# Laffer Associates

**YOU CAN RUN BUT YOU CAN'T HIDE:**

**INVESTING IN TECHNOLOGY AND THE NEW ECONOMY**

By Russell Redenbaugh*

**Introduction**

Whether investors own technology or not, they are still making a bet on technology. The decision whether or not to own technology stocks can dramatically affect investment returns. Investors who exclude technology from their portfolios may not produce satisfying results. Also, if investors fail to understand ways in which the business models of companies in which they invest could be disrupted by technology, they may also experience below average performance. The bet on technology will have dramatic consequences for investment returns.

In today's market we are seeing different dynamics than the dynamics that produced the standard long-term average annual return from equities of 11%. It is risky to assume that returns on intellectual capital will be the same as those for bricks-and-mortar and other types of physical capital.

Long-term stock market returns, although not predictable, have been relatively well behaved and appeared to follow the rules of reversion to the mean. Above trend years were followed by below trend years, periods of over valuation or under valuation reverted back to the mean, and the 11% long-term rate of return on common stocks became an article of faith.

There is, however, a deeper truth, which is that government policies tend to be variable and for much of the post-war period, policies have not tended to be consistently good or consistently bad. This pattern of alternating good and bad policies was broken, however, with the string of presidents beginning with Johnson and ending with Carter (bad policies) and beginning with Reagan and continuing on with Clinton (good policies). This run of good policies since 1981 threw off the broadly accepted theory of stock market returns reverting to the mean. Of course, good policies generated a new and much higher mean return.

Moore's Law (Gordon Moore of Intel fame) posited that microprocessor price performance doubles every 18 months. His law is well known, certainly by all technology investors, and probably by most investors. Until now, for the vast majority of investors who did not invest in technology companies, Moore's law and its consequences could be ignored. Technology companies were small, high-growth companies, located primarily in California and off to the side of the economy. Bricks-and-mortar investors could ignore them without significantly affecting their relative performance.

Now we have Moore's Theorem (from Geoffrey Moore of the Chasm Group and technology investing fame) which states that returns revert to the extreme. That is, in winner take all or winner take most markets, the winners will always look overpriced and the losers will always look like great values. This can be thought of as the relative value trap or 50 ways to lose your money.

We are in a new paradigm of business and investment. The digital economy operates under different rules than the industrial economy and it is a mistake to apply industrial benchmarks to measure performance. Moore's Law can no longer be ignored by the bricks and mortar (the old economy), by managements or by investors. Said glibly, if you are in business, your business is innovation. If you do not adopt the technology of ubiquitous communication made possible by nearly free computing and bandwidth, and do this in a way that disrupts your existing business model, someone else will. Returns on the correct paradigm have always been fantastic and will continue to be for those who get there early and stay with the paradigm leaders.

Many businesses, most investors and absolutely all value investors are discovering that what used to work is no longer valid. The vast majority of stock valuation models indicate that the market is either substantially overpriced or massively overpriced. These models are probably wrong. They are based on rules of thumb and static approaches that worked fine

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when growth was an unexpected surprise, as was the case from the mid 1960s to the mid 1980s. This time span covers the working lives of most professional investors. It is no wonder that these models presume that we are not in an age of abundance and that growth is not normal.

Money managers must come to grips with valuation models that are dynamic and open. Economic policies drive inflation rates, interest rates and rates of growth. These policies drive stock market returns. Rules of thumb and valuation methodologies that worked well during the decades of poor policy priced their followers out of the market about 100% ago. They must consider models that explicitly address the assumptions about inflation, growth and after tax returns, rather than assuming that the "bleak" economic environment from 1965-82 was "normal" and will return. Value investing tends to work when policies are bad or inconsistent. The rest of the time, the growth sector is likely to produce better returns.

The fundamental questions that cause the most trouble for investors are:

- What are the fundamental forces or drivers or insights that you must understand to be a successful investor in technology?
- How can you build lasting value in an economy built on constant change?
- How do you compete when market boundaries are collapsing and new ones are being built?
- Can old economy companies learn new economy tricks?
- Can new companies acquire wisdom and experience?

The rate of change in business and investing now requires a different sort of practitioner, both in business and investing. Many economists, analysts and investors are rooted in the industrial economic base and are used to the comfort and accuracy of being able to count the objects that the industrial businesses make or move. They take the position, at least implicitly, that if you can't measure it, it doesn't exist. In the digital economy, where we move bits as well as atoms, the old rules of counting, measuring and creating value are insufficient.

Investing, especially for the professional investor, is a game based on relative results. That is, you must have good results relative to other money managers or you will lose clients. For individuals, investing is about building wealth, and this also tends to be oriented around building relative wealth. Accordingly, success is unlikely to be achieved by ignoring the technologies that so fundamentally change business.

If investors are to move effectively in this new world they must reflect on the changes that are occurring. With the rules of the game changing so rapidly, investors cannot avoid the requirement of having an understanding of technology, any more than a retailer can avoid the requirement to understand and use technology to sustain their business. Investors can run but they can't hide.

## What is Technology?

In order to navigate the field of technology and its impact on investing we must first build a common background. What follows is a pragmatic and useful interpretation of technology that differs from the understanding that most of us have.

*What is technology?*

Traditionally, we think of technology as a device or gizmo, a new gadget of some sort. This notion began sometime during the 20th century, with the introduction of electronics. We talk about collecting technological "toys" or coming up with the latest "new technology." Technology is assumed to be a thing that does something faster, cheaper, better or all of the above.

This definition hides the real impact of technology. When we consider technology as merely the gadget or device, it becomes very difficult to understand the consequences of technology on the companies we manage or the stocks we own. We become overwhelmed with having to stay up on all the latest terminology and products, such as RISC processors, CDMA, WDM, add-drop multiplexers, erbium doped fiber optics, storewidth, etc.

To understand the impact of technology and its consequences for investing we must broaden our emphasis from the product, device or technology itself to consider how the technology is used and how it changes what people do at work and in their lives.

Human history is largely synonymous with the history of technology. History is the chronicle of inventions that have increased man's ability to extend his power and augment his capacity to be effective at his endeavors. Technology is one of the strategies people have used to improve their lot and take care of their concerns.

From the economist's point of view, innovation or technology is a different way of doing more with less. It is a change that enables the same level of output with lower levels of input. This is the sweep of history. If this were not the case, living standards could never rise.

A new "technology" is not merely a new thing or device. Successful technologies precipitate new habits and more effective ways to conduct one's affairs. E-mail, for example, is not merely a faster way to send a paper letter. Television is not just a picture of a radio program. The computer is not merely an elaborate calculator. These devices dramatically expanded users' capacity to communicate, shop and stay connected to communities and information. Successful technologies change the people who use them.

What we normally call "technology" usually refers to a "new" method for conducting affairs in business or life. When the new method becomes commonplace and passes into the background of our everyday lives, we no longer refer to it as "technology." It becomes merely part of standard conduct.

For example, the wheel, double-entry accounting, the candle, the pen and the zipper are all technologies. Each of them expanded the effectiveness and success in certain endeavors, but they have all become commonplace, and we no longer think of them as technologies because they are not "new."

Successful technologies also change the standards of what is satisfactory to their users. Shifts in expectations regarding time, quality, and cost can be altered dramatically by a new technology or practice.

Innovations in movie production completely changed the standard of quality for production values and special effects. The invention of the credit card made capital available to consumers in a new way and allowed businesses, airlines and financial institutions to offer entirely new products and services.

ATM machines, for example, make waiting in teller lines unsatisfactory and, largely, obsolete. Any bank that does not offer the new technology -- the ATM machine -- is behind the times and less attractive to customers. In contrast, although adding a second teller would indeed shorten the line, it is not new technology. It is not a change in practices and it uses an additional unit of labor. And, when you consider the time it would take a teller to fulfill all of the requests allowed at the ATM machine -- check account balances, produce statements, transfer funds, etc. -- ATMs are still a much faster alternative.

Users will always consider the time, cost and energy required by them to learn and adopt any new technology. Thus, technologies that "work" but which don't produce a substantial (10x) improvement in value to customers will fail because they will only increase costs to the user without sufficient benefit. Products that "work" but don't spread, don't get widely adopted or don't alter people's lives will not build power and momentum and will not pay their costs. They will fail.

Investors must always be alert for technologies that are likely to be adopted and will produce significant improvements in time, quality or cost -- technologies that will change the relative factor costs.

*Common Orientations to Technology*

We all have our own personal reactions to technology. We even have words for these reactions. "Luddites" resist, distrust or fear the inevitable changes brought about by new technology. They oppose the adoption of new technologies and believe their opposition to be virtuous. The term was first used after a group of British workers in the early 1800s conducted a series of riots and destroyed laborsaving textile machinery, mimicking the earlier actions of Ned Ludd. These Luddites, as they called themselves, feared the new technology would increase unemployment.

