEO. Intel also invested in creating internal support groups to help other independent software vendors develop applications requiring high processor power to stimulate demand for its next generation processors. Intel provided its partners with advance information about its next microprocessor designs and support products.

Forward integration into chipsets and motherboards. Intel's chipsets and motherboards made it possible to leverage its strong strategic position in microprocessors by enabling OEM customers, who did not have the resources to develop these system-level products, to introduce PCs with Intel's latest microprocessors. This is turn was helpful in

reducing its dependency on the stronger OEMs, in case the latter were reluctant to stay with Intel's road map for developing next-generation microprocessors. This actually happened when some major OEMs initially decided to wait to introduce Pentium-processor-based PCs, and Intel enabled Packard Bell and Dell to take the lead.

Successful Coevolution Turns into Inertia

During Epoch II, in contrast to Epoch I, Intel's distinctive competencies continued to evolve with the basis of competition in the PC market segment of the microprocessor industry, and the official strategy clearly drove strategic action, leveraging both position and distinctive competence. This gave the company great momentum between 1987 and 1997, which is reflected in revenue growth and profit growth (table 4). In late 1998, Intel's stock market valuation surpassed $200 billion for the first time.

Lock-in. Intel's narrow business strategy tied its success increasingly to that of the PC market segment. By 1993, 486 microprocessors accounted for 75 percent of the company's revenues of $8.8 billion and 85 percent of its $2.3 billion in net profit. By 1998, 80 percent of Intel's $26.3 billion in revenues and just about all of its $6.1 billion in net profits came from microprocessors. Signaling the company's extreme dependence on the prospects of its product-market environment, revenues grew only 5 percent, and net income declined 13 percent during 1998, in part as a result of the unexpectedly rapid relative growth of the low end of the PC market segment. Table 4 shows the increasingly large capital and R&D investments that needed to be made to keep driving the coevolutionary process. Also, Intel's dependence on the OEM customers as a distribution channel for its microprocessor products made forward integration into systems products difficult. Intel's strong interdependence with Microsoft impeded strategic initiatives in the software area. In one widely noted case—Intel's Native Signal Processing (NSP) initiative to augment the microprocessor's video capability (table 4)—Grove admitted that Intel "caved" in the face of Microsoft's displeasure (Schlender, 1996).

Inertia. By 1997, Intel's road map for the development of next generations of microprocessors determined its long-term development trajectory, which was not easily changed. While Intel had put mechanisms in place that allowed very fast response to short-term contingencies affecting the road map, Dennis Carter explained that the ability to make quick adjustments, paradoxically, reinforced the company's strategic focus and the lock-in with the PC market segment. The successful crash effort to develop the Celeron processor, however, signaled that while Intel's lock-in with the PC market segment remained strong, the lock-in of the PC market segment with Intel was perhaps loosening. Also, toward the end of 1996, Andy Grove was beginning to worry about the effect Intel's strong influence with its OEM customers was having on its strategy-making process. In an MBA class discussion in fall 1996, Grove said, "There is a hidden danger of Intel becoming very good at this. It is that we become good at one thing only."

COEVOLUTIONARY LOCK-IN AND STRATEGIC INERTIA

Reduced Capacity for New Business Development

By 1997, then COO Craig Barrett did not believe that Intel could sustain its historical growth rate and profitability solely with microprocessors. Barrett realized that Intel's intense focus on microprocessors had made it difficult for new ventures to thrive inside Intel (hence, his use of the creosote bush metaphor mentioned earlier). Different groups in the company continued to explore a multitude of new business ideas (Burgelman, Carter, and Bamford, 1999), but Intel's autonomous strategy process had become less able to exploit new business opportunities. Dennis Carter noted that outbound marketing (delivering a technology to the market) dominated inbound marketing (finding new market needs that could be met by technology). Frank Gill, an executive vice president in charge of Intel's new business development during most of Epoch II, pointed out that Intel's matrix organization did not provide managers with much opportunity to learn to make trade-offs among various functional considerations. This impeded the development of new generations of general managers able to develop new businesses. Also, business-level general managers must resolve the initial ambiguity about the correct strategy of a new business, but in the corporate context this is not sufficient. To continue to obtain corporate support, the process of strategic context determination must be activated, which helps link the new business strategy to the corporate strategy. This explorative, iterative process involves multiple levels of management in building a new strategic thrust for the corporation (Burgelman, 1983).

During fall 1999, Andy Grove reflected on the slowing down of growth in the core microprocessor business and his efforts to develop new businesses during Epoch II: "The old CEO knew that this was coming. He tried like hell to develop new business opportunities, but they almost all turned into [dirt]." Public data support Grove's contention that he knew relatively early on that Intel would have to transform itself again. Already in 1993, he had said:

Our people have navigated successfully through one transformation, so perhaps it won't be as hard to sign them up for another one. But success can trap you. The more successful we are as a microprocessor company, the more difficult it will be to become something else. To take advantage of some opportunities I see ahead, we're going to have to transform ourselves again. The time to do it is while our business is still strong. (Grove, 1993: 60)

While Grove recognized the need for strategic renewal, difficulties in developing new businesses during Epoch II suggest that he and Intel were subject to sources of strategic inertia associated with coevolutionary lock-in. Table 5 identifies these two sources of strategic inertia. The ProShare case shows that the CEO's active involvement in driving new business development is likely to impose the logic of the successful core business in an area in which it may not apply, thereby impeding development of an appropriate business strategy and simultaneously inducing escalation of commitment. The Hood River case shows that even if the CEO is

not actively involved, he or she may cast a shadow of influence that also impedes the development of an appropriate strategy for the new business, even though not inducing escalation of commitment. The chipset case shows some of the major difficulties a new business must overcome to get corporate support if the CEO initially views it as an enabler

