

Diffusion Confusion

The Rising Role of the Replacement Cycle



- Most investors focus primarily on the rate of new customer acquisition, or rate of diffusion, with the launch of new products. We show that once the diffusion process is established, replacement cycles surge in importance. We call the undue focus on market opportunity “diffusion confusion.”
- We develop a three-stage model, and show that once a product reaches Stage II (roughly seven to ten years into a product diffusion process), replacement cycles become critical. Importantly, the need to focus on replacement cycles has become more immediate, as products diffuse faster today than in the past.
- Replacement cycle analysis shows that a product in Stage II can see a volume *decline* even in the face of rising penetration and population. This is because as a product matures, it becomes more dependent on repurchase cycles than on new user penetration.

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Executive Summary

There have been over 4,000 publications on diffusion research over the past 60 years. This body of work documents that product diffusion typically follows an S-curve: product sales start slowly, increase at an increasing pace, and then plateau. Products like automobiles and wire line telephones took over 75 years to diffuse while more contemporary products like personal computers and wireless phones diffused in less than 20 years.

But the rate of product penetration does not solely define product unit volume. The rate at which customers replace their products, or the replacement cycle, is also critical. Indeed, most products cross a threshold when replacement unit volumes exceed new user volume. At that point, investors need to redirect their focus to the drivers of the replacement cycle. The report seeks to demonstrate the significance of replacement cycle sales in understanding product growth for various industries, including PCs, wireless phones, and personal digital assistants.

We can point to one counterintuitive conclusion right off the bat. It is possible to have a rising population, rising penetration, and a *decline* in unit volume growth as a result of an extension of the replacement cycle. Investors that do not consider the role of the replacement cycle in some detail risk overlooking a major leading indicator of value.

Key points from this report include the following:

- Most investors focus primarily on the rate of new customer acquisition, or rate of diffusion, with the launch of new products. We show that once the diffusion process is established, replacement cycles surge in importance. We call the undue focus on market opportunity at the expense of the replacement cycle “diffusion confusion.”
- We develop a three-stage model, and show that once a product reaches Stage II (roughly seven to ten years into a product diffusion process), replacement cycles become critical. Importantly, the need to focus on replacement cycles has become more immediate as products diffuse faster today than in the past.
- Replacement cycles are often driven by improvements in a complementary network. For example, more powerful semiconductors spurred more memory-using software, etc. Wireless handset growth is likely to track the rollout of 2.5G and 3.0G wireless networks. At some point, however, product performance exceeds customer needs, making a product vulnerable to shifting preferences or a disruptive technology.
- Even a relatively modest shift in replacement cycles can lead to sharp drops in cumulative product volumes and growth rates. Investors should realize that a sustained shift in replacement cycles has significant implications for a product’s long-term growth.
- We show that the replacement cycle is at the crux of the debate about both PC and wireless handset growth. We demonstrate the sensitivity to various replacement cycle assumptions for 2001 wireless handset volume.

Introduction

Over the past decade, investors seeking to forecast industry growth focused primarily on a pretty straightforward driver: penetration. Just look at the best-selling technology books, like Geoff Moore's *Crossing the Chasm*. Will the market get to critical mass? Will it take off into a tornado? These were (and are) fundamental questions, and the models to understand network formation remain a vital part of an analyst's toolbox.¹

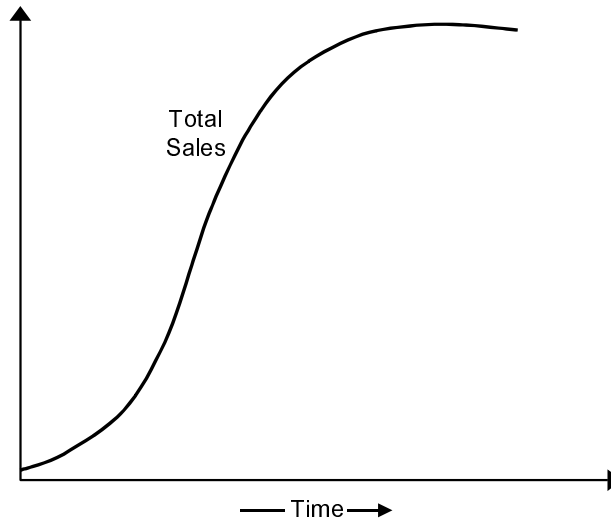
But along the way, another key facet to industry demand has emerged, which analysts and investment pundits have not sufficiently heeded: the replacement cycle. Indeed, we show that the replacement cycle is the key variable to watch for a handful of bellwether technology sectors, including personal computers (PCs) and wireless phones. Once replacement sales become sufficiently large as a percentage of industry unit sales, something somewhat counterintuitive can happen. Both the target population and product penetration can grow concurrent with a *decline* in industry unit volume growth. The culprit in shrinking replacement sales is an extension of the replacement cycle (i.e., people keep a particular product longer before they upgrade it for a new one).

