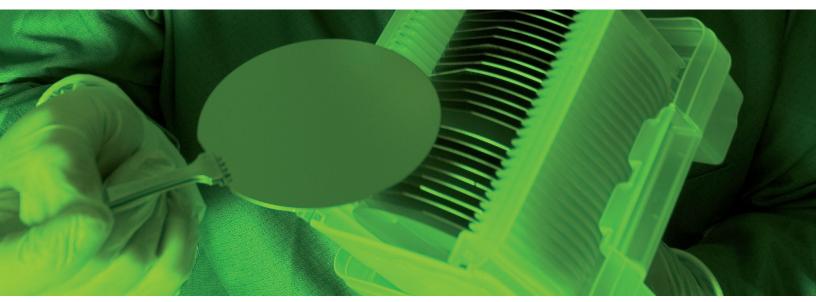© leezsnow/Getty Images

SEMICONDUCTORS

From hardware to software:
How semiconductor companies can lead a successful transformation

Many semiconductor companies struggle when attempting to transition from hardware to software. How can they improve the process?

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It's a familiar scenario: a semiconductor company sees profits drop as core hardware products become commoditized. In response, it tries to move into embedded software and associated application software. The transformation begins optimistically, with the company projecting strong software sales, but difficulties quickly emerge. Timelines increase, the project hits snags, and software revenues fall below expectations. Instead of improving margins, the new business creates even more financial stress.

Despite these problems, we expect more semiconductor companies to increase their software capabilities over the next few years, attracted by the potential for high profits. To their credit,

many players have acknowledged that previous transformation attempts were subpar and have made some improvements—for example, by taking a new approach to talent recruitment or streamlining product development. These efforts have helped, but they only address a few parts of the puzzle. No company has yet developed a comprehensive approach for navigating all stages of a software transformation.

We've tried to fill this gap by developing a framework based on our work with numerous companies in high-tech and advanced industries, including semiconductor players. It focuses on ten recommendations designed to optimize both

strategy development and execution (Exhibit 1). Although the framework aims to create a thriving software business, the recommendations will also help companies enhance their core hardware business, which will always provide some of their revenues.

Software strategy: Keeping the focus on value

Traditional hardware players will be on unfamiliar ground when creating a software strategy. With a limited knowledge of the competitive landscape, customer needs, and effective pricing models, they may have difficulty developing a targeted approach. The following steps can help.

Creating a detailed transformation plan and incorporating it into the existing corporate strategy

Many semiconductor companies assume that their existing corporate strategy will serve them well for software. But software customers are fundamentally different from their hardware counterparts, requiring more frequent product upgrades and greater ongoing support. To reach them, companies will need a specific plan.

As with hardware, the software strategy will include a few basic elements—product offerings (including the main business opportunity for each one), sources

Exhibit 1

There are ten core elements of strategy and execution for software transformations.

Strategy	Creating a detailed transformation plan that links to corporate strategy
	Involving board members in strategy development from day one
	Taking advantage of innate strengths, rather than imitating digital natives
	Capturing critical control points and network effects to create a competitive advantage
	Exploring multiple pricing options for software, rather than providing it for free
Execution	Appointing a high-profile software leader from another industry
	Taking a more strategic approach to talent recruitment
	Giving software groups independence, including their own governance bodies
	Maintaining separate processes for hardware and software development, but ensuring that groups communicate
	Considering the acquisition of a software company

Source: McKinsey analysis

of differentiation, and specific goals, such as the time frame for becoming a market leader. The best strategies will go beyond this, however, by considering market research about common pain points and inefficiencies that a strong software product could resolve. For instance, Intel developed a high-performance software suite to assist with advanced analytics after research revealed that customers wanted help with such tasks. In some cases, companies may also gain a sense of a customer's software priorities and preferences through interactions on the hardware side.

Finally, the software strategy should support the existing corporate strategy. That means executives need to consider goals for the core hardware business—a segment that will always contribute to a company's bottom line, especially in the early days of a transformation, when it may be difficult to take market share from digital natives with strong customer ties. For instance, NVIDIA created deep-learning software based on its latest-generation graphic-processing unit, hoping that the new product would encourage sales of existing devices. It's also important to support the brand image articulated in the corporate strategy. Consider the auto manufacturer Daimler, which has a reputation for producing leading-edge hardware. To maintain its image as a technology leader, the company recently invested in building the digital capabilities needed to create sophisticated software offerings.