Table 5

Company Level of Analysis: Coevolutionary Lock-in and Sources of Strategic Inertia during Epoch II

Views from below	Intel's strategic intent	Strategic action
	If strategic, apply logic of core business strategy	

Intel's strategy for videoconferencing (ProShare)

Patrick Gelsinger (GM ProShare): "ProShare was viewed as a horizontal capability—that was Andy's [Grove] wish." "We could have acted on the vertical markets six months sooner if Andy had not had such a strong opinion." *Another ProShare executive:* "There wasn't a debate about it, there wasn't even a discussion. . . . Andy had already trained the organization, meaning Intel, that periodically he gets all these flashes of an idea." *Frank Gill (senior executive):* "It was not being out of the loop so much as not being sure. . . . [I thought] maybe the throwing of massive resource at it would work. I didn't know for sure and Andy and Pat were quite confident."	Grove's intent was to make videoconferencing an integral capability of the PC. To this end, he favored a frontal assault on the entire PC market segment, rather than targeting vertical segments first.	Grove assigned Patrick Gelsinger, in charge at the time of the next-generation microprocessor development, to ProShare. *Grove:* "Moving Pat off of P6, a product on which the future of our company truly depends, to run this new initiative was a very controversial step. But in many way this is the test of it." Grove continued to be deeply involved in the strategic decision making until 1996, when he asked Frank Gill to scale down the effort, which involved some 700 people at the time. *Grove in 1999:* "We assumed that just because it could be done technically there would be high demand. I was an enthusiastic user and supporter, but I've stopped using it. . . . If we were to do it over again, our approach would be not so much like the Normandy invasion, but more of a vertical focus. . . . We brought a style and conceptual approach to an area where it did not work."

Intel's strategy for bringing the PC into the living room (Hood River)

Rob Siegel (project manager) and his team identified the target applications and uses for the Hood River product. The design called for the use of Intel's 233 MHz Pentium II processor, the highest performance CPU at the time. *By August 1996, Siegel:* ". . . we had accomplished a lot. We had Microsoft doing what we wanted them to do, and we had established an impressive customer list. In addition, the Product Line Business Plan presentation went well. We received the highest rating, and Andy Grove came up with the phrase, 'Hijack the TV,' which became our rallying cry."	*Andy Grove:* "'The PC is it,' Grove declares. 'That sums up Intel's business plan and rallying cry.' 'Some think the information superhighway will come through their TV,' Grove proclaimed . . . '[But]the information tool of the future is on your desk, not in your living room'" (Burstein and Kline, 1995: 24).	Siegel and his team continued their efforts through the fall of 1996. But they ran into funding problems when the idea of a "network computer" (NC) gained some tracking under the impulse of Oracle's Larry Ellison, and the Desktop Product Group (DPG) reallocated resources to meet the perceived threat to the core business. Siegel was able to get funding reinstated, but the market for Hood River did not develop as planned. In early 1997, Mike Aymar (GM of DPG) halted the venture. *Aymar:* "Originally we expected the venture to . . . generate demand for another 1 million PCs per year. But market projections were for various vendors worldwide to ship only in the tens of thousands of units in '97 and '98. . . . This is insufficient."

Continued

Table 5 (Continued)

Views from below	Intel's strategic intent	Strategic action
	If non-strategic, pay as you go	

PCI chipsets as a new business

Views from below	Intel's strategic intent	Strategic action
Andy Beran (finance mgr.): "We never would have gotten into the business if we had to fight for internal capacity. . . . It always would have looked like a lower [return] to the processors." Beran noted that top management let them keep the cash they generated with old products to fund the development of chipset business: "At the point where that wasn't enough, we were already successful enough to keep going." Randy Wilhelm (technical mgr.): "There was some doubt, I think, in certain parts of Intel that we were able to push a bus standard, whereas in the past we had always had key OEMs pushing the bus standard." Eric Mentzer (marketing mgr.): "They said, we don't believe you guys are going to be successful, so we don't want you going into those accounts. . . . The processor division was out telling the field sales force and the customers, don't use this; use the low-risk thing."	Ron Smith (GM chipset business): Regarding his intent to develop the chipset business based on Intel's new PCI technology: "Andy Grove told me that we had no damn business doing PCI. . . . That was early on. He and I had a heated discussion about it. . . . He basically said something to the effect of who do we think we are, a chip company thinking we are going to drive an I/O bus standard?"	Senior Microprocessor Group executives supported Smith's efforts to develop the chipset business. Smith was able to use the new PCI technology to wrest control of chipsets away from PC OEMs and make the chipsets an important tool for supporting the launch of Intel's new Pentium processor. Having succeeded in the face of corporate ambivalence, Grove wrote Smith a note saying, "And I said it couldn't be done." From then on, Grove viewed chipset business as strategically important for the core business.