In this report, we identify some frameworks that can help investors understand the valuations and expectations—especially in certain sectors of technology. We first explain why the replacement cycle is more important than ever. We then show a three-stage model of technology diffusion and show the relevance (graphically and numerically) of shifting replacement cycles. We finish with a case study of the wireless handset industry, and show the impact a various replacement cycle assumptions on the near-term growth outlook.

Why the Replacement Cycle Is So Important

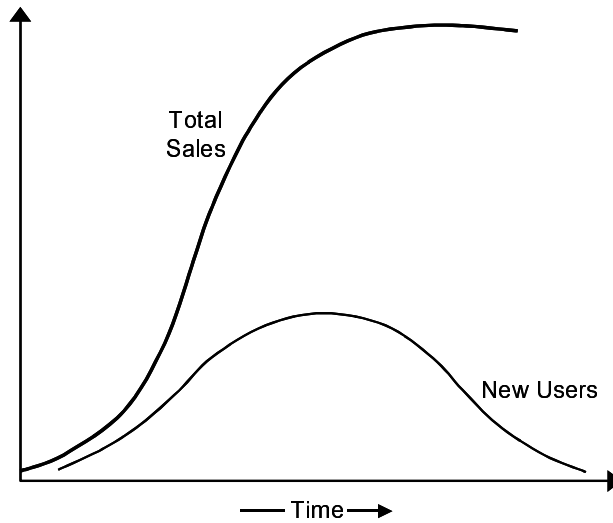
In order to fully appreciate the role of the replacement cycle in unit demand, we start at the beginning with the diffusion of a particular product. There have been literally thousands of studies that show that the typical pattern of product diffusion looks like an S-curve.² Exhibit 1 shows a generic S-curve. We discussed the mechanisms of this diffusion in detail in our “Network to Net Worth” report. The process of diffusion is an important mental model.

Exhibit 1: Generic S-Curve



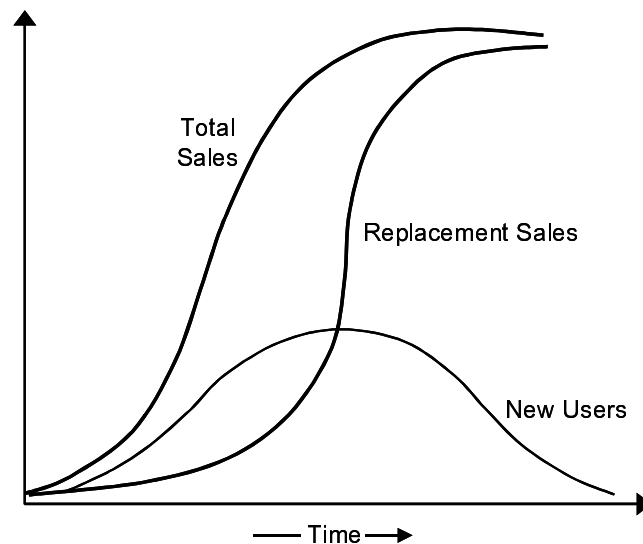
While the S-curve reflects cumulative product adoption, *new* adopters plot in what looks like a normal distribution. (See Exhibit 2.) In his seminal book, *Diffusion of Innovation*, Everett Rogers classifies the adopters, from the innovators—the first to try out a new product—to the laggards, the last group to get involved. While companies launch many new products, very few of them succeed. Passing the critical point in the distribution is what Geoff Moore calls “crossing the chasm.” The idea is also consistent with the “tipping point,” an idea that Malcolm Gladwell made popular with his best-selling book by the same name.

Exhibit 2: S-Curve Reflecting Cumulative Product Adoption



Now that we have a sense of how a product diffuses and the adoption pattern, we turn to the important role of replacement sales in defining unit sales. As it turns out, for many products, it doesn't take long for replacement sales—not the adoption by new users—to be the most important influence on *total* unit sales. (See Exhibit 3.) Specifically, within five to seven years of new product diffusion, replacement sales become a significant percentage of the total. Often, after a dozen years, replacement sales become the majority of all unit sales.