Involving board members in strategy development from day one

At many semiconductor companies, IT middle managers develop software strategies. This approach was appropriate when software was a secondary offering, but today's disruptive transformations, which see businesses shifting their focus from hardware, require board-level oversight from day one. Without central guidance, individual business units may create a mélange of small-scale programs that use different tools and platforms. In addition

to generating low returns, these programs prevent companies from realizing synergies resulting from scope and scale.

Given that semiconductor companies have traditionally focused on hardware, board members will need to gather extensive information on the software value chain before creating a strategy. They may be able to gain customer insights by analyzing how their competitors moved into software, since this could help them identify popular products and services.

As with any strategy, many board members will have firm opinions about the best direction to take. Some, for example, may want to focus on becoming the top software provider in the semiconductor industry, while others view software as a lever for increasing hardware sales. Boards may be able to avoid these differences by closely involving all members in strategy development from the earliest stages. In some cases, it may help if the board creates a fact base that members can consult when making decisions, especially if leaders have limited software experience.

Taking advantage of innate strengths, rather than imitating digital natives

Semiconductor companies may be tempted to venture into areas where software start-ups are flourishing. Such moves may be challenging, however, since they typically lack the agility and speed of start-ups, as well as their highly specialized software skills. As an alternative, we suggest that semiconductor companies focus on opportunities where they can leverage their existing assets, such as a strong customer base, brand loyalty, a broad hardware portfolio, and domain knowledge.

Consider, for example, a semiconductor company that wants to develop network-communication software. If a start-up already offers data-visualization software that charts network efficiency, it could be difficult to create a competitive offering. A

better strategy might involve developing a software program that delivers additional insights based on the semiconductor company's proprietary data, such as the reasons why a network access point had less data throughput on a certain day.

Semiconductor companies should also draw on their long-standing and powerful partnerships with suppliers, IT companies, and connectivity providers as they expand into software, since this will help them achieve scale more rapidly and efficiently. In some cases, they may even benefit from forming alliances with their traditional competitors. For instance, Audi, BMW, and Daimler—normally rivals—jointly acquired HERE, a data-mapping company, from Nokia. In addition to reducing the risks for each company, the acquisition increased their ability to compete with established mapping players.

Capturing critical control points and network effects to create a competitive advantage

Across industries, many companies have become software leaders by capturing control points—business segments that they can dominate because they offer unique products or services such as software programs based on proprietary data or algorithms. For instance, Siemens captured a control point by creating innovative automation hardware and software for manufacturing industries. The company now dominates this segment and serves 80 percent of original-equipment manufacturer (OEM) manufacturing lines, as well as 14 out of 15 major automotive OEMs.

In some cases, companies may attempt to strengthen their control points by giving their unique assets to other companies. The hope, of course, is that these companies will develop complementary products for use in a single system. NVIDIA takes this approach with its software-development kit for deep learning, which it provides free to start-ups interested in machine learning.

In addition to helping companies win control points, a strong product may generate a network effect—the phenomenon by which it becomes more valuable as more people use it. And once the network effect occurs, it may create new sources of income. For instance, Apple was able to generate significant revenues from its app store after the iPhone's ascent.

A product with a network effect may also boost a company's reputation for knowledge and expertise, allowing it to shape industry standards. For instance, Qualcomm was able to drive standardization efforts for 3G wireless technology because its telecommunications equipment was so popular. Since many of these standards are based on the company's own products, Qualcomm now derives one-third of its revenues and two-thirds of its profits from licensing royalties.

Exploring multiple pricing options for software, rather than providing it for free

Semiconductor players typically give customers free software in combination with a hardware purchase, hoping to encourage additional sales. Some companies also offer free software as a stand-alone product to attract customers that do not need new hardware. When companies do charge for software, many default to a one-time license fee because it provides guaranteed revenue at time of sale and allows them to sell additional services or charge for maintenance after a product warranty expires.

While free software and one-time fees are sometimes appropriate, semiconductor companies should not automatically revert to these models. Instead, they should evaluate several innovative pricing options, including the following (Exhibit 2):