Networking as a new business

Views from below	Intel's strategic intent	Strategic action
Frank Gill (GM Networking): "First, in the early 1990s, there was Andy Grove's ability to get everybody to focus on job 1. . . . Any other activity was viewed as a distraction. . . . A second factor was that. . . . Since all the planning activity involving Andy focused on job 1, he did not have sufficient insight or knowledge to meaningfully contribute to our networking and connectivity businesses." "In 1994–95, Andy would tell me, 'Frank, I make a billion dollars in profit per quarter and you make a billion dollars in revenue per year. This is all distraction, so focus on Job 1.'" Mark Christensen (Gill's successor): "For the first six years, from 1991 to 1997, it was basically 'pay your own way' for growth. If you didn't grow, you had the threat of getting downsized. Much of the funding was being funneled into programs that would help microprocessor growth—Job 1."	Grove: "There was a time when I could have flipped a switch between videoconferencing and networking." "I have been rabid about four things in my career at Intel: motherboards, Intel Inside, chipsets, and videoconferencing. What if I had been equally rabid about networking? Intel could be a very different company." Reflecting on strategic discussion concerning the networking business with Frank Gill, Grove said, "I am not happy with statements that are somewhat right, but mostly wrong. Maybe I am too good for my own good. I weed out all the weeds, but also some of the potential seeds. . . . Barrett is more comfortable with leaving strategy a bit more murky, undefined."	Grove funded both opportunities, but he said, "Much more funding was going to videoconferencing." Grove did not allow much time for discussion of the networking business during the strategic long-range planning sessions of the early-to-mid-1990s. As of 1997, Frank Gill: "Mark [Christensen] clearly got networking better connected within Intel. He came up with the fast Ethernet 'big pipes need big processors' notion and building remote management hooks into the network cards. He also put more focus on OEM customers where Intel had channel power." After 1997, networking was viewed as part of the corporate strategy, leading to a major acquisition and full corporate support for growing the business.

only of the core business. The networking case shows that these difficulties are exacerbated if the link with the core business cannot be easily established, thereby limiting its growth funding to the resources that it can generate on its own. Table 6 summarizes the comparative analysis of these four cases using the process model of internal corporate venturing (Burgelman, 1983). The process model identifies key interlocking activities of different levels of management (corporate, middle, and venture) in the core (definition and impetus) and overlaying (structural context and strategic context) subprocesses of venture development.

Strategic Inertia I: If Strategic, Apply Logic of Core Strategy

The ProShare case. The ProShare venture's purpose was to make videoconferencing a standard PC capability, which would help create additional demand for microprocessor power. Grove's strategic intent determined the strategic context for the venture from the start (table 5). His support shielded the venture from the strong selection pressures of the structural context, in particular Intel's rigorous financial reviews. Grove got deeply involved in monitoring the definition of the venture strategy and in authorizing funding of its development (table 6). In a fall 1999 discussion with an MBA class, Grove mentioned that Intel had spent about $750 million on the unsuccessful venture. His insistence on applying the horizontal, frontal assault strategy of the microprocessor business to ProShare reduced the degrees of freedom of the executives in charge of the new business development effort (table 5). Pat Gelsinger's task was to deliver a technology to the market in the same way that Intel delivered next-generation microprocessors to the market. Technical and need-linking efforts were limited in their effectiveness, discipline-instilling product-championing efforts were not required to secure resources internally, and the effectiveness of strategic forcing efforts to secure a fast-growing beachhead in the market was limited (table 6). Frank Gill, the senior executive positioned between Grove and Gelsinger was left—or rather, as he put it, "able to stay"—out of the loop. With Grove performing the role of Gill in the strategic context determination process, the discipline-instilling organizational championing efforts—requiring Gill to convince peers, as well as top management, that the continuation of the videoconferencing venture was in the long-term interest of the corporation—were not required (table 6). Finally, as a consequence of the early and sustained support from the CEO, the opportunity costs associated with ProShare were not considered until 1996, when Gill was asked to scale the venture down (table 5).

The Hood River case. The Hood River venture's purpose was to bring the PC into the living room as an electronic entertainment device. Hood River was started as a seed project with initial funding from Intel's Corporate Business Development group in February 1996. The venture's strategy was influenced from the start by Grove's publicly stated strategic intent that the "PC is it," which was taken to heart by Rob Siegel, the project leader (table 5). This drove the technical and need-linking efforts in the Hood River product definition. Since there was no direct and forceful support

Table 6

Intra-company Level of Analysis: Comparative Process Model Analysis of Four New Business Development Cases during Epoch II

Leadership activities by management level and subprocess*	ProShare	Hood River	Chipsets
Corporate management level:			
Definition: Monitoring	From the start	From the start	Fly under radar
Impetus: Authorizing	From the start	Erratic	Pay as you go
Strategic context: Rationalizing	Premature	Didn't get to	Lagging (link to Pentium)
Structural context: Structuring	Suspended	Strong influence	Strong influence
Selecting (links to structural and strategic contexts)	Suspended	Strong influence	Strong influence
Middle management level:			
Definition: Coaching	Limited	Limited	Strong
Impetus: Strategic building	Didn't get to	Didn't get to	Not necessary
Organizational championing (links impetus and strategic context)	Not necessary	Didn't get to	Strong
Strategic context: Delineating	Premature	Didn't get to	Strong
Structural context: Negotiating	Not necessary	Ineffective	Strong
Venture management level:			
Definition: Technical and need linking	Limited effectiveness	Ineffective	Effective
Product championing (links definition and impetus)	Not necessary	Ineffective	Effective
Impetus: Strategic forcing	Limited effectiveness	Ineffective	Effective
Strategic context: e.g., bootlegging	Little room	Not possible	Anticipate Pentium
Structural context: Questioning	Little room	Ineffective	Work around

Leadership activities by management level and subprocess*	Networking Until 1997	Changes after 1997
Corporate management level:		
Definition: Monitoring	Little interest	Strong
Impetus: Authorizing	Pay as you go	Strong
Strategic context: Rationalizing	Lagging	Link to core
Structural context: Structuring	Strong influence	Adjusted
Selecting (links to structural and strategic contexts)	Strong influence	Adjusted
Middle management level:		
Definition: Coaching	Strong	
Impetus: Strategic building	Limited	Strong
Organizational championing (links impetus and strategic context)	Give up	Strong
Strategic context: Delineating	Limited	Strong
Structural context: Negotiating	Defensive	Strong
Venture management level:		
Definition: Technical and need linking	Effective	
Product championing (links definition and impetus)	Effective	
Impetus: Strategic forcing	Effective	
Strategic context: e.g., bootlegging	Limited	
Structural context: Questioning	Work around	