Exhibit 3: Replacement Sales as a Percentage of Total Sales



Given the importance of replacement sales relatively shortly after a product takes off, replacement cycles become the most important leading indicator of value. Simply stated, if users upgrade the product less frequently, industry unit volume growth suffers. Alternatively, shrinking replacement cycles help drive industry unit volume growth. We show the sensitivity of total unit sales to replacement cycles in the next section.³

The replacement cycle is more prominent today because product diffusion, like lots of other phenomena, happens a lot faster today than it did in the past. For example, it took approximately 20 years to reach the current 60% household penetration of PCs in the United States. It took the television about 25 years to do the same, electricity over 40 years, and automobiles in excess of 80 years.⁴ As a result, the shift from new penetration to replacement sales happens sooner for today's product than for products of the past.

The Three Stages

Building on the above exhibits, we can break a product's life into three stages:

- *Stage I—Penetration.* Here, the increase in penetration is key. The product is new, and getting to widespread acceptance in the main priority. While replacement sales often contribute to aggregate unit volumes early on, they tend to be negligible and to be swamped by the importance of attaining new customers. Products in this stage include personal digital assistants (PDAs) and digital video discs (DVDs).
- *Stage II—Transition.* This is a transition stage, during which replacement sales exceed new penetration sales for the first time. The analytical emphasis, then, shifts from determining the rate of penetration to assessing the length and likely change in the replacement cycle. Products in this stage include wireless handsets (the subject of our case study) and PCs.
- *Stage III—Maturity.* In this final stage, the market is penetrated. Unit sales are largely a function of replacement sales. Products in this stage include fax machines and microwaves.

Exhibit 4: Three Stages of a Product's Life

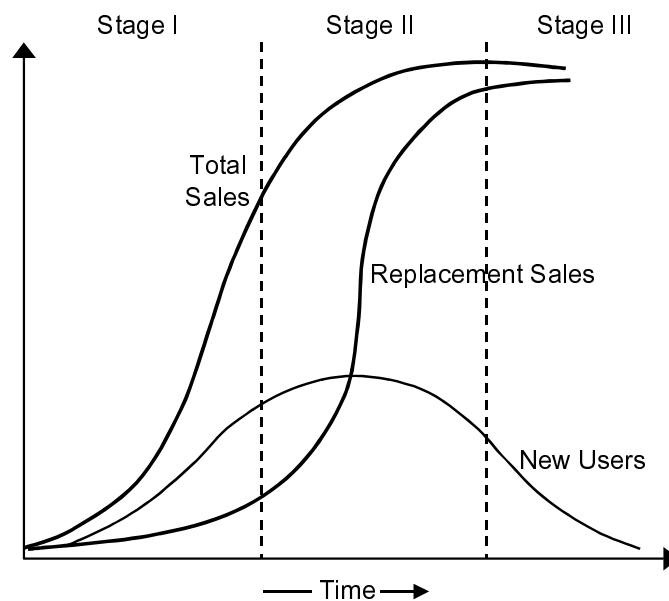


Exhibit 4 shows the three stages. Given this progression, investors must consider three issues. The first is the drivers of the replacement cycle. The second is whether or not customer needs change as a product matures (they do). The final issue is the impact of a shift in replacement cycles on unit volume growth.

So what drives the replacement cycle? We believe the best answer lies in thinking about co-evolution in a complementary network. Let's break that statement down. There are various types of networks, and one of the most prominent is a complementary network—that is, the value of the network is contingent on complementary products. Examples of complementary networks include DVD players and DVDs, computer

operating systems and PCs, wireless handsets and the wireless telecommunications networks. Improvements in the price-to-value relationships of complementary products often spur upgrades, or replacements. Some investors call this the “killer application” driver.

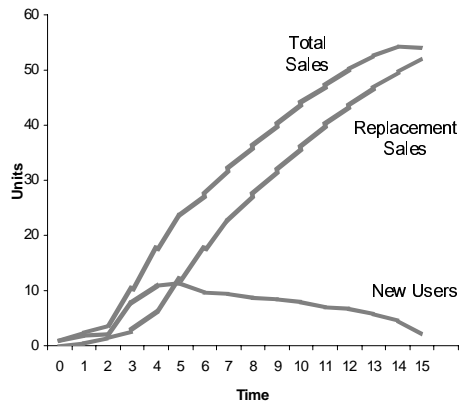
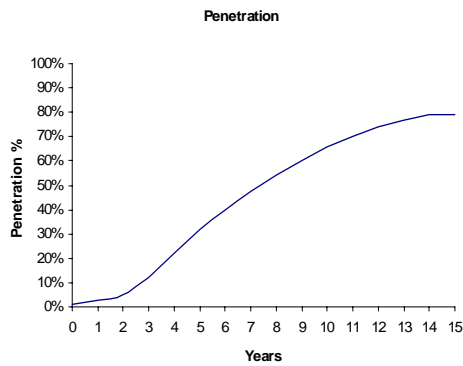
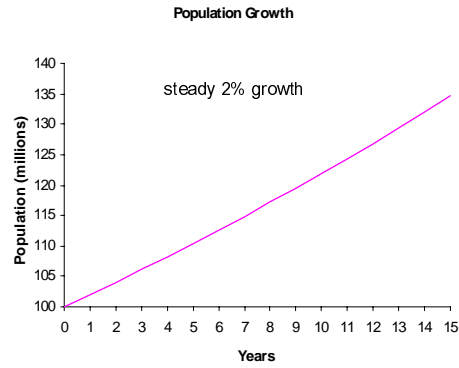
Perhaps the canonical example over the past 15 years is the Wintel standard—Microsoft’s PC operating system/applications and Intel semiconductors. More powerful chips—spurred on by Moore’s Law—suggest more sophisticated and memory-using software. This co-evolution spawned ongoing upgrades, enriching the whole PC industry. Indeed, the hot topic today in judging PC unit growth is the impact of Windows XP will have on demand. Bulls argue that it will create replacement demand while the bears suggest that consumers have all they need. Ironically, Intel recently admitted that it was lengthening its own PC upgrade cycle from three years to three and a half years in order to save costs.⁵