Similarly, there are the saboteurs. "Sabot" is the French word for wooden shoe or clog. Stories tell of French industrial workers who, like their English counterparts, rebelled against the tyranny of industry by throwing their sabots or shoes into the machinery of their employers, bringing production to a halt.

These attitudes see only the burden and negative aspects of a new technology. They believe the old ways are better and do not consider the possibilities that will be opened by new technology. They see only the burden of change.

On the other end of the spectrum are the nerds or "early adopters" who continually seek out new technologies, gadgets and gizmos. The history of "nerd" is not clear but the word has certainly come to refer to a person who is single-minded, accomplished in scientific pursuits and socially inept or unattractive. Nerds are clearly focused in their pursuit of the latest technology. They *only* see the new possibilities of the device or practice, and do not consider the costs of change that coincide with the adoption of a new technology or tool.

*Consequences For Investing*

Either of these extreme orientations to technology can produce breakdowns for managing companies and investments. Both involve problems of timing. Luddites resist, delay and postpone. They follow the innovations and adoptions of others, changing their business models or methodologies only after the technology has become ubiquitous and they have already lost power, prestige, profit and market share to others. The nerds tend to move too quickly. They are fascinated by the gizmo and underestimate the adoption rate, the costs of adoption (including the difficulty that many will have in learning the new practices) and the fundamental unreliability of the new technology.

Both orientations miss the fundamental impact of successful technology. A new technology has the possibility of *shifting the relative costs of resources.* New technology has the capability of substituting abundant resources for scarce ones and generating new opportunities for investment and the generation of wealth.

## What We Did and How We Did It: The Sky is Rising, By Chicken Big

1999 was a spectacular year. As always, good timing contributed to results. Buying companies whose problems were operational and whose stock market dips were temporary was an important source of investment return. However, this source of return paled when compared to the monster returns earned by being in the companies that were positioned on the right side of technological and economic forces in a period of improving policies.

Most investment advice takes the accurate but useless form of "buy low, sell high." In assembling a portfolio of growing, innovative companies, the advice to "buy low sell high" is not merely useless, it orients investors in precisely the wrong direction. To build wealth and enduring value, investors need a different common sense, must ask different questions and, thus, develop different rules and strategies.

In this section, we address the question: How can you do it? How can you produce those unusual returns? How can you identify tomorrow's blue chips today?

## How to Play: General Rules for Managing Growth Portfolios

The following are general strategies for playing the technology investing game.

- Strategy #1: Know the Prevailing Winds of Policy -- Always Work With The Wind At Your Back
- Strategy #2: Ignore Valuation: Watch Policy and Ignore Price
- Strategy #3: Watch Power, Not Earnings
- Strategy #4: Watch the Supply Curve
- Strategy #5: Watch the Basics -- They Still Apply
- Strategy #6: Don't Sell Your Winners
- Strategy #7: Don't Keep Your Losers

### 1) Know the Prevailing Winds of Policy -- Always Work With The Wind At Your Back

As a first and critical step, check the forces or policies that affect all investments. Review monetary, tax and trade policies. Are they improving or getting worse? If they are getting worse, you can only play to lose less. If policies are generally improving, then play to win.

Where you bet matters. For example, check the Laffer Associates Conditional Forecaster for an advantage in seeing where to invest. Then with the wind at your back, with demographic, economic and social forces favorable to the kinds of investments you are making, the following strategies can increase your odds of winning and your chances of keeping more of what you win.

**2) Ignore Valuation: Watch Policy and Ignore Price**

Stocks are always at either the right price or the wrong price, but future price changes are much more likely to be caused by changes in situation than by the market's recognition that they are mispriced. In other words, the notion of "fair value" is probably a dangerous illusion. Stocks do not know their own fair value.

If economic policy is poor, stocks will decline. They may appear to be "undervalued," but if policy stays bad or worsens, they will become even more "undervalued." There is no reversion to the mean. On the other hand, if policy is improving, stocks will probably be a great buy, although they will be up from their lows.

What to do? Watch policy and ignore price.

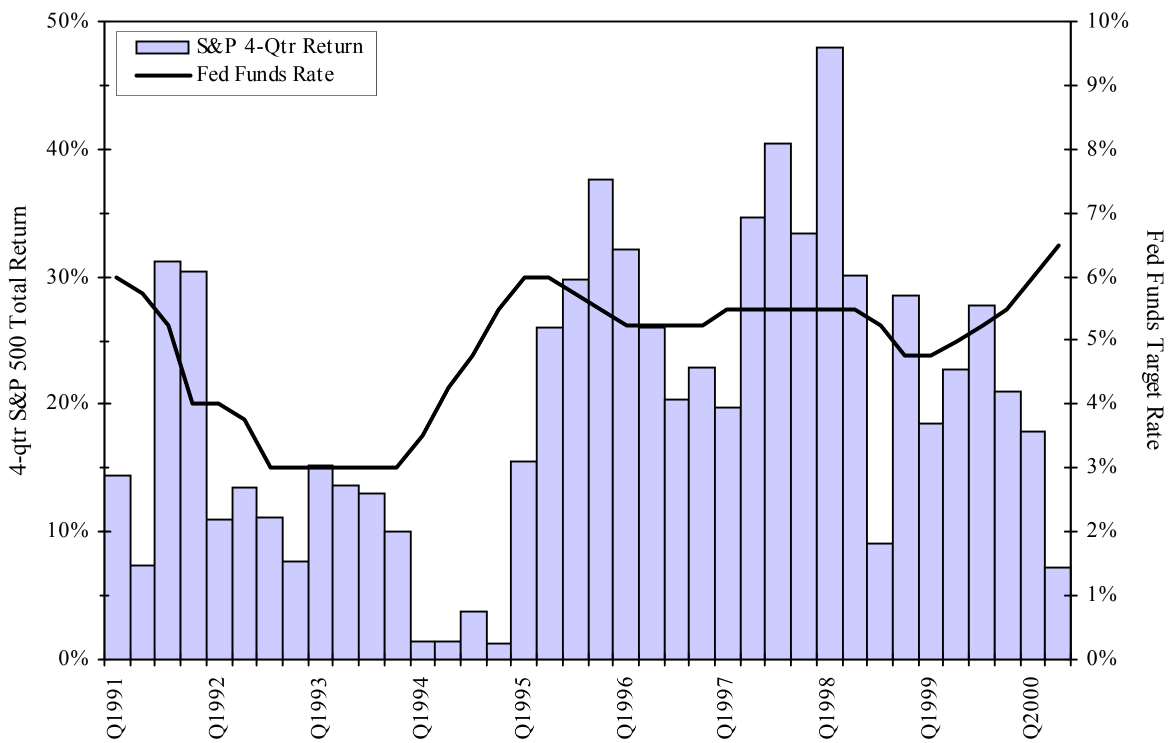
We all know that the market's long run average return is 11% per year. Few of us know there were no average years, and in fact, no average decades. The 11% is made up of decades of good policy and decades of poor policy.

A review of stock market returns shows that long runs of above average performance are unusual. Only twice since the 1950s has the stock market experienced three above average years in a row. Ten times there have been two above average years in a row. It is difficult to keep things going. This is probably because policies wobble. The key is to watch policy.

For example, has any investor ever lost money buying after a cut in marginal tax rates or buying after three cuts in the fed funds target rate? This is one reason why 1998 was such a spectacular buying opportunity (Figure 1). When to buy was so obvious. The Fed cut rates and the cap gains tax rate had been cut in 1997.

**Figure 1**

**Rates Matter: Rate Cuts Precede Market Jumps**



Of course, the effects of economic policy on asset returns vary by the nature of the policy in question. Falling interest rates favor certain industries over others, and the same for rising interest rates; a weakening dollar favors exported-goods industries while a strengthening dollar favors non-traded industries; high-tax states, both U.S. states as well as foreign, depress competitiveness and corporate profits relative to businesses in low-tax states; an increase of business regulation imposes more costs on doing business and depresses the returns of those industries that do not adjust well to these new costs. These considerations have all been incorporated in the Macro-500 Stock Forecaster that Laffer Associates produces and updates quarterly.

**3) Watch Power, Not Earnings**

High margins and great returns on equity come only after the accumulation of power. They are the rewards for playing the power game well. Don't confuse them with the strategy for winning the game.

Companies that acquire a dominant position in a growth market are likely to consume enormous quantities of capital and have no earnings. The game is won by dominating the market, not by earnings growth. In fact, good earnings growth might coincide with a loss of dominance, as with IBM in the 1980s.