*Source: Burgelman (1983).

from the CEO for this project, the selective effects of the structural context were very strong (table 6). This was evident when funding was temporarily cut off without warning in December 1996 to harness resources in the face of the perceived threat of the "network computer" (NC) to Intel's core business. Ineffective technical and need-linking activities made it difficult to collaborate with the consumer electronics OEMs, who had a very different view of the market and the

technology required. Siegel tried to pursue product-championing activities, but, as a relative newcomer, he could not exert influence in the network of resource-controlling relationships of Intel's matrix. Strategic forcing never got started, as no consumer electronics OEMs or PC OEMs were willing to adopt the Hood River product concept (table 6). As a result, Michael Aymar, the middle-level executive, had no foundation to build on and could not continue to ask top management for support. He stopped funding Hood River in 1997 (table 5).

Strategic Inertia II: If Non-strategic, Pay as You Go

The PCI chipset case. Intel Architecture Labs developed the PCI bus technology in the early 1990s. Top management's initial intention was to organize a consortium to bring PCI to the PC industry as an enabling technology for the core microprocessor business, as the previous bus standard was too slow to take advantage of increased processing power. Determination of the strategic context of the PCI chipset venture was lagging because Grove was opposed to the idea of turning PCI chipsets into a business (table 5). Ron Smith nevertheless decided to pursue PCI chipsets as a new business. He tried to "fly under the radar" to protect the venture from close top management scrutiny to build a viable business foundation (table 6). He assembled a team of experienced functional managers who were well connected with the rest of the corporation and could access resources that would otherwise not be available. These managers engaged in careful technical and need linking to define Intel's chipset opportunity. Realizing they would not be able to secure scarce manufacturing capacity internally against the more profitable microprocessors, their product championing efforts took the form of contracting with outside manufacturers. Smith convinced his team that winning inside required winning outside through successful strategic forcing (table 6). Each year, the venture delivered more than it had promised, which gave senior executives such as Albert Yu, Paul Otellini, and Craig Barrett a reason for supporting it in the face of Andy Grove's doubts. The chipset venture's potential was sufficiently large that no additional business opportunities needed to be found to reach critical mass. Ron Smith did not have to engage in strategic building, which requires the agglomeration of additional business opportunities through internal transfer of projects and/or through carefully targeted acquisitions, and could focus on coaching the venture team. Also, Smith had anticipated that the PCI chipset would be important for facilitating the launch of the Pentium processor in 1993 and had instructed the team to design the chipset accordingly. Smith's prediction turned out to be correct, which facilitated the determination of the strategic context later on (table 6). Eventually, Grove concluded that the chipset venture was an important business for Intel. His retroactive rationalization concluded the process of strategic context determination. From then on, it had his full support.

The networking business case. In the early 1990s, Frank Gill's charter was to develop new businesses for Intel, but because of the enormous growth of the core business, Andy Grove began to view these efforts as a distraction. Grove felt that Gill was too much focused on the success of the net-

working business and not enough on that of the core business. Grove also felt uncomfortable with the lack of clarity of the networking strategy (table 5). Gill pointed out that Grove had been totally focused on the core microprocessor business and that the strategic long-range planning process (SLRP) spent little time on businesses that were not considered strategic. Top management looked at networking as an industry enabler, rather than as a new business. Gill gave up on the organizational championing efforts in the face of peer resistance and top management's recalcitrance and focused on short-term financial performance to protect the business (table 6). This created a vicious circle. Unsuccessful organizational championing limited the amount of corporate resources made available for the networking business, which limited the scope of the strategic building activities that Gill could engage in: large acquisitions were simply not permitted. And this, in turn, limited the growth of the business in the fast-growing industry to what could be achieved with the strategic forcing activities based on the internally developed products. Fortunately, these were the result of effective technical and need linking and experienced strong market acceptance. The effectiveness of these activities was at least in part the result of Gill's strong coaching of his team and successful shielding of the networking business from top management. Only in 1997, when a new general manager was able to show the importance of networking for the microprocessor business and for Intel's future growth, was its strategic context determined, and it received full top management support.

DISCUSSION AND CONCLUSIONS

Coevolutionary Lock-in

This study shows how Andy Grove was able to take advantage of the fortuitous circumstances Intel faced in its microprocessor business with the rapid ascendance of the IBM PC and to turn good luck into a strategy vector. He made Intel focus on a narrow business strategy and established an induced strategy process that tightly aligned strategy and action and produced extraordinary success. His deep understanding of the forces that gave rise to the strategy vector also gave him great confidence in dealing with several crises that challenged it. This study, however, also reveals the complex reciprocal causation between Grove's strategic intent and the structures and processes that he put in place and how the very success of the strategy vector resulted in the emergence of coevolutionary lock-in and impeded new business development. Although Grove was a master of strategy, who knew that Intel would have to transform itself again eventually, he and Intel were subject to inescapable evolutionary dilemmas associated with the dynamics of coevolutionary lock-in.

Intel's success as the sole source of the highest value component of PCs made it increasingly able to appropriate the available rents in the PC market segment. But this asymmetry created a positive feedback loop, requiring Intel to make more and more of the investments necessary to enable adoption of next-generation microprocessors. These comple-

mentary strategic thrusts helped Intel to control its external environment (Pfeffer and Salancik, 1978), but they also increasingly tied its strategic direction and economic fortunes to the evolution of the PC market segment. Coevolutionary lock-in engendered by strategic dominance entangled Intel in a system of relationships that reduced its freedom of action, a paradox well articulated by J. G. March: "You can have autonomy or you can have power but you cannot have both. Power depends on linkages and linkages destroy autonomy" (personal communication).