While it is tempting to assume perpetual upgrades as technology advances, innovation guru Clay Christensen suggests that technologies “can advance faster than market demand” and can hence “overshoot” their market. As a result, customer needs and demands change—often away from performance toward price and convenience—and the overshoot paves the way for potential disruptive technologies.⁶ The message to investors is that they must consider not only the co-evolution of products but also the point of product overshoot. PCs may already be there today.

The last point is the main message of this report. Once an industry reaches Stage II, you can see rising population, rising penetration, and *down* industry unit volume growth if the replacement cycle lengthens. Since replacement units are a significant percentage of total units, the decline in replacement unit volume that results from the shift in replacement cycle exceeds the increase in unit sales as a result of penetration.

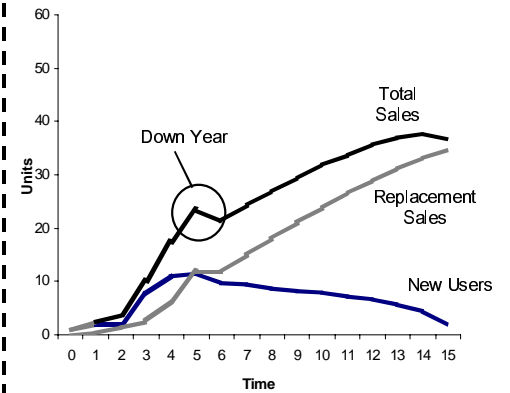
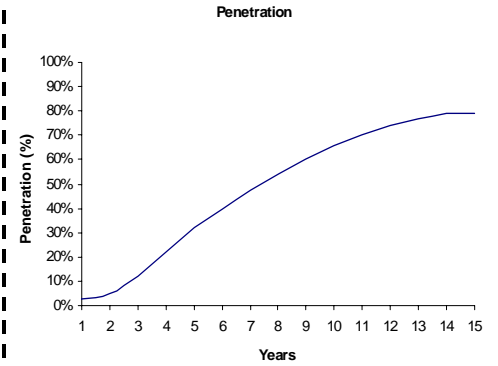
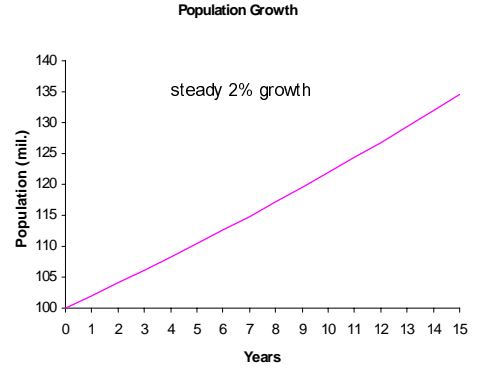
Exhibit 5: The Impact of a Lengthening Replacement Cycle

Scenario 1: Base Case
2 year Replacement cycle



Statistics:
 Cumulative units 497
 Compounded annual growth 31%

Scenario 2: Replacement Cycle Shift
Replacement cycle shifts from 2 to 3 years after Year 5



Statistics:
 Cumulative units 374
 Compounded annual growth 27%

Source: CSFB estimates.

Exhibit 5 shows two scenarios side-by-side. Scenario 1 assumes that the replacement cycle remains at 2 years through a 15-year diffusion process. Scenario 2 assumes that the replacement cycle shifts from two to three years after year five. The result is a down year in unit sales in what is an otherwise “growing” industry. (Exhibit 10 shows the data that support these charts.)