- Under the "freemium" model, software is free but customers must pay for improved features or functionality.
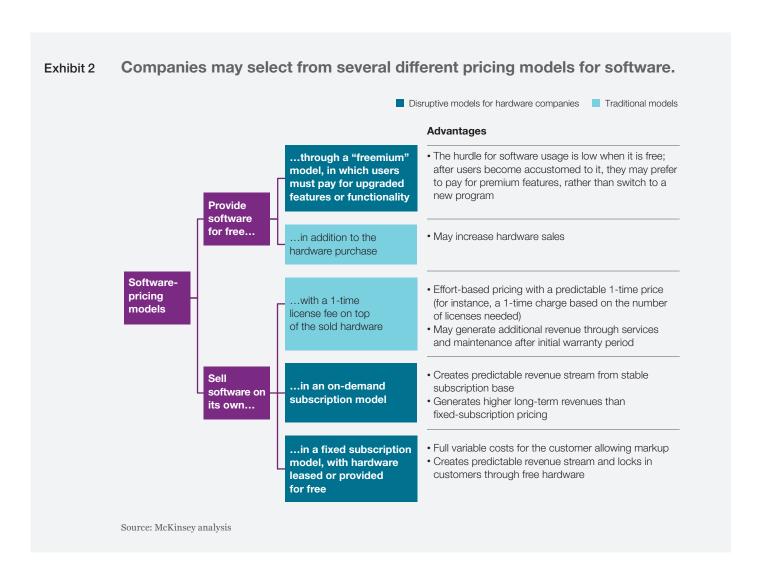
- With on-demand subscription services, customers pay only when they use software. Companies typically charge for any necessary hardware, since software revenues vary greatly under this model and may not cover their costs.

- With fixed-subscription services, customers pay a regular fee, regardless of how often they use software or receive upgrades. They lease hardware or receive it free.

Semiconductor customers may object to buying software, since they are accustomed to receiving it for free, so companies will need to create compelling

products. For instance, semiconductor companies could provide software that allows multidevice configuration management or secure over-the-air flashing.

Software strategy: Optimizing execution

During each software transformation, semiconductor companies embark on extensive hiring campaigns to attract the talent needed for execution. While they begin optimistically, expecting the same enthusiastic response they receive when recruiting hardware experts, their efforts often falter. Company culture is one obstacle. Many software engineers do not believe that a traditional hardware player can create an environment that promotes

Exhibit 2   **Companies may select from several different pricing models for software.**

■ Disruptive models for hardware companies   ■ Traditional models

Advantages

Software-pricing models	**Provide software for free…**	**…through a "freemium" model, in which users must pay for upgraded features or functionality**

• The hurdle for software usage is low when it is free; after users become accustomed to it, they may prefer to pay for premium features, rather than switch to a new program

…in addition to the hardware purchase

• May increase hardware sales

…with a 1-time license fee on top of the sold hardware

• Effort-based pricing with a predictable 1-time price (for instance, a 1-time charge based on the number of licenses needed)
• May generate additional revenue through services and maintenance after initial warranty period

Sell software on its own…

…in an on-demand subscription model

• Creates predictable revenue stream from stable subscription base
• Generates higher long-term revenues than fixed-subscription pricing

…in a fixed subscription model, with hardware leased or provided for free

• Full variable costs for the customer allowing markup
• Creates predictable revenue stream and locks in customers through free hardware

Source: McKinsey analysis

the development of leading-edge software products. Some also fear that their career opportunities will be limited. To address these concerns, semiconductor companies need to take a more innovative approach to talent recruitment and retention, both for top executives and mid-level managers. They also need to show their commitment to software by transforming both their company culture and organizational structures.

Appointing a high-profile software leader from another industry

Semiconductor companies that lack top software talent should recruit experienced leaders from other industries, rather than asking an internal hardware expert to manage the transformation. Unlike lower-level managers, many of these executives view software transformations as an exciting challenge, particularly if they began their careers in hardware. To attract the best talent, companies must emphasize that they will reward leaders for building the software business. They should also give leaders some freedom to shape the transformation—for instance, by allowing them to develop their own road map of improvement initiatives.

The appointment of a well-known software executive sends a clear message that software is central to a company's goals, both internally and externally, and it may prompt other talented engineers to investigate job opportunities. Experienced software leaders will also have numerous industry contacts and can reach out to talented colleagues if an appropriate position opens.