As a driving force of the PC market segment, Intel was able to influence the pace of industry change. Such time-paced strategy is a powerful alternative to event-paced strategy (Gersick, 1994; Brown and Eisenhardt, 1997). It allows a company to dictate the pace of strategic change that other players—customers, competitors, suppliers, and complementors—must adhere to. Intel's time-paced strategy, however, did not simply try to impose its strategic intent on the product-market environment unilaterally. Grove had learned that there was a natural adoption cycle in the PC market segment, with a period of about three years between the maximum ramp-up for different microprocessor generations. He also knew that Intel could not expect to change that much. At the same time, having put in place the competencies and support infrastructure to deliver new generations of microprocessors to the PC market segment, there was a strong internal drive to do so. Intel's time-paced strategy thus reinforced the lock-in with the PC market segment. Also, Intel was able to win the two defining battles in the microprocessor market segment—against other Intel Architecture suppliers and against the RISC architecture—that Grove had identified in late 1993. But Intel's competitive intensity increasingly specialized the company's competitive repertoire for the PC market segment (Barnett, 1997), further reinforcing coevolutionary lock-in.

Intel's introduction of the Celeron processor in 1998 to counter AMD at the low end of the PC market segment testifies to the company's relentless competitive intensity. The need for a crash effort to introduce the Celeron processor, however, also suggests that Intel, while continuing to innovate at a high rate with its Pentium processor product family, had begun to produce innovations that were less in tune with evolving environmental demands (Sørensen and Stuart, 2000). Intel seemed to have difficulties recognizing that the importance of the external selection environment relative to the internal selection environment was increasing toward the end of Epoch II (Sorenson, 2000). Intel's difficulties in this respect seem consistent with the observation that in successful organizations there will be a natural tendency for internal selective-retentive processes to dominate external ones (Miller, 1999: 94). Coevolutionary lock-in may thus be an extension and further elucidation of the sources of structural inertia (Hannan and Freeman, 1984).

Extraordinary success associated with coevolutionary lock-in heightened Andy Grove's confidence in the logic of the core business strategy (e.g., Prahalad and Bettis, 1986). But Grove's direct involvement in ProShare made it difficult for

the middle-level executive in charge to develop a strategy that was appropriate for the new business and to act in accordance with an objective analysis of the situation. Grove's approach in the ProShare case supports Audia, Locke, and Smith's (2000) suggestion that success may increase a decision maker's feelings of self-efficacy. It confirms that the inertia of success is often best understood in terms of the strength of the decision maker's beliefs in the validity of the current strategy, rather than in terms of complacency or drifting without further attempts at improvement (Miller and Chen, 1994). It also supports Miller's (1994) finding that decision-making styles tend to be more extreme during periods following success than during periods following poor or mediocre performance. Grove eventually came to realize this, but his strong involvement early on, before major market and technical uncertainties had been reduced, led to escalation of commitment and prevented scaling down or timely exit from the failing business. This raises important questions about the limitations of using top management's strategic intent as a means for guided evolution (Lovas and Ghoshal, 2000). Within Intel's induced-strategy process, guided evolution worked fine: many new projects related to the strategic intent expressed in the microprocessor road map were useful variations that were effectively selected and retained. When Grove tried to use strategic intent to shape new variations that were not commensurate with the logic of the core business, however, the result was misguided evolution.

Much of Intel's R&D investments went into technologies that complemented the microprocessor and thereby offered opportunities to launch new businesses, but the company rarely attempted to do so. One reason for this was that any technology advance that enriched the PC market segment was likely to create more demand for microprocessors, which had very high margins. Thus, it was generally more valuable in the short run to give away technology and quickly disseminate it in the market, rather than try to build a business around it. This suggests the powerful effect that financial strategy and capital market considerations may have on product-market strategy. It also indicates, however, another strong structural inertial consequence of coevolutionary lock-in. As Intel's extraordinary lucrative core business continued to grow very fast in the mid-1990s, Grove began to consider non-core business development as a distraction. Consequently, it was increasingly difficult for non-core new businesses to command top management attention and corporate resources. This was exacerbated by Intel's structural context, which facilitated execution of the core business strategy but was less able to deal with non-core new business development: strategic planning was almost exclusively focused on the core business. New general management talent was not easily developed in Intel's matrix organization. Resource allocation favored the core business, and new businesses were constantly in danger of experiencing random shocks when critical resources were taken away to cope with a perceived threat to the core business. The measurement and reward system was unforgiving for deviations from objectives, even though new business strategies require such flexibility. While

many new ideas continued to emerge, the structural context made it difficult to activate the process of strategic context determination necessary to link the new business to the corporate strategy.
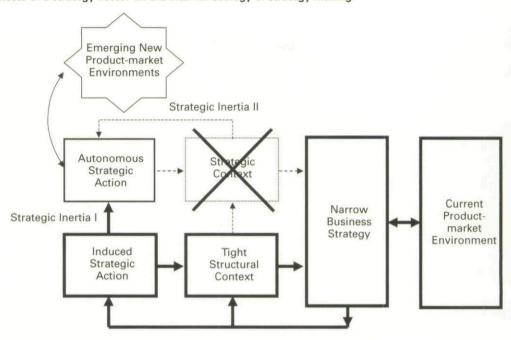
Implications for Theory

The causes and consequences of coevolutionary lock-in suggest that this little-noticed process might help illuminate some of the inescapable dilemmas in the natural dynamics of organizational adaptation. It also helps connect ideas about the internal ecology of strategy making, the modern economic theory of the firm, and an evolutionary perspective on organizational learning.