But the long-term implications are actually quite a bit more dramatic. The shift from 2 to 3 years also reduces cumulative industry unit volumes about 25% and reduces the product’s 15-year compounded annual sales growth rate by 400 basis points (from 31% to 27%). While our scenario is meant only to illustrate the phenomenon, it is not hard to imagine that fairly sizable changes in expected growth rates follow shifts in the replacement cycle.

Needless to say, the replacement cycle math can also work *for* investors. Indeed, we estimate that the replacement cycle had been shortening for the wireless handset market until this year.

This replacement cycle affects a number of industries, including:

- *Personal computers.* PC analysts note that industry sales over the past two years have suffered from a lack of compelling applications to justify user upgrades. Microsoft recently released information about the minimum hardware requirements for its Windows XP operating system, which include a 233MHz processor and 64MB of RAM. Microsoft’s new OS releases have historically accelerated new computer purchases.
- *Wireless handsets.* Cell phone penetration has risen dramatically over the last five years. However, the slower-than-anticipated rollout of next-generation networks (2.5G and 3G) has left consumers without the vaunted “killer app.” While the cell phone handset replacement cycle accelerated from 3.6 years in 1997 to an estimated 2.5 years in 2000—boosting unit volumes—estimates for 2001 suggest an extension of the replacement cycle to anywhere from 2.9 to 3.7 years. The case study on the following page explores this issue in more detail.
- *Casino games.* Multiline, multicoin video-based games are among the most popular on the casino floors. These new machines are more profitable than the older machines they replace, stimulating the replacement cycle. International Gaming Technology (IGT), a key player in the industry, is attempting to introduce more sophisticated, interactive games in order to invigorate the replacement-machine market.
- *Other.* Other industries where the replacement cycle is important include personal digital assistants (PDA), automobiles (leasing), and wireless e-mail devices (Research-in-Motion’s Blackberry).

Case Study—Wireless Handsets

The global wireless handset market provides a good case study highlighting the importance of replacement rates. In the late 1990s, the industry was in Stage I, with unit volume growth from new users constituting over 60% of the industry's total unit. Further, industry unit growth rates were typical of a Stage I industry, consistently exceeding 50%.

In 2000, however, the industry appeared to transition to Stage II. Replacement units were nearly one-half of total units sold. The story shifted from a focus primarily on penetration to a combination of penetration and replacement cycle. In fact, the replacement cycle drove sharp unit growth in 2000, as users upgraded models faster—every two and a half years on average. (Total sell-through is the sum of new user units and replacement cycle units.) Exhibit 6 summarizes the numbers.

Exhibit 6: Wireless Handset Subscriber Growth, 1996–2000

Year	1996	1997	1998	1999	2000
Subscribers	133,000	204,000	309,000	478,000	700,000
New users		71,000	105,000	169,000	222,000
Replacement Cycle Units		37,000	63,000	113,000	189,000
Subscriber Growth %		53%	51%	55%	46%
Replacement Cycle Years		3.6	3.2	2.7	2.5
Replacement Cycle Growth %			70%	79%	67%
Total Sell Through		108,000	168,000	282,000	411,000
PRICE		\$220	\$198	\$178	\$160
MARKET SIZE		\$237,600	\$332,640	\$502,524	\$659,162
Unit Growth			56%	68%	46%
Market Size			40%	51%	31%

Source: CSFB estimates.

Questions abound about the demand for wireless handsets in 2001, and we can now see how important the replacement cycle is in shaping the outcome. Exhibit 7 outlines three potential scenarios for 2001 growth, based on our estimates.⁷ Our forecast is that the total number of new users will drop from 222 million in 2000 to 215 million in 2001. As a result, whether or not there is growth in total sell-through for 2001 depends on the replacement cycle. The impact on growth expectations is dramatic as Exhibit 7 documents. Consider the following scenarios (2000 total unit sales were 411 million):

- If the replacement cycle expands to 2.9 years (from 2000's 2.5 years), replacement units will grow to 241 million, and will, for the first time, exceed the number of units purchased by new users. In addition, aggregate unit growth will *expand* by 11% for the year to over 456 million units.
- If the replacement cycle expands to 3.3 years, replacement units will rise modestly and total units will *expand* 4%, to 427 million units. This is the scenario we believe is most likely.

- If the replacement cycle extends to 3.7 years, then replacement units will fall to 189 million, and unit growth will *contract* 2%, to 404 million units.