*How Do We Observe Power?*

To be a better observer of power than your competitors is not as hard as it seems. The business schools teach everybody to watch the wrong thing: earnings. Companies that rapidly convert non-customers into customers will gain power and achieve hypergrowth. Hypergrowth probably never occurs by taking market share. Market share is always well defended. Hypergrowth occurs by converting non-users to users. It occurs by competing with the old ways of doing things.

Let's take a look at the hypergrowth company Qualcomm, a 1999 favorite for my clients and me. Qualcomm's stock price advanced 2400% in 1999 as it moved from dominating a number of niche markets to becoming the preferred provider of chip sets for mobile phones. Basically, Qualcomm went from having a technology that some said couldn't possibly work to having the preferred solution to the spectrum and power consumption problems of the mobile phone industry.

Qualcomm is growing the mobile phone industry and producing new conversions because its proprietary technology is more effective than that of its competition. Qualcomm's sales grew from $3.3 billion in 1998 to $3.9 billion in 1999.

Geoffrey Moore, in all of his books, but especially his latest -- *Living On The Faultline: Managing for Shareholder Value in the Age of the Internet* -- gives some useful criteria for watching power. None of them include earnings growth. In Moore's view, Qualcomm can strive to dominate its market since it has proprietary technology rather than open standards. Qualcomm can be a "gorilla," rather than a "chimp" or "monkey." In Moore's framework, gorillas are companies with strong moats that defend their excess profitability. These moats must be based on intellectual property -- either patent protected, trade secrets or proprietary standards that have no close substitutes and produce high switching costs to customers. In short, gorilla companies have barriers to entry for their competitors and barriers to exit for their customers. Their products are highly valued and not easily copied.

Qualcomm is playing to be a gorilla and succeeding. Its jungle of patents gives Qualcomm a long period of competitive advantage. Additionally, it has superior product performance relative to the two critical scarcities of radio spectrum and battery power. Qualcomm's ability to squander the abundant resource, silicon, and preserve two scarce resources, radio spectrum and mobile phone battery power, give it a remarkably high future profitability level. Qualcomm has a steeply sloped supply curve because it has enforceable patents. This combination of factors, including a prospective high profit margin and a long period for this profitability, make valuation difficult but tantalizing.

Finally, Qualcomm has built a value chain that includes many other companies which do the lower-margin and tedious activities needed to make cell phones. Qualcomm no longer makes or assembles telephone handsets and no longer makes cellular base stations.

As of this writing, Qualcomm's share price has declined substantially on speculation that Korea and China will either adopt technological solutions that put Qualcomm at a serious disadvantage or find some way to avoid paying royalties on the Qualcomm patents. What started as a rather traditional technological or investment decision has now become a political or geopolitical decision. That is, will China find a way around Qualcomm's intellectual property? Specifically, how will the U.S. State and Commerce Departments move to protect the intellectual property of a U.S.-based company? Importantly, how will Nokia, the largest player in the global cell phone market and a Finnish company, align itself? Now we are solidly in the game of power. Still unresolved is the question of whether or not Nokia will honor Qualcomm's third generation patents. Of course, the answer can only be they won't if they don't have to.

My own view is that the spectrum and power consumption advantages offered by Qualcomm, especially for data transmission, are so overwhelmingly clear that the issue is really whether or not Qualcomm can assert its intellectual property rights. With the stock down in the low $60s, it appears to be priced as though they can't assert these rights. I'm betting they will prevail.

*Watch Political Alliances and Networks*

Giant, fully integrated companies of the past are too rigid and too slow to live at Internet speeds. In the 1930s, it may have made sense for Ford Motor to integrate all the way back to iron ore and rubber plantations, but today the imperative is to outsource everything that is not a differentiator. As Geoffrey Moore states, outsource everything not at the core of the competitive strategy, everything.

Integrated companies, the hallmark of the old economy, are disintegrating. Clayton Christensen is the clearest thinker on this point.[1] Hypergrowth favors the flexible and rapid. The essential managerial skills are no longer making and moving things, that's old economy. *The essential skills today are making and maintaining alliances and collaborative networks.* Supply chain management is not merely a good idea, it is a survival imperative.

Watch companies for their ability to build value networks, to maintain alliances and to configure a community around their products and services that can rapidly rally to handle the important but lower margin components. Don't buy the secondary and tertiary companies. Identify and buy the companies that convene these configurations. Once the pace of technological change slows, the dominant company, the convener of the community, will find a way to capture the margins in the supply chain. If it is the gorilla, it can do this with ease.

In the PC industry, Microsoft and Intel are the gorillas and conveners. The others players in the industry are the PC assemblers, motherboard and RAM manufacturers and disk drive makers.

Dell may be one exception to the rule "don't buy the suppliers." Dell's distribution model, "Be Direct," is stunningly innovative and its apparent competitors are finding it very hard to copy or block. Dell understands that inventory is what you need when you don't know what you are doing. Dell strategy has been to disrupt the distribution system of the PC industry, not the PC manufacturing business but the PC selling business. They do not make the machines until the order is placed. They don't need inventory because they know the specifications of each order. They are paid before they purchase parts and thus the channel is not filled with the wrong machines or parts.

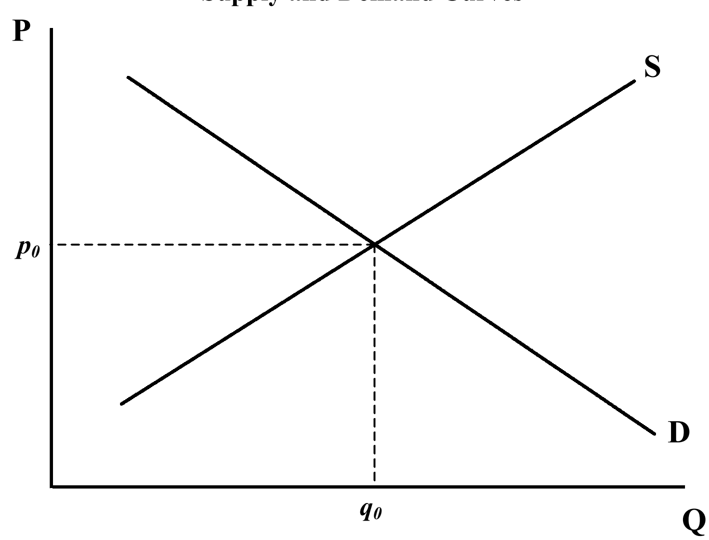
The challenge for Dell will come in the post-PC era. So far, they are managing the transition well. Dell has established its presence and power directly with the customer, from the individual in a small business to the large-company purchasing department. Building these relationships has been one of Dell's fundamental skills and is proving to be a valuable asset. With these relationships and their innovative distribution channel, it has been easy for Dell to move to other products such as network servers, Palm Pilots, digital cameras and office supplies.

**4) Watch the Supply Curve**

Remember our old friends supply and demand? Demand curves are downward sloping; supply curves are (hopefully) upward sloping (Figure 2). The elasticity of supply is measured by the slope of the curve. A vertical curve is supply inelastic. This means that any increase in demand will be accommodated by an increase in price, not an increase in the quantity supplied. In this case, rising demand equals rising profitability.

**Figure 2**

**Supply and Demand Curves**



A flat or horizontal curve is supply elastic. Any change in demand will be accommodated by a change in quantity, not a change in price. Investors hate these supply curves. Somebody else supplies all the increase in demand and profitability remains marginal. The world hates a vertical supply curve and will do everything to kill it because a vertical curve indicates a firm that is gaining power and is a monopolist.

There is something wrong with the common sense of those who are investing in the dot-coms. The supply curves will flatten where there is no proprietary knowledge, low switching costs and low barriers to entry. New entrants flatten the curve and reduce profitability. This is the case with many dot-com businesses today. The only advantage is that of "first mover," and even this is very fleeting. In many cases, customers can switch to competitors with merely the click of a mouse.

If online pharmacies, for example, are successful, existing brick and mortar pharmacies are compelled to enter the online world for two reasons: first, to keep the customers they will be losing, and second to maintain the brand equity they already have and to avoid becoming irrelevant.

There are strategies to diminish the threat of online competition that are defensive in nature. One of the ways to shore up a flattening supply curve is to use the excess profit to build brand equity, which then becomes a differentiator. Sony and other branded consumer products are examples of this.

In short, don't invest where supply curves are flat. Don't own companies whose supply curves are flattening. When there really is a steep curve, it can flatten. Customers want it to flatten. Competitors want it to remain steep but then flatten it through their actions. Compaq, Honeywell-Burroughs, Atari, Osborne, Apple, IBM, strip-mall shopping centers, department stores and airlines are all examples of companies or industries whose supply curves have flattened. In selecting stocks, make sure the curve really is steep, not just hyped by reporters making news.

Watch for the following capacities in potential investments: innovative and/or patented technology, intellectual property, high switching costs, brand identity and skill in execution.