Organizational adaptation. Previous findings based on a study of Intel's transformation during Epoch I (Burgelman, 1991, 1994) supported the proposition that companies that are successful over long periods of time maintain top-driven strategic intent, through the induced strategy process, while simultaneously maintaining bottom-up-driven strategic renewal, through the autonomous strategy process. Recent efforts by scholars to formalize parts of the induced and autonomous strategy processes framework seem to support this proposition. In Rotemberg and Saloner's (2000) mathematical model, the firm employs a visionary CEO who is consistently biased in favor of certain projects but who leaves the door open for pursuing sufficiently good opportunities outside the existing vision. They have shown that this may offer greater profit-maximizing possibilities than committing to a narrow business strategy (Rotemberg and Saloner, 1994). They showed the important role played by objective middle managers supporting promising projects outside the CEO's vision. Importantly, they also showed that the CEO must not interfere with the autonomy of middle managers in allocating resources to autonomous projects.

The study of Grove's tenure as CEO initially cast doubt on the importance of the autonomous strategy process. Like other great leaders, Grove was able to recognize the unique opportunities facing Intel and to mobilize his organization to exploit them by creating an extremely focused induced strategy process. If the growth of the PC market segment had continued unabated, Intel's induced strategy process would probably have sufficed to secure continued adaptation, thereby reducing further the relevance of the autonomous strategy process. This would have undermined the validity of the internal ecology perspective on strategy making. Toward the end of Epoch II, however, it became clear that Intel's future growth would also depend on new business development and that the strategies for new businesses might have to be defined by general managers who were closer to the front line. Inertial consequences of coevolutionary lock-in, however, had significantly reduced the effectiveness of Intel's autonomous strategy process. Figure 1 provides a schematic representation of the paper's core theoretical idea: a company's relentless and successful pursuit of a narrow business strategy through the induced strategy process may produce coevolutionary lock-in and reduce the effectiveness of the

Figure 1. Effects of a strategy vector on the internal ecology of strategy making.

autonomous strategy process, which weakens a company's long-term adaptation.

The heavy lines in figure 1 indicate the reinforcement of Intel's induced strategy process, the creation of the strategy vector, and the coevolutionary lock-in with the PC market segment that it engendered. Figure 1 also shows the impact of the sources of inertia associated with coevolutionary lock-in on the autonomous strategy process. Some initiatives that needed to be pursued through the autonomous strategy process were erroneously subjected to the logic of the induced strategy process (Strategic Inertia I); others faced Intel's reduced ability to activate strategic context determination processes (Strategic Inertia II).

Figure 1 illuminates inescapable evolutionary dilemmas arising in the natural dynamics of organizational adaptation. Grove's strategic leadership approximated the classical rational-actor model in pursuing Intel's enormous opportunity in the PC market segment, but at the cost of reducing Intel's capability to develop new businesses. Was this a mistake? This study suggests that objective necessities arising from the coevolutionary lock-in of the induced strategy process and the product-market environment were a major cause of the relative neglect of the autonomous strategy process. The resource requirements of pursuing the microprocessor business, especially top management time and attention, did not leave much room for alternative pursuits. And the short-term opportunity costs of pursuing the microprocessor business were perceived as low. Also, it seems quite possible that Andy Grove passed on the CEO baton to Craig Barrett in early 1998 when he realized that a new, less singularly focused strategic leadership approach was necessary and there was still time to rebuild Intel's new business develop-

ment capability. Alternatively, might an effort to maintain the internal ecology of strategy making have severely hampered the firm? Does optimal long-term adaptation follow a punctuated equilibrium pattern (e.g., Tushman and Romanelli, 1985), perhaps involving a series of discrete periods, each focused on maximally exploiting the available opportunities, rather than a more continuous evolutionary process of balancing exploitation of available opportunities at a given time with preparing the ground for future growth opportunities? This study cannot definitively answer these alternative questions. Its findings suggest, however, that without major acquisitions, the likelihood of moving instantaneously and discontinuously from one period's opportunity frontier to that of another is low. For instance, it took more than ten years for microprocessors to become Intel's new core business. In 2002, Intel management realizes that large new businesses do not emerge fully formed out of the blue. Recognizing the possibility of alternative developmental paths, this paper's identification of coevolutionary lock-in nevertheless casts new light on the role of strategy making as a long-term adaptive organizational capability. This advance of administrative science provides company leaders responsible for designing the strategy-making process with a conceptual framework for considering more explicitly and sooner the trade-offs involved in balancing induced and autonomous strategic processes and exploitation and exploration in organizational learning.

Strategy and learning. This study's findings raise the question of whether induced and autonomous strategy processes are fundamentally at odds with one another or can be effectively pursued simultaneously. Maintaining the simultaneity of induced (variation reducing) and autonomous (variation increasing) strategy processes may involve difficulties similar to maintaining a balance between exploitation and exploration processes in organizational learning (March, 1991). Both processes compete for limited resources, and company leaders necessarily make trade-offs between them. Given the extraordinary opportunities Intel faced in the core business, focusing on learning that increased its mean performance rather than on learning that could increase the variance of performance seemed rational (March, 1991: 82). Also, Grove's ability to vectorize everybody at Intel in the same direction led to quick convergence of individual beliefs (strategic initiatives) and the organizational code (the corporate strategy) (March, 1991: 75). Intel experienced turnover because the lowest 10 percent of individual performers were systematically replaced, but this also ensured the rapid socialization of new employees to Intel's organizational code because they were keen to understand Intel's performance expectations, which were clearly tied to implementing the core strategy. Overall, Intel's induced-strategy process during Grove's tenure as CEO favored organizational learning that was maximally concerned with exploitation.