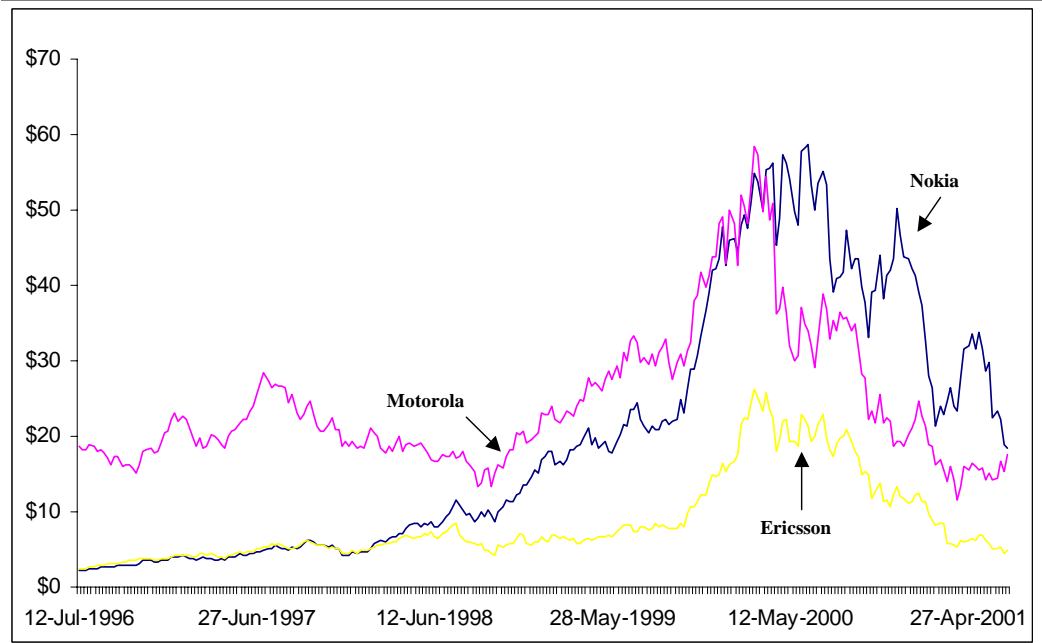
Exhibit 7: Wireless Handset: An Uncertain 2001

Year	1996	1997	1998	1999	2000	ESTIMATES		
						2001E	2001E	2001E
Subscribers	133,000	204,000	309,000	478,000	700,000	915,000	915,000	915,000
New users		71,000	105,000	169,000	222,000	215,000	215,000	215,000
Replacement Cycle Units		37,000	63,000	113,000	189,000	241,379	212,121	189,189
Subscriber Growth %		53%	51%	55%	46%	31%	31%	31%
Replacement Cycle Years		3.6	3.2	2.7	2.5	2.9	3.3	3.7
Replacement Cycle Growth %			70%	79%	67%	28%	12%	0%
Total Sell Through		108,000	168,000	282,000	411,000	456,379	427,121	404,189
PRICE		\$220	\$198	\$178	\$160	\$144	\$144	\$144
MARKET SIZE		\$237,600	\$332,640	\$502,524	\$659,162	\$658,747	\$615,055	\$582,032
unit volume growth			56%	68%	46%	11%	4%	-2%
market size growth			40%	51%	31%	0%	-7%	-12%

Source: CSFB estimates.

The market, of course, has reflected the overall technology slowdown and concerns about the speed of the 2.5G rollout by sharply reducing the share price of the leading handset manufacturers.⁸ (See Exhibit 8.) *The replacement cycle is central to understanding future growth rates and cumulative industry unit volume growth.* Further, when companies over- or underestimate industry growth, they often run into manufacturing and logistical problems.

Exhibit 8: Nokia, Motorola, and Ericsson Share Price Performance



Source: Bridge Information Systems.

Conclusion

This brief analysis of replacement cycles shows that a product can witness negative unit volume growth even when product penetration is rising. This conclusion, while counterintuitive, reflects the fact that as an industry matures it becomes more and more dependent on repurchase sales by its existing user base. Investors are well served to isolate these numbers for companies where the phenomenon applies.

This analysis can serve as a leading indicator of value and forces investors to focus their efforts on analyzing specific product lines for potential catalysts that affect the upgrade cycle. Staying attune to upgrade cycle sales can help investors identify potential opportunities as the upgrade cycle contracts or avoid situations where the upgrade cycle may be expanding.

N.B.: CREDIT SUISSE FIRST BOSTON CORPORATION may have, within the last three years, served as a manager or co-manager of a public offering of securities for or makes a primary market in issues of any or all of the companies mentioned.