**5) Watch the Basics -- They Still Apply**

Until the Nasdaq and dot-com collapse in April, investors were confusing a business strategy with a business. To be a dot-com doesn't mean you are a real business. Selling a product or service online can be a strategy, but the real business lies in selling the product or service itself.

The dot-coms have now died. What has become clear is that the real businesses -- bricks and mortar or old economy companies -- can use the web either as a tactic to sell their existing products or as a strategy for selling new products or services. E-commerce is either a strategy or a tactic, but not a business.

What's the difference? The Gap uses its website to sell the same products you can get at its stores. This is a tactic. Charles Schwab is offering online brokerage. This is a strategy. Both are inside the existing business of apparel and financial services.

It is critical now more than ever to invest in the people whose business model is sound and who have the technology which have the possibility to change society. Many of the dot-coms are run by people who haven't run businesses, who don't understand well the notion of brand or the phenomenon of trust. This will produce a big opportunity for the brick and mortar companies with brand equity and proficient business skills. They can learn from the mistakes of the new dot-coms. The Gap is a likely example of this.

Yahoo! is an example of a dot-com that understands branding. The content they provide they have branded as Yahoo!: Yahoo! Finance, Yahoo! Shopping, Yahoo! Auctions and Yahoo! Travel, for example, all dramatically increase the value of the firm. Excite, on the other hand, missed the point. They were trapped in the notion of information. Rather than branding their services, they operate as an aggregator or channel of information. For example, Excite offers ZDNet Tech News, "My Stocks" sponsored by Charles Schwab, Intuit's Quicken Mortgage.com, and a Product and Service Finder powered by Jango.

Excite is borrowing the brand equity of these other providers. This may give them a short-term edge, but they are not building brand equity of their own. And, in a world where a competitor is only a mouse click away, brand equity is even more important.

*Beware New Technologies - They Don't Always Produce Profit For Their Shareholders*

New technologies don't always produce value for the shareholders because they can't sustain the production of excess profits. Why? They have a flat supply curve. They are missing barriers to entry for potential competitors and barriers to exit for existing customers.

There are technologies that you must embrace but for which you get no return, they become merely mandatory for staying in the game. Examples of this are the fax machine, e-mail and probably a web site. These are mandatory, but they're not technologies that will build you a competitive advantage. These technologies become ubiquitous but they define a new minimum standard. No longer are these technologies a way for companies to establish a new minimum standard that must be met by its competitors. Investors are at risk if they confuse new minimum standards for business success (requirements for staying in the game) with investing in a technological infrastructure that will confer a competitive advantage.

The key question for investors then becomes: How do we use technology to support and enhance the value of our offer to our customers, where "value" is verified by customers who will pay more.

**6) Don't Sell Your Winners**

Theorem #1 regarding market winners is: If stocks don't fall because they are overpriced, don't make your sell decisions based on price. The corollary to this is Theorem #2: If stocks don't rise because they are underpriced, don't make your buy decisions based on price.

If you have the enormous good fortune to buy a company before it enters hypergrowth, and before it becomes a gorilla, don't sell! Stocks don't know they are overpriced. If a company has operating problems, don't sell the stock. In fact, buy more. Problems can be divided into two categories: strategic and operational. Strategic problems -- like a bet on the wrong technology, a misinterpretation about what customers want or the wrong alliances -- are very difficult to fix. Operational problems -- like a new plant that doesn't start on time, a slippage in a product release date or missing the quarter due to parts shortages -- are incredibly common and they can be fixed. Hypergrowth companies usually have operating problems. Pray for them! They give you the opportunity to buy more.

However, if the company begins to lose power -- if its market is maturing, if competitors are disrupting either its technology or its business model, if executives are "buying market share," or any of other indicators of a loss of power or a poor strategy -- sell, sell, sell! Of course, the stock will already be down significantly, you can't be the only one to have noticed the loss of power, but don't let the price decline trap you in a company that is losing its power.

**7) Don't Keep Your Losers**

The investment business is organized all wrong. It is dominated by bright people who can't stand to be wrong. We lesser mortals don't like to be wrong either, we just get more practice at it.

Investment departments strive to avoid mistakes. This is not the way to build wealth, although it may be the way to build egos. To build wealth, investors must make mistakes and correct them early.

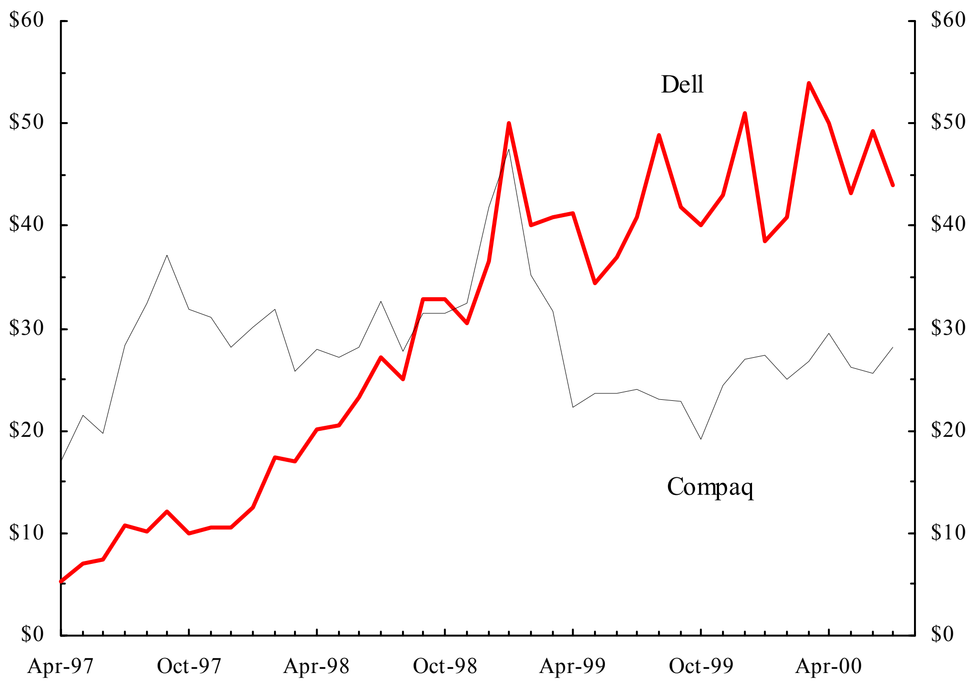
If a company is behind the power curve, its stock can never be cheap enough. Companies that are behind the power curve are losing margin, losing customers, losing value chain members, losing talent and losing shareholders. Stocks that are down are not necessarily cheap, they are just lower in price.

Look at the share price performance for Dell and Compaq (Figure 3). Compaq can never be cheap enough; it is losing power while Dell is gaining power.

Dell has learned a fundamental secret of production and distribution. Inventory is what you need when you don't know what you are doing. Said another way, information substitutes for inventory. Additionally, Dell has learned the fundamental secret of cash management: if your customers pay in advance, acceleration in business produces a cash storm, not a cash drought.

Your clients will forgive you for catching a mistake; they won't forgive you for continuing to hold the stock of a company that is obviously losing power.

**Figure 3**
**Share Price Performance: Dell vs. Compaq**
**(through 7/31/00)**




The rules of thumb presented here are by no means complete, but they indicate approaches that work especially well when investing in growth and technology companies.

**Picking Your Cards: Keys to Stock and Industry Selection**

How can we find the right companies? Figuring out which companies to buy is easy to say but hard to do. In the section that follows we put forth a list of steps to take and the factors or characteristics of potential big winners that we all want to have in our portfolios.

As investors we strive to follow the following steps:

- Step #1: Identify Hypergrowth Markets
- Step #2: Identify the Scarcities and Abundances
- Step #3: Distinguish Cost and Price
- Step #4: Identify Companies That Have the Possibility of Dominating a Giant Future Market
- Step #5: Determine One or Two Factors That Are Critical for Success in the Target Industry
- Step #6: Locate Companies That Will Earn Monopoly Rents Due To: Proprietary Technology, Barriers to Entry for Competitors and/or High Switching Costs or Barriers to Exit for Customers
- Step #7: Find Companies That Will Create a Vertical Supply Curve
- Step #8: Look for Companies That Assemble a Value Chain and Leave Other Companies to Handle Tedious and Low Margin Activities

**1) Identify Hypergrowth Markets**

Hypergrowth markets occur around technological advances that have the consequence of collapsing costs. The collapsing of costs transforms scarcities into abundances and allows for the generation of a hypergrowth market.

As George Gilder has written so eloquently, the defining paradigm of our time is the collapse in the cost of processors and the collapse in the cost of bandwidth. These two steep declines trigger hypergrowth in various markets because they produce an economic substitution phenomenon. For example, in computing and telecommunications, silicon and glass fiber substitute for distance, space and time.