Exploration involves experimentation (March, 1991) and is viewed here through the lens of the autonomous strategy process, which dissects exploration into autonomous strategic initiatives and the process of strategic context determination. The strategic context determination process, which

depends critically on the general management abilities of middle-level executives, helps companies turn exploration efforts into new exploitation opportunities. The distinction between exploratory initiatives and the strategic context determination process helps explain the mixed record of new business development during Intel's Epoch II. In spite of Grove's efforts to vectorize everybody in the same direction, numerous autonomous strategic initiatives continued to emerge, indicating continued attempts at exploration. The decrease in Intel's capacity to activate strategic context determination processes, however, prevented the company from exploiting the more viable autonomous initiatives. Strategic context determination processes thus appear to be the crucial nexus between exploration and exploitation and key to balancing induced and autonomous strategy processes effectively. Strategic context determination processes complement a company's structural context in important ways. They make it possible to suspend the selective effects of the structural context, which almost unavoidably tends to become fine-tuned for supporting top management's current strategic intent. And they serve to create links between autonomous strategic action and the company's strategy, thereby amending it. The capacity to activate and successfully complete such processes can be viewed as a measure of the intelligence of the company's internal selection environment and may be at the very heart of strategy making as an adaptive organizational capability.

This study's main contributions concern the natural dynamics of organizational adaptation. An evolutionary perspective on strategy making helps bridge and extend related ideas about the benefits and potential opportunity costs of narrow business strategies in the modern economic theory of the firm and ideas about exploitation and exploration in theory about organizational learning. Fine-grained detail of a strategy-making process approximating the classical rational-actor model suggests that the pursuit of focus and efficiency may also become the potential enemy of effective exploration and strategic renewal. Strong positive environmental feedback strengthens the relative importance of the internal selection environment but also causes coevolutionary lock-in, which is a double-edged sword: strategic dominance begets dependence. The relative dominance of the internal selection environment may last a long time, more than ten years in the case of Intel's Epoch II, but eventually, cumulative changes in the external selection environment are likely to reduce its efficiency. Coevolutionary lock-in exacerbates tendencies toward structural inertia in novel and potentially insidious ways because it affects the balance between induced and autonomous strategy processes and a company's ability to develop new businesses and, hence, the long-term adaptive capability of its strategy-making process.

Conclusions from a single case study warrant healthy caution, but by examining a case of extraordinarily successful CEO-driven strategy making that approximated the classical rational-actor model, this paper provides further support for the internal-ecology model of strategy making as an adaptive organizational capability. There is little doubt that companies

that find themselves in the fortuitous circumstances that Intel faced in the PC market segment after its defeat in the DRAM business can greatly benefit from a leader with an exceptional ability to capitalize on them. Yet the benefits of the rational-actor model must be tempered by the realization that in dynamic environments, even in digital industries characterized by winner-take-all competition, the relative strength of the company's strategy vector will eventually decline, because the forces that make periods of extraordinary success possible are unlikely to last forever. The inertial consequences of coevolutionary lock-in, however, are likely to linger on if company leaders do not address them. An organization's long-term adaptation, spanning multiple generations of CEOs, may therefore critically depend on maintaining the strategic renewal capability of its internal ecology of strategy making.

REFERENCES

Aldrich, H.
1999 Organizations Evolving. London: Sage.

Allison, G., and P. Zelikow
1999 Essence of Decision: Explaining the Cuban Missile Crisis, 2d ed. New York: Addison Wesley Longman.

Arthur, B.
1987 "Competing technologies: An overview." In G. Dosi (ed.), Technical Change and Economic Theory: 590–607. New York: Columbia University Press.

Audia, P. G., E. A. Locke, and K. G. Smith
2000 "The paradox of success: An archival and a laboratory study of strategic persistence following radical environmental change." Academy of Management Journal, 43: 837–853.

Bamford, Raymond S., and Robert A. Burgelman
1997a "Intel Corporation: The Hood River Project (A)." Stanford Business School Case SM-49A.
1997b "Intel Corporation: The Hood River Project (B)." Stanford Business School Case SM-49B.
1998 "Intel's strategic position in the family room, 1998." Stanford Business School Case SM-50.

Barnett, W. P.
1997 "The dynamics of competitive intensity." Administrative Science Quarterly, 42: 128–160.

Barnett, W. P., and M. T. Hansen
1996 "The red queen in organizational evolution." Strategic Management Journal, Summer Special Issue, 17: 139–157.

Baum, J. A. C., and B. McKelvey (eds.)
1999 Variations in Organization Science: In Honor of Donald T. Campbell. Thousand Oaks, CA: Sage.

Bendor, J., and T. H. Hammond
1992 "Rethinking Allison's models." American Political Science Review, 86: 301–322.

Bower, J. L.
1970 Managing the Resource Allocation Process. Boston: Harvard Business School Press.

Brown, S. L., and K. M. Eisenhardt
1997 "The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations." Administrative Science Quarterly, 42: 1–34.

Burgelman, R. A.
1983 "A process model of internal corporate venturing in the diversified major firm." Administrative Science Quarterly, 28: 223–244.
1991 "Intraorganizational ecology of strategy making and organizational adaptation: Theory and field research." Organization Science, 2: 239–262.
1994 "Fading memories: A process theory of strategic business exit in dynamic environments." Administrative Science Quarterly, 39: 24–56.

2002 Strategy is Destiny: How Strategy-Making Shapes a Company's Future. New York: Free Press.

Burgelman, R. A., D. L. Carter, and R. S. Bamford
1999 "Intel Corporation: The evolution of an adaptive organization." Stanford Business School Case SM-65.