All prices as of July 31:

Ericsson (ERICY) \$5.36
Intel (INTC) \$29.81
International Gaming Technology (IGT) \$51.98
Nokia (NOK) \$21.81
Microsoft (MSFT) \$66.19
Motorola (MOT) \$18.69
Research In Motion (RIMM) \$23.53

Exhibit 9: Base Case

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Population Growth	2%															
Price Depreciation	5%															
Replacement Cycle (yrs.)	2	<i>First 5 years</i>														
Replacement Cycle (yrs.)	2	<i>After 5th year</i>														
Population	100.0	102.0	104.0	106.1	108.2	110.4	112.6	114.9	117.2	119.5	121.9	124.3	126.8	129.4	131.9	134.6
Total Penetration	1%	3%	5%	12%	22%	32%	40%	48%	54%	60%	66%	70%	74%	77%	79%	79%
Cum penetration units	1.0	3.1	5.2	12.7	23.8	35.3	45.0	54.6	63.3	71.7	79.8	87.0	93.8	99.6	104.2	106.3
New Sales	1.0	2.1	2.1	7.5	11.1	11.5	9.7	9.5	8.7	8.4	8.1	7.2	6.8	5.8	4.6	2.1
Replacement sales		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
			1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
				1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
					3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77
						5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54
							5.76	5.76	5.76	5.76	5.76	5.76	5.76	5.76	5.76	5.76
								4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
									4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76
										4.35	4.35	4.35	4.35	4.35	4.35	4.35
											4.22	4.22	4.22	4.22	4.22	4.22
												4.07	4.07	4.07	4.07	4.07
													3.60	3.60	3.60	3.60
														3.41	3.41	3.41
															2.88	2.88
																2.32
Replacement sales	0.00	0.50	1.53	2.60	6.37	11.91	17.67	22.52	27.28	31.63	35.85	39.92	43.52	46.92	49.80	52.12
Percent from penetration	100%	80%	58%	74%	64%	49%	35%	30%	24%	21%	19%	15%	14%	11%	9%	4%
Percent from replacement	0%	20%	42%	26%	36%	51%	65%	70%	76%	79%	81%	85%	86%	89%	91%	96%
UNIT VOLUME	1.0	2.6	3.7	10.1	17.4	23.4	27.4	32.0	36.0	40.1	44.0	47.1	50.3	52.7	54.4	54.2
PRICE	100.0	95.0	90.3	85.7	81.5	77.4	73.5	69.8	66.3	63.0	59.9	56.9	54.0	51.3	48.8	46.3
MARKET SIZE	1.0	2.4	3.3	8.7	14.2	18.1	20.1	22.4	23.9	25.3	26.3	26.8	27.2	27.0	26.5	25.1
Unit volume growth		156%	43%	176%	72%	34%	17%	17%	12%	11%	10%	7%	7%	5%	3%	0%
Market growth		143%	36%	162%	64%	28%	11%	11%	7%	6%	4%	2%	1%	-1%	-2%	-5%

Source: Company data, CSFB estimates.

Exhibit 10: Replacement Case

Population Growth	2%	
Price Depreciation	5%	
Replacement Cycle (yrs.)	2	<i>First 5 years</i>
Replacement Cycle (yrs.)	3	<i>After 5th year</i>

15

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Population	100.0	102.0	104.0	106.1	108.2	110.4	112.6	114.9	117.2	119.5	121.9	124.3	126.8	129.4	131.9	134.6
Total Penetration	1%	3%	5%	12%	22%	32%	40%	48%	54%	60%	66%	70%	74%	77%	79%	79%
Cum penetration units	1.0	3.1	5.2	12.7	23.8	35.3	45.0	54.6	63.3	71.7	79.8	87.0	93.8	99.6	104.2	106.3
New Sales	1.0	2.1	2.1	7.5	11.1	11.5	9.7	9.5	8.7	8.4	8.1	7.2	6.8	5.8	4.6	2.1
Replacement sales		0.50	0.50	0.50	0.50	0.50	<i>*SHIFT to 3 year replacement cycle!</i>									
			1.03	1.03	1.03	1.03	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
				1.07	1.07	1.07	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
					3.77	3.77	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
						5.54	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51
							3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69	3.69
							3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84
								3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24
									3.17	3.17	3.17	3.17	3.17	3.17	3.17	3.17
										2.90	2.90	2.90	2.90	2.90	2.90	2.90
											2.81	2.81	2.81	2.81	2.81	2.81
												2.71	2.71	2.71	2.71	2.71
													2.40	2.40	2.40	2.40
														2.27	2.27	2.27
															1.92	1.92
																1.54
Replacement sales	0.00	0.50	1.53	2.60	6.37	11.91	11.78	15.02	18.19	21.09	23.90	26.61	29.01	31.28	33.20	34.75
Percent from penetration	100%	80%	58%	74%	64%	49%	45%	39%	32%	29%	25%	21%	19%	16%	12%	6%
Percent from replacement	0%	20%	42%	26%	36%	51%	55%	61%	68%	71%	75%	79%	81%	84%	88%	94%
UNITS	1.0	2.6	3.7	10.1	17.4	23.4	21.5	24.5	26.9	29.5	32.0	33.8	35.8	37.0	37.8	36.8
PRICE	100.0	95.0	90.3	85.7	81.5	77.4	73.5	69.8	66.3	63.0	59.9	56.9	54.0	51.3	48.8	46.3
MARKET SIZE	1.0	2.4	3.3	8.7	14.2	18.1	15.8	17.1	17.8	18.6	19.2	19.2	19.4	19.0	18.5	17.1
Units		156%	43%	176%	72%	34%	-8%	14%	10%	10%	9%	6%	6%	3%	2%	-3%
Market Size		143%	36%	162%	64%	28%	-13%	8%	4%	4%	3%	0%	1%	-2%	-3%	-8%