In 1989, Gilder wrote:

> *[Microcosm] is an exploration of the meaning and future of modern technology. With its origins in quantum physics and its embodiment in the microchip, the exemplary product of this technology is the computer. Still in the infancy of its influence and power, the computer in its current form is the product of some twenty-five years of development….*
>
> *Broadly considered, the computer is the most important product of the quantum era. By exploring this central machine of the age, however, we discover not the centrality of machines and things but the primacy of human thought and creativity.*
>
> *The quantum era is still unfolding in a fourfold transformation of the world -- in science, technology, business and politics -- and even in philosophy. But all the changes converge in one epochal event: the overthrow of matter.*
>
> *The change originates in the microcosm of quantum theory itself -- the new physics launched in Europe early this century -- which overthrew matter in the physical sciences. At the foundation of the universe, Isaac Newton's hard, inert, and indivisible solids gave way to a rich panoply of paradoxical sparks, comprising waves and particles that violate every principle of Newtonian solidity. At the root of all the cascading changes of modern economic life -- devaluing material resources in technology, business, and geopolitics -- is this original overthrow of material solidity in the science of matter itself.*
>
> *The second step in the overthrow of matter came in the use of quantum theory to overcome the material limits of weight, heat, and force in the creation of new machines. The industrial age essentially managed and manipulated matter from the outside, lifting it against gravity, moving it against friction, melting or burning it to change its form. The quantum era manipulates matter from the inside, adapting its inner structure to human purposes.*
>
> *In the microchip, combining millions of components operating in billionths of seconds in a space the size of the wing of a fly, human beings built a machine that overcame all the conventional limits of mechanical time and space. Made essentially of the silicon in sand -- one of the most common substances on earth -- microchips find their value not in their substance but in their intellectual content, their design or software.*
>
> *The third great manifestation of the overthrow of matter is the impact of this technology on the world of business. By overcoming the constraints of material resources, the microchip has devalued most large accumulations of physical capital and made possible the launching of global economic enterprises by one entrepreneur at a workstation. With the overthrow of the constraints of material scarcity, gravity, and friction, large bureaucracies in government and business lose their power over individual creators and entrepreneurs.*[2]

Hypergrowth markets are triggered by a substitution of the abundant for the scarce. Steam engine power displaced muscle power. Petroleum and the tractor replaced horses. The steam engine, the internal combustion engine and later the fraction horsepower electric motor allowed for the explosion of the industrial revolution. More recently, transistors substituted for vacuum tubes. Integrated circuits replaced discrete devices. Glass fiber is replacing copper. Each of these fundamental technologies displaced an older, slower and more costly technology and produced a hypergrowth market.

Chips and glass fiber are producing hypergrowth in communication, entertainment and in any other market where we can substitute the movement of bits for atoms. Graphics, color printing, digital photography, wireless phones, pagers and palm pilots are just a few of the hypergrowth examples made possible by the collapsing price of chips and fiber.

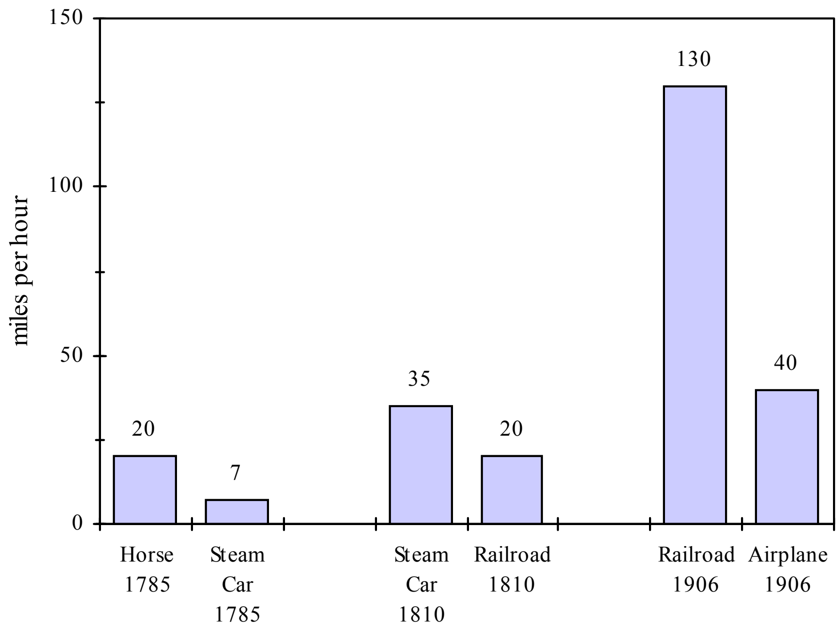
In sum, locate hypergrowth markets. Look for fundamental technologies whose costs are collapsing.

**2) Identify the Scarcities and Abundances**

When we assess a new technology or practice and its potential for growth and investment return, we are often unable to see the possibilities. Often, at their inception, the new technology is worse than the existing methods. New technologies nearly always start out more expensive and less capable than that which they ultimately replace (Figure 4). We often miss that the new technology is really a product or service that conserves a scarce resource and squanders an abundant one. In today's world the scarce resource often squandered is time. Several products and services that have preserved this resource have done well.

**Figure 4**

**Initially, The New is Often Worse Than The Old**




To understand the phenomenon of change through technology, consider these areas where technological innovation produced enormous transformations: automobiles, televisions and computers. The car is not merely a faster horse, the television is not merely a radio with pictures, and the computer is not merely a calculating machine. Although at their inception the new technologies often pale to the existing ones, in each of the above cases the new technology not only covered the functionality of the former devices, but also eventually opened entirely new opportunities for communities, communication and work.

The car allowed for the expansion of communities -- families and friends who lived further apart could visit for a day or weekend. The suburbs became possible. The television has evolved to a place where we can shop, purchase movies and see events happening around the world as they occur. None of this was possible with the radio. The computer opened up new worlds far beyond the electronic manipulation of data: we can connect to business colleagues internationally, converse with friends across the country, join forums to learn about common interests and make airline reservations. These possibilities are unthinkable if we consider the computer only as an information-processing machine. Furthermore, by opening up whole new possibilities for business, each of these technologies has generated new scarcities and abundances.

Certainly this is contrary to the scarcity theories and Malthus' claim that populations expand faster than their resources. Unfortunately, these theories gripped both policy makers and investors in the 1970s and 1980s. With the perspective of 20 years, we can now see the foolishness of believing that markets would no longer work, or that energy markets would no longer work. It was clearly silly to squander scarce capital on solar farms, windmills and synthetic fuels merely because we thought that oil was a non-renewable resource and its price would be $100 per barrel by 1999. Although oil, currently around $30 per barrel, is a non-renewable resource, it remains abundant. Thanks to technology, finding and production costs have collapsed.

The <u>first law of wealth</u> is that wealth flows to the enterprise that squanders the abundant resource and conserves the scarce resource. New wealth is produced by those organizations that are best able to maximize their use of those resources that are falling in price and minimize the use of those that are rising in price.

The <u>second law of wealth</u> is that it is very difficult to determine which is the abundant and which is the scarce resource. Every technological epic inverts the hierarchy of scarcities and abundances and leaves us with the wrong common sense. Whatever was scarce when our habits of mind were formed is likely to be abundant now. This is how free markets work. They concentrate on innovations, technology and changes in practices that reduce the prices of the scarce resources. There is no point in inventing something that reduces the usage of an abundant resource. Accordingly, the next technological revolution will always seek to make abundant that which was previously scarce.

Time used to be the abundant resource. We expected to wait in line, watch the wrong TV program, limit our long distance calls and submit our punch cards for overnight processing on the third shift of the computer. We expected doctors to manage their schedules by always having a full waiting room, forcing us to wait. And, perhaps most of all, we expected a large choice of standardized, mass-produced products from a small number of national vendors -- i.e. K-mart, Sears, Safeway.

None of this prepared us for the frictionless economy -- e-mail and telephony whose costs are independent of their distance. Production systems that produced mass customization, catalogs and Internet commerce broke the tyranny of geography and dissolved customer ignorance about competing prices. “Anywhere, anytime and at the lowest price” is the reality of ubiquitous telecommunications.

Companies prosper by transforming scarcities into abundances. As investors, it is important to remember that shortages and scarcities are temporary. It is essential to not get caught up in the fad and fashion of the moment. One of the common mistakes we make in anticipating the future is that we dramatically overestimate the rate of change in the short term and dramatically underestimate its consequences in the long term. It is even worse than this. We overestimate the short-term effects of change, and in the disappointment that follows; we not only underestimate, but also often ignore the long-term and cumulative effects.

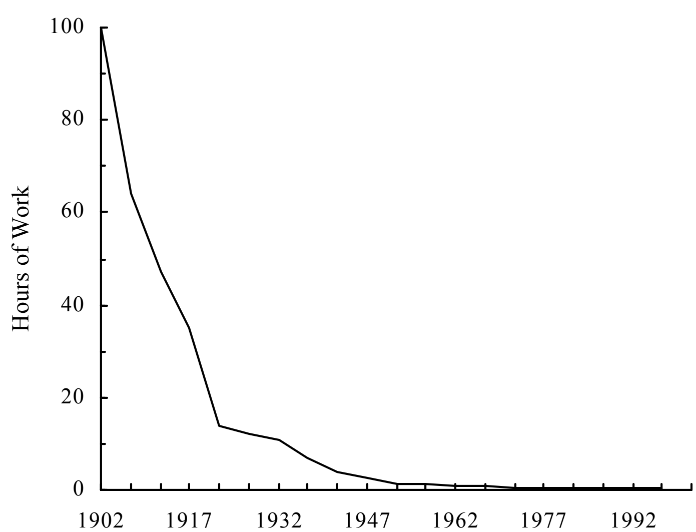
The technological forces that we breathlessly expect to change our lives overnight nearly always fail to do so, overnight. However, over the space of a decade these forces can produce significant change, for which we are often unprepared. The current manifestation of this is the Internet. There is too much enthusiasm right now. People think it will change everything overnight. It won’t. But over a long horizon, the Internet will produce dramatic changes in every aspect of our lives.

We are unprepared to grasp that time is the scarce resource and that computing power and bandwidth are the abundant resources. Many of us are still saving string, even after string has become free.

### 3) Distinguish Cost and Price

The other common mistake made by reviewers of technology (whether investors or potential users) is in confusing cost versus price. The cost of something is not merely its price in dollars. The true economic cost is the amount of capital -- financial, labor, time, etc. -- we must give up to acquire it. Using data from the Federal Reserve Bank of Dallas’ 1997 Annual Report, Figures 5, 6 and 7 use the average manufacturing wage to show reductions in the cost of living in terms of the work time needed to purchase certain goods and services. As Thoreau said: “The cost of a thing is the amount of…life which is required to be exchanged for it, immediately or in the long run.”[3]

**Figure 5**
**The Cost of Electricity Falls Toward Zero**



> *Burning just 10 light bulbs for 100 hours cost $16.20 in 1902, the equivalent of 2 weeks wages for factory workers. As a result, only one in 200 American households could afford to be wired. Today, with its work-time toll a mere 0.6% of what it was then, over 99.9% of U.S. households enjoy electricity (Figure 5).*[4]

In 1920, it required 35 minutes of work to purchase a gallon of gasoline. In 1997, it required only 5 minutes (Figure 6). Cellular phones have dropped in price from over $4,000 in 1984 to approximately $100 today for models with many more features (Figure 7). In addition, airtime costs have dropped to one-tenth of 1984 levels.

**Figure 6**
**The Cost of Gasoline Falls Toward Zero**

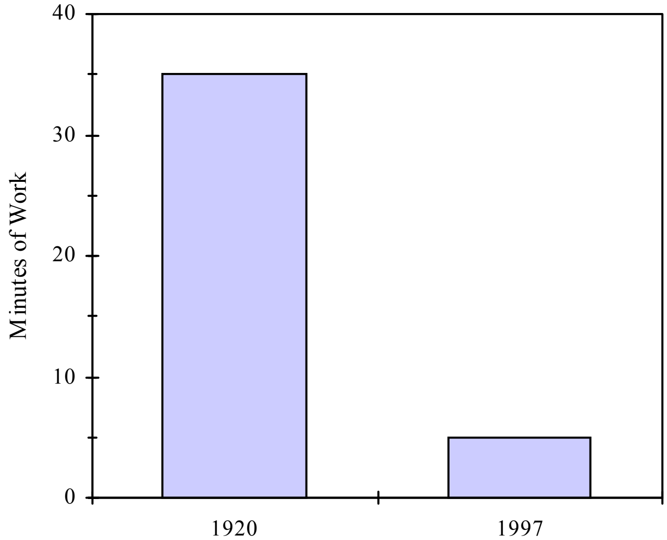
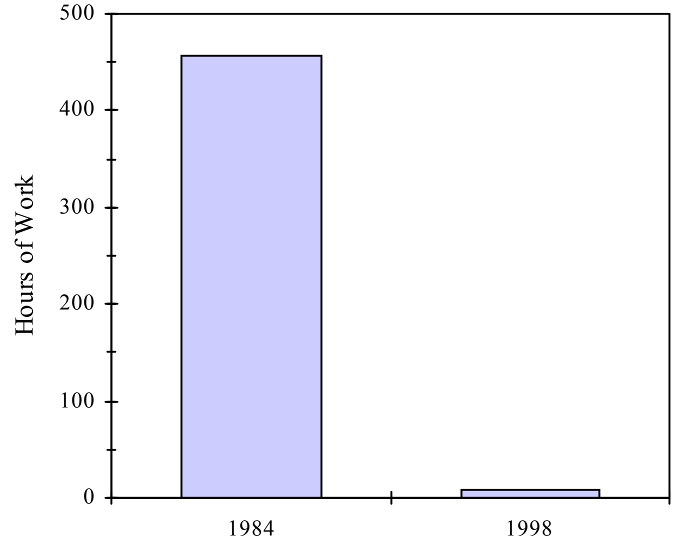



**Figure 7**
**The Cost of Cellular Phones Falls Toward Zero**




New technologies are nearly always more expensive and often worse than those which they *appear* to be replacing. We miss that there is an economic substitution effect. The resource that is growing in abundance substitutes for a previously used resource. Economic substitution is the explanation for what drives the change in practices. If we misunderstand that, we can only see the new technology as a dramatically more expensive way to do the same thing. The new is not substituting for the old, but is creating something else.

Thus, although the price of a light bulb, for example, may have been more than that of a candle, if we judge the potential market share and widespread use of the light bulb against only the price, we will miss the costs associated with the adoption and possibilities of these two tools. A candle must be tended to (wicks cut, wax cleaned), it cannot be used effectively out of doors and it brings certain hazards with its use. A light bulb, although more expensive to purchase, opens up opportunities for extending the work day, for activities out of doors after sundown and diminishes the hazard of fires.

Since the new is always more expensive than the old, there will always be the false competitor. The car was more expensive than the horse and it may have appeared easier to acquire a horse, but in the long run the one with the car was able to excel with a competitive advantage for his/her family or business. These technologies are not the same.

Often, the new technology almost always has to find a different audience to start. Digital photography, for example, couldn't compete with silver halide film. Most of the time, it still can't. But, for some audiences and purposes -- such as children, company newsletters, and family albums -- the technology is good enough.

There is no good theory of economic development that accounts for the technological change we are experiencing. Recent data on productivity and GDP growth indicate that we have been growing much faster with more productivity and less inflation than previously reported. Perhaps as much as a whole percentage point faster.

Stephen Roach, senior economist at Morgan Stanley Dean Witter, says there is no new economy. Productivity gains are overstated, and prosperity is in danger. Apparently he does not have a theory for what's happening, so he thinks it is not happening. Everyone's bottom-up, microeconomic experience shows that it is happening. The GDP is getting lighter and is moving from manufactured goods to services. Economists don't have a good theory for services, they prefer stuff you can more easily measure and count.

The economists who are counting output miss the shift in externalities. The waiting time of a customer was an externality. We expected to wait in bank teller lines. This wait appeared as a cost to the customer, but not as a cost of the service, and it surely wasn't in the price. ATMs have been so successful because they, in effect, lower the cost for the customer. Economists miss this.

Our own common sense and experience have raced ahead of the economics profession's capacity to count and measure. The same thing probably happened during the agricultural and industrial revolutions. Economists define productivity as output per man-hour. Then, if hours worked increased faster than output, productivity declined. Investors think of productivity as output divided by inputs. This includes both capital and labor productivity. Entrepreneurs probably think even broader still, and realize that their companies will gain share and power if they include the externality of the consumer's time, that is if they make it easier and less costly for the consumer to deal with them. Successful entrepreneurs understand that the offer is much more than merely the product.

New products may appear more expensive than the old. This is the case, especially, if one looks only at price received and not the total cost borne by the purchaser or user. This difference between the price received and the cost borne can be understood as the now famous Laffer Tax Wedge, or the theory of two prices. The marginal rate of substitution is influenced by the size of the wedge (the difference between the price received and the cost borne) and the rate at which the new technology collapses the wedge.

**4) Identify Companies That Will Dominate**

Find a number of companies that are serving a market that is in hypergrowth or might be in the future. (See Step 1 above). These companies are likely to be competitors or suppliers to one another.

Market domination will rely on superior technology, trade secrets, industry standards or innovative business models. It is very unlikely that dominance will be achieved by either first mover advantage, which is overrated, or brilliant execution, which is unlikely to be an enduring source of domination.

Additionally, look to see where the "network effect" may give a company or a technology an edge. The "network effect" comes from Metcalfe's Law, named after Robert Metcalfe, the man who invented the Ethernet, the fundamental technology of computer networks. Metcalfe's law explains that the value of a network increases with the square of the number of nodes on the network. This means that the World Wide Web increases in value every time someone new joins.

This "network effect" has been demonstrated again and again, such as with PCs, telephones and fax machines. Who would want to have the one and only fax machine? A lone fax machine is useless. No one is on the other end to receive or send. Add another machine, and another and another, however, and now you have a meaningful way to communicate and send documents. Each time a fax machine is added, the value of the original machines increase.

Metcalfe's Law is the principle behind the strategy of many Internet startup firms. It has been called the "installed base race," the urgent push to sign up as many customers in the shortest period of time, even if it means giving away free service. This installed base race -- the commercial version of Metcalfe's Law -- is the basic concept behind America Online, Yahoo!, Amazon and Microsoft.

To spot market domination potential, look for technologies that are protected by either patent or trade secrets, or manufacturing skills that are rare and difficult to duplicate. Potential market leaders may perceive each other as competitors, but their true competitors are the old practices or traditional ways of doing things. These companies are competing not for each other's business, but for the business that none of them have currently. They are competing to dominate a future market.

In the past we've had the following hypergrowth markets, contestants and winners:

*The PC Industry*

In the PC industry, the race was originally between Apple and IBM. More recently Dell, Compaq, HP and many others have entered the brawl. The IBM standard won the game, but neither IBM nor Apple won. The winners are Intel and Dell.

Intel won because of its processors -- they were good enough, available in a great variety, supported the network effect and squandered the abundant resource, silicon. Dell won because it substituted information (knowledge) for inventory. They build the machines after they are ordered and paid for, instead of trying to get customers to compromise and buy the inventory on the dealers' floors.

*Packaged Software and Operating Systems*

In the packaged software battle, there were in fact about 2000 companies including Ashton Tate, Lotus, IBM, Microsoft, WordPerfect and VisiCalc. The winner was Microsoft.

In the battle of operating systems, contestants including Apple and CPM lost to DOS and to proprietary operating systems such as Wang. The winner was, again, Microsoft.

In both cases, Microsoft was superior at squandering lines of code and silicon. Their product was good enough (not the best) and they offered great variety. Other operating systems and applications were often more elegant, better engineered and more efficient, especially in their use of hard drive storage (memory, RAM) and clock cycles. But with the cost of computing (RAM, clock cycles and hard drive storage) collapsing, they were using more of what was falling in price, which let them get to market faster. They offered products that optimized the time of both the software developers and customers.

*Long Distance Telephony*

The long distance voice telephone market never became a hypergrowth market. Despite the ubiquity of long distance telephony, the market had a flat supply curve as deregulation changed the rules and allowed more and more competitors to offer long distance. Now, voice is subsidized by data and, in fact, voice will end up being free.

*Cellular Phones*

In the cellular phone market, the key to success is not the phone itself but the chip sets and software that are embedded in the phones. The transition from analog to digital is complete. The current battle is over which method of digital transmission will prevail. There are currently three methods: GSM, used in Europe; TDMA, originally popular in the U.S.; and CDMA, developed by Qualcomm and now the industry standard in the U.S. and China.

How did Qualcomm's CDMA become the standard? Its technology squandered the abundant resource, silicon, and protected the scarce resources of radio spectrum and battery life. Furthermore, the next frontier is broadband wireless. This is only possible with CDMA chip sets. The cell phone makers -- Qualcomm, Motorola, Ericsson and Nokia -- are now merely competing over features and functions. Everyone who uses CDMA has to pay a royalty to Qualcomm.

*Fiber Optics, Optical Switches, Internet Routers and Everything Else*

The Internet is no longer made of wires. For the most part, it is comprised of strands of glass and photons of light. The copper wire that carries the telephone signal inside your house (twisted pair) can carry about 64 kilobits per second, enough for voice but a mere eyedropper for data. This can be supercharged with DSL to several times that (364 kilobits to 1.5 gigabits) but it falls far short of the light speeds attainable with even the slowest fiber optic cable. The fastest fiber can now be divided into 800 "colors" of light or lambdas. One cable can carry 864 strands of fiber, or 2.86 million lambdas. Each lambda can carry 10 gigabits of data per second. This means that one cable can carry, per second, nearly the total volume of Internet traffic per month as of a couple of years ago.

These lightening speeds mean that fiber and optical switches will replace copper and electrical switches at an alarming rate. The local telephone company or LEC (local exchange carrier) is bound in a copper cage. Its copper network, once a great asset, is now a liability. As any nutritionist will tell you, you need a small amount of copper and a large amount of fiber.

The game has not yet been won. The contestants are Lucent, Nortel, Corning, Cisco, JDSU, Redback and a myriad of small optical component makers. In the ownership of the transmission lines, the carriers include Global Crossing, AT&T, MCIWorldcom, Level 3, Qwest, and Williams.

*Storewidth*

Storewidth is another new game that is not yet settled. Storewidth companies address the problem that the Internet and networks are too slow. They are slow not only because of bandwidth insufficiencies, but because the "train" makes too many stops. Every time an Internet packet hits a router on its way to its destination, the address on that packet must be read and the packet must be re-directed toward its destination through a number of other routes and delays. This is called latency. Said simply, it is the time that you spend waiting for a page view to be returned to your screen. It is not only irritating; it kills the notion of video. Routers and satellites produce unacceptable latency.

One solution is an all-optical switched network -- in effect, an open light path between two computers. Currently, this alternative is very expensive, but experiencing a thousand-fold price collapse. Other methods include various ways of "caching" data locally or regionally at storage area networks (SANs) so that the information or page view is duplicated or pre-positioned at the local metropolitan area where demand is likely to be high. The contestants in this game are Akamai, Network Appliance and CacheFlow, to name a few.

**5) Determine the Factors Critical for Industry Success**

Now comes the hard part. In each industry or sub-sector, identify the critical success variables. Think about this from the point of view of solving the problem of scarcity. Remember, rapid adoption of new practices and new products only occurs when the collapsing cost curve alters the marginal costs between the scarce and abundant resources. The marginal rate of substitution is driven by differences in marginal costs.

In the wireless telephone industry it is now obvious that the scarce factors are radio spectrum and battery power. This discovery led us to identify Qualcomm as a potential dominator of a hypergrowth market. Additionally, what led us to identify Qualcomm as a gorilla is the proprietary technology and patent protection that produced barriers to entry for competitors and, once the standard was adopted, barriers to exit for customers.

In determining the critical factors for success, ask yourself: What is the fundamental scarcity? What is the one component of the value chain that will leverage all of the rest? Monster returns will be earned by the factor that solves this problem. Said another way, what is the fundamental technological bet in any industry that produces a "religious" divide?

"Religious" divides are often found in technology debates. Participants have a point of view to which they cling and they are not open to other interpretations. Often these divides are found around critical factors. Importantly, once the debate is settled, the stock prices will adjust in such a way that investors can't capture an excess return. The big money is made is by anticipating the outcome of the election before the election. Once the winner becomes obvious, the 10x gains are behind.

To identify and track these "religious" issues, you must locate and listen to experts. However, you must be careful as you listen, particularly since, if you're lucky, you will be able to find experts on both sides of the "religious" divide. This is the technological equivalent of "tastes great" or "less filling."

In the last few years in the telecommunications industry there have been two heated debates with proponents on either side. The questions were: Should networks be dumb or smart? and should network topology[5] be based in switches or routers?

In listening to the experts, do not search for which technology is "best," but for which technology better solves the problem of scarcity. Remember, Betamax was "best," as was Apple. George Gilder, my favorite technology expert, has founded his technology career on distinguishing these religious issues from the point of view of the differential in marginal costs and especially the differential in the marginal costs between the scarce and the abundant resource.

These two major questions regarding telecommunications, the two "religious" issues, have now been settled, but of course, only for now. For your information, the prior winning answers were dumb networks and routers.

Dumb networks won over intelligent networks. Intelligence in a network makes it rigid, failure prone and expensive. Routers won over switches because routers use bandwidth much more efficiently. Switches, for example, open the connection between two points and hold it open whether it is filled to capacity or not. The telephone is a switched network. All the spaces between words are unused bandwidth that could be packed with data if routers and Internet protocol packets were used.

In the next round of rapid innovation and hypergrowth the winner is still likely to be dumb networks, but in an all-optical world, switches will win over routers and the network topology will go back to what it was: switched beams of light rather than switched circuits and distributed intelligence.

Since the switch back is likely, the winners of the last round -- Cisco and Nortel -- may be the losers of the next. Cisco didn't thrive merely because it took customers from Northern Telecom or Lucent or Bay Networks. Rather, Cisco converted the world's telecommunications networks from being based on switches to being based on routers.

Now that we are in an optical world, and traffic is data, audio, video in digital forms, and not analog voice, a new economics emerges. Latency, the time delay, can be more costly than bandwidth. Time is the new scarcity and bandwidth is the new abundance. We now find our 56K modems unacceptably slow, forgetting the sufficiency of a 24K modem in an all text, no graphics world.

With the marginal cost of time rising and the marginal cost of bandwidth falling, a new network topology emerges as optimal: the all optical switched network, photons all the way, switched by micro mirrors a nanometer wide, rather than routers that must convert photons to electrons, examine the internet protocol packet headers, redirect them, convert them back to photons and send these light beams to the next router. In this case, routers will lose to optical switches. They are cheaper, but they are slower, and the scarce resource is time, not money.

A new optimal topology based on the products of fiber optic technology -- glass, micro mirrors, lasers, wave guides, modulators, diffusers, transmitters, couplers, mutiplexers etc. -- will not only create a huge market for the builders of systems and the suppliers of components, but generates a whole new economics around the new scarcities and the new abundances.

**6) Locate Emerging Monopolies**

Certain companies are able to produce an effective monopoly that enables them to generate high margins for extended periods of time. These companies have engineered what we call the Holy Trinity of investing. In its purest form these companies have a "forever monopoly," with rates of return high enough to be remarkable and low enough to be tolerable so that the political forces don't rally against them. Microsoft got on the dangerous side of this line and its competitors have organized the political process against it.

The trinity of (1) monopoly control, (2) resultant high profitability, and (3) projected long duration is rarely found. Rather, we should say it is found more often than it exists.

The trinity can be identified from the economist's point of view as follows: they are fixed factors in a time of rising demand. These will, of course, result in a positively sloped supply curve; increases in demand will be reflected in higher prices and higher margins

Companies strive to achieve this trinity with a small set of strategies and a myriad of tactics. The first strategies include patent protection or other proprietary intellectual property or systems that are closed rather than open and not built on public standards.

For example, the mainframe industry was dominated by IBM and the seven dwarfs -- Sperry Rand (formerly Remington Rand), Control Data Corp., Honeywell, Burroughs, General Electric, RCA, and National Cash Register. Only IBM enjoyed monopoly profits. Initially, they all competed on the basis of proprietary hardware and software and closed systems, rather than open standards. The seven dwarfs were unsatisfied with their sub-par returns and, roughly simultaneously, adopted an open standard, a non-proprietary operating system in the public domain called UNIX. This collapsed the profitability of the seven dwarfs by commodifying their offer. They no longer competed on the basis of hardware and software differences, but rather on price. This is the investor's old enemy: the flattening supply curve.

Everyone would prefer to own the proprietary and de facto standard while everyone else maintains open standards and open systems. Microsoft's competitors, for example, don't want to kill the possibility of being the next Microsoft. They just want to kill Microsoft. Proprietary monopoly based on proprietary de facto standards is very hard to achieve but easy to maintain.

A second strategy for producing the trinity lies in producing barriers to entry. A jungle of patents is a great barrier to entry. Other barriers include a strong brand or reputation, or what we call symbolic capital. Examples of this include Coke, Gillette, Nike, Gap and Sony.

Real capital is a great barrier to entry as well. The heavy capital investment required for fulfillment and operations has clearly provided protection for Federal Express, and appears to be a protective strategy being adopted by Amazon and WebVan. The strategy is to get there first, capture the prime real estate, spend heavily, and hope you can block others.

A third strategy to produce the trinity is to establish high barriers to exit for customers. Customers that confront a high switching cost will find it more difficult to leave you. It is very expensive to train employees to a new and substantially different software product, or to switch law firms or accounting firms, or to scrap all of the legacy systems that you have. AOL members are reluctant to switch to free Internet Service Providers because they are part of a "community." They have buddy lists and reputations in certain chat rooms. This is what gives AOL the power to demand $100m from companies that want placement on AOL pages, as it recently charged Homestore.

**7) Find Companies That Are Creating a Vertical Supply Curve**

Find companies that are creating a vertical supply curve, or at least steeply sloped or highly inelastic curves. Remember, a horizontal supply curve is the kind of curve that is specified in the "pure competition" model, with a zero slope and is completely elastic. This means that any increase in demand will be met by an increase in the quantity supplied, rather than by an increase in the price paid. This also means that it will be very difficult, actually impossible, to pass supplier cost increases to consumers through higher selling prices.

Elastic supply curves are no fun for the suppliers and mean no monopoly profits, no return above the cost of capital. For any supplier with an elastic supply curve that pays above market wages or buys a cappuccino machine, the earned rate of return will be below the cost of capital and you will be destroying wealth, not creating it.

A horizontal supply curve means that any increase in market demand will show up as an increase in long run supply. This is not good. Steeply sloped curves are probably the best you can do. A vertical curve is the optimum optimorum. This optimum optimorum is the ideal, perfect monopoly, and certainly not attainable in a free society.

The steeply sloped supply curve is the economist's term for trying to find proprietary products or strategies that are valuable and hard to copy or block, barriers to entry for competitors, and barriers to exit for customers. These are tollbooths on the commercial superhighway. Two of the most famous of these are, of course, Microsoft and Intel, and both of these are weakening.

Silicon Graphics (SGI) is a great example of an inelastic supply curve that flattened and became elastic. SGI generated a hypergrowth market in graphical workstations for the movie and entertainment business. The company dominated this market and produced monopoly rents based on proprietary products that generated barriers to entry for competitors and barriers to exit for customers.

By converting movie production special effects to Silicon Graphic terminals, the company triggered the hypergrowth market that previously had not existed. The competitors were the old methods of producing special effects for movies. Within five years the increasing power of the PC eroded the pricing power of SGI. SGI ignored the PC in the same way that minicomputer and mainframe makers ignored the "trivial" PCs until, of course, it was too late. The supply curve for SGI's high-end workstation flattened, as it increasingly had to match the price/performance characteristics of the PC.

**8) Locate Companies That Build Useful Value Chains**

Most technology companies offer components rather than whole products. The highest returns go to the companies whose products complete the whole product. In personal computers this is Intel and Microsoft. Between them they have captured more than 100% of industry profit. In electronic components, high margins are likely to be temporary, caused by a supply-demand imbalance, with a fixed factor, rather than a proprietary advantage as represented by an inelastic supply curve -- sloped rather than flat.

It is important to distinguish between component manufacturers that supply the missing or critical link, from those that merely supply products that are in short supply. The former set of companies will continue to earn high margins, or will more likely be acquired by a company that is assembling the value chain around them. Cisco, Lucent and Nortel are the three premier examples of companies assembling the value chain around them and acquiring the businesses of the high-margin component makers needed for completing the whole product. Micron Technologies, at the peak of the cycle, enjoys super margins, but they lose money at the trough because they are a commodity producer of random access memory (RAM). They confront a flat supply curve, but because capacity can't easily be added or withdrawn from the industry, changes in demand in the short run reflect changes in selling prices and profitability.

Another way to look at value chains is to look at the relationship between suppliers of components, sub-assemblies and assemblies on the one hand, and the makers of whole products on the other. Clayton Christensen thinks about industries as being either vertical and integrated or horizontal and dis-integrated. The structure of the industry reveals much about its technological development and which classes of players are gaining or losing power (profit margin).

The auto industry, during its period of ascendancy, great profitability and expanding corporate power, was integrating, acquiring its suppliers and establishing control over the rate of change of innovation in the end product. The PC industry has always been horizontal, made up of a myriad of component suppliers and assemblers. All of these components were built to certain interface standards, but the final assembler had no control over innovation and change.

This horizontal structure allows for a much greater rate of innovation, shorter product cycles and much less profitability. The disk drive makers innovate at a rate very different from the microprocessor or graphics card makers. This arrangement produces a short product life and transfers all of the profitability to the owners of the proprietary standard (Intel and Microsoft). Public standards, or industry standards, are associated with flat supply curves because a great many vendors can build products to that standard, and they will.

When product complexity is great enough (mainframes and minicomputers in the early days) customers may demand a whole product solution. They want end-to-end solutions from one vendor, one place to complain, one promisor for workability. They don't want half a dozen vendors, each blaming the other, for machine downtime. The telecommunication equipment industry -- the Internet infrastructure -- is moving in this direction. Customers increasingly want a whole product.

## Conclusion/Summary

Today there are great investment opportunities in technology, and it is very important to be open-minded and opportunistic. Do not be confused by old-economy graybeards. As technology is constantly changing, the rules for investing in technology are constantly changing and a successful investor needs to adapt to these changes. Investing in technology requires a new