Burstein, D., and D. Kline
1995 "In the square-off between TV and computer, the smart money might be on the boob tube." Los Angeles Times, October 29.

Christensen, C. M., and J. L. Bower
1996 "Customer power, strategic investment, and the failure of leading firms." Strategic Management Journal, 17: 197–218.

Cogan, G. W., and R. A. Burgelman
1991 "Intel Corporation (C): Strategies for the 1990s." Stanford Business School Case PS-BP-256C.

Collins, J. C.
2001 Good to Great. New York: HarperBusiness.

Dyck, B., and F. A. Starke
1999 "The formation of breakaway organizations: Observations and a process model." Administrative Science Quarterly, 44: 792–822.

Farrell, J., H. K. Monroe, and G. Saloner
1998 "The vertical organization of industry: Systems competition versus component competition." Journal of Economics and Management Strategy, 7: 143–182.

Fine, K. M., and R. A. Burgelman
1997 "Intel Corporation (F): Going beyond success in 1997." Stanford Business School Case S-BP-256F.

Gersick, C. J. G.
1994 "Pacing strategic change: The case of a new venture." Academy of Management Journal, 37: 9–45.

Gilder, G.
1989 Microcosm: The Quantum Revolution in Economics and Technology. New York: Simon and Schuster.

Glaser, B. G., and A. L. Strauss
1967 The Discovery of Grounded Theory. Chicago: Aldine.

Grove, A. S.
1993 "How Intel makes spending pay off." Fortune, February 22: 57–61.
1996 Only the Paranoid Survive. New York: Doubleday.

Hannan, M. T., and J. Freeman
1977 "The population ecology of organizations." American Journal of Sociology, 83: 929–984.
1984 "Structural inertia and organizational change." American Sociological Review, 49: 149–164.

Isaacson, W.
1997 "The microchip is the dynamo of a new economy driven by the passion of Intel's Andrew Grove." Time, December 29: 46–51.

Kawamoto, D., and S. Galante
1998 "The legacy of Andy Grove." CNET, March 26.

Leonard-Barton, D.
1990 "A dual methodology for case studies: Synergistic use of a longitudinal single site with replicated multiple sites." Organization Science, 1: 248–266.

Levinthal, D., and J. G. March
1993 "The myopia of learning." Strategic Management Journal, Winter Special Issue, 14: 95–112.

Lovas, B., and S. Ghoshal
2000 "Strategy as guided evolution." Strategic Management Journal, 21: 875–896.

March, J. G.
1991 "Exploration and exploitation in organizational learning." Organization Science, 1: 71–87.

Miller, D.
1994 "What happens after success: The perils of excellence." Journal of Management Studies, 31: 85–102.
1999 "Selection processes inside organizations: The self-reinforcing consequences of success." In J. A. C. Baum and B. McKelvey (eds.), Variations in Organization Science: In Honor of Donald T. Campbell: 93–109. Thousand Oaks, CA: Sage.

Miller, D., and M.-J. Chen
1994 "Sources and consequences of competitive inertia: A study of the U.S. airline industry." Administrative Science Quarterly, 39: 1–23.

Mintzberg, H., B. Ahlstrand, and J. Lampel
1998 Strategy Safari. New York: Free Press.

Pfeffer, J., and G. R. Salancik
1978 The External Control of Organizations. New York: Harper & Row.

Pollack, A.
1988 "An 'awesome' Intel corners its market." New York Times, April 3.

Prahalad, C. K., and R. A. Bettis
1986 "The dominant logic: A new linkage between diversity and performance." Strategic Management Journal, 7: 485–501.

Reinhardt, A., I. Sager, and P. Burrows
1997 "Can Andy Grove keep profits up in an era of cheap PCs?" Business Week, December 22.

Rotemberg, J. J., and G. Saloner
1994 "The benefits of narrow business strategies." American Economic Review, 84: 1330–1349.
2000 "Visionaries, managers, and strategic direction." RAND Journal of Economics, 31: 693–716.

Schlender, B. R.
1989 "Intel produces a chip packing huge power and wide ambitions." Wall Street Journal, February 28.
1996 "A conversation with the lords of Wintel." Fortune, July 8.

Sorenson, O.
2000 "Letting the market work for you: An evolutionary perspective on product strategy." Strategic Management Journal, 21: 577–592.

Sørensen, J. B., and T. Stuart
2000 "Aging, obsolescence and organizational innovation." Administrative Science Quarterly, 45: 81–112.

Steere, D., and R. A. Burgelman
1993a "Intel Corporation (D): Microprocessors at the crossroads." Stanford Business School Case S-BP-256D.
1993b "Intel Corporation (E): New directions for the 1990s." Stanford Business School Case S-BP-256E.

Suzuki, O., and R. A. Burgelman
1998 "The PC-based desktop videoconferencing systems industry in 1998." Stanford Business School Case SM-51.

Tredennick, N.
1991 "1991: The year of the RISC." Microprocessor Report, February 6: 16.

Tushman, M. E., and E. Romanelli
1985 "Organization evolution: A metamorphosis model of convergence and reorientation." In B. M. Staw and L. L. Cummings (eds.), Research in Organizational Behavior, 7: 171–222. Greenwich, CT: JAI Press.

Van de Ven, A. H.
1992 "Suggestions for studying strategy process: A research note." Strategic Management Journal, Summer Special Issue, 13: 169–188.

Welch, J., with J. A. Byrne
2001 Jack. New York: Warner Business.

Yin, R. K.
1984 Case Study Research. Applied Social Research Methods Series, 5. Beverly Hills, CA: Sage.

Zuckerman, E. W.
2000 "Focusing the corporate product: Securities analysts and de-diversification." Administrative Science Quarterly, 45: 591–619.