Taking a more strategic approach to talent recruitment

Semiconductor companies will need to be more aggressive and strategic when recruiting mid-level managers and entry-level software staff, given their reluctance to consider traditional hardware companies. First, they need to understand what high-tech employees truly value. Some of these are obvious, such as high pay, but others are more subtle. Drawing on our experience with high-tech
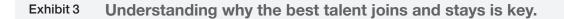
companies, McKinsey has created a framework that classifies the factors contributing to employee satisfaction by four dimensions: compensation, job, company, and leadership (Exhibit 3). For instance, we found that employees were more satisfied when they could work on leading-edge content with up-to-date technology.
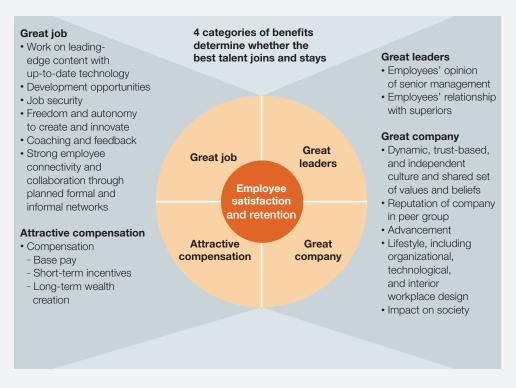
While it may be tempting to hire any talented engineer who becomes available, semiconductor companies should initially focus on recruiting the software and systems architects who handle interface specification and other crucial tasks during early development. These employees are in extremely high demand and are often difficult to find, but teams will make little progress without their guidance.

Companies based outside of tech hubs like Silicon Valley face additional recruitment hurdles because of the small local talent pool. To attract a greater number of qualified applicants, including recent software graduates, their leaders should consider opening a new site in a location with a thriving technology culture. Software engineers often gravitate to such areas, knowing that they will have multiple job options and can strengthen their professional networks. The benefits associated with improved recruitment will outweigh the drop in productivity that often occurs when companies expand their geographic footprint.

Giving software groups independence, including their own governance bodies

Software engineers differ from hardware experts in how they think, work, and behave. Their projects are more likely to require collaboration with coworkers, for instance, and their products go through more frequent testing and revision cycles. Such differences mean that a well-intended effort to integrate software engineers into the existing organization could backfire, with new employees leaving because the company's culture is unfamiliar.

Exhibit 3   **Understanding why the best talent joins and stays is key.**

Great job
- Work on leading-edge content with up-to-date technology
- Development opportunities
- Job security
- Freedom and autonomy to create and innovate
- Coaching and feedback
- Strong employee connectivity and collaboration through planned formal and informal networks

Attractive compensation
- Compensation
  - Base pay
  - Short-term incentives
  - Long-term wealth creation

4 categories of benefits determine whether the best talent joins and stays

Great job

Great leaders

Employee satisfaction and retention

Attractive compensation

Great company

Great leaders
- Employees' opinion of senior management
- Employees' relationship with superiors

Great company
- Dynamic, trust-based, and independent culture and shared set of values and beliefs
- Reputation of company in peer group
- Advancement
- Lifestyle, including organizational, technological, and interior workplace design
- Impact on society

Source: McKinsey analysis

The solution to this dilemma is simple: semiconductor companies must adapt their organizational structures, rather than expecting employees to change how they work. Executives should consolidate software staff into a single group that has its own governance body and decision-making power. For instance, software leaders should be able to establish their own processes for product testing and version control. As an added benefit, the group's scale, combined with its independence, will signal that software is central to a company's goals. Consolidation will also ensure that software employees use the same processes and tools, something that might not happen if they were scattered across multiple departments.

Maintaining separate processes for hardware and software development but ensuring that groups communicate

Many companies follow sequential development processes, always creating a hardware product before they devote any attention to software. This strategy may seem logical, since software has to run on devices, but it often leads to excessively long development timelines and potential synchronization problems.

As an alternative, companies should pursue a parallel development strategy enabled by leading-edge tools. Under this model, software development begins before hardware is available, with engineers testing

their programs on virtual prototypes and making revisions. In some cases, they may finish their work before the hardware team has a final product. For this approach to succeed, hardware and software teams must discuss their progress at critical points, especially during hardware releases with tape outs, to reach consensus about goals, timelines, and desired features.

Considering the acquisition of a software company

If companies have an aggressive timeline for building their software capabilities, or if they are having difficulty finding an adequate number of engineers, they should consider acquiring a software company. This strategy could help reduce attrition, since team members who have a good working relationship with their colleagues are less likely to seek opportunities elsewhere. Established teams are also more productive from day one, since they have a shared understanding of development processes and procedures. On the downside, acquisition costs for a software company can be two to five times higher than those for hardware companies.

The journey from a traditional, hardware-focused company to one with strong software offerings—either stand-alone or within other products—is long and difficult. This transformation is not a choice but a necessity, since companies that focus solely on hardware will see their margins continue to deteriorate, especially as customer preferences continue to shift toward integrated solutions. The ten recommendations outlined here are not a magic bullet, since transformations will always involve unexpected issues and company-specific challenges, but they may eliminate the most perplexing problems on the road from strategy to execution. ∎

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