Source: Company data, CSFB estimates.

¹ Michael J. Mauboussin, Alexander Schay and Stephen G. Kawaja, "Network to Net Worth: Exploring Network Dynamics," *Credit Suisse First Boston Equity Research*, May 11, 2000.

² See Everett M. Rogers, *Diffusion of Innovations*, 4th Edition (New York, Free Press, 1995), also Theodore Modis, *Predictions* (New York: Simon & Schuster, 1992).

³ We operate under the assumption that more unit sales are better. This is not always the case. Take the example of computer print. Manufacturers lose money on the actual printer, but earn exceptional margins on the replacement cartridges. Gibboney Huske shows that the net present value of selling a printer is \$58 over its lifetime assuming a three-year life, and a lesser \$39 assuming a two-year life. See Gibboney Huske, "Print Prevue: The Implications of a Printer Price War," *Credit Suisse First Boston Equity Research*, March 7, 2001.

⁴ W. Michael Cox and Richard Alm, *Myths of Rich & Poor* (New York: Basic Books, 1999), p. 162.

⁵ Fred Hickey, *The High-Tech Strategist*, July 1, 2001, p. 6.

⁶ Clayton M. Christensen, *The Innovator's Dilemma* (Boston: Harvard Business School Press, 1997), p. xvi.

⁷ "Wireless Communications: Assessing the Global Wireless Handset Supply Chain," *Credit Suisse First Boston Equity Research*, June 28, 2001.

⁸ See "Handset Hangup: Market Analysis and Forecast Preview" *IDC Bulletin #24659*, May, 2001, p. 2. "At the end of July (2000), Nokia warned that seasonality and product release timing would lower third quarter sales. Within a week, Motorola announced it would manufacture fewer phones during the year than previously expected—and the industry began to take notice. Huge volumes of handset shipments began to create a shortage of components and the evolution of standards, along with wireless Internet access, forced vendors to continually tune their production strategies as well as research and development efforts. These challenges, combined with the industry entry of numerous Korean and Japanese handset makers, placed significant pressures on established vendors."

AMSTERDAM.....	31 20 5754 890	KUALA LUMPUR.....	603 2143 0366	SAN FRANCISCO.....	1 415 836 7600
ATLANTA.....	1 404 656 9500	LONDON.....	44 20 7888 8888	SÃO PAULO.....	55 11 3841 6000
AUCKLAND.....	64 9 302 5500	MADRID.....	34 91 423 16 00	SEOUL.....	82 2 3707 3700
BALTIMORE.....	1 410 223 3000	MELBOURNE.....	61 3 9280 1888	SHANGHAI.....	86 21 6881 8418
BANGKOK.....	62 614 6000	MEXICO CITY.....	52 5 283 89 00	SINGAPORE.....	65 212 2000
BEIJING.....	86 10 6410 6611	MILAN.....	39 02 7702 1	SYDNEY.....	61 2 8205 4433
BOSTON.....	1 617 556 5500	MOSCOW.....	7 501 967 8200	TAIPEI.....	886 2 2715 6388
BUDAPEST.....	36 1 202 2188	MUMBAI.....	91 22 230 6333	TOKYO.....	81 3 5404 9000
BUENOS AIRES.....	54 11 4394 3100	NEW YORK.....	1 212 325 2000	TORONTO.....	1 416 352 4500
CHICAGO.....	1 312 750 3000	PALO ALTO.....	1 650 614 5000	WARSAW.....	48 22 695 0050
FRANKFURT.....	49 69 75 38 0	PARIS.....	33 1 53 75 85 00	WASHINGTON.....	1 202 354 2600
HOUSTON.....	1 713 220 6700	PASADENA.....	1 626 395 5100	WELLINGTON.....	64 4 474 4400
HONG KONG.....	852 2101 6000	PHILADELPHIA.....	1 215 851 1000	ZURICH.....	41 1 333 55 55
JOHANNESBURG.....	27 11 343 2200	PRAGUE.....	420 2 210 83111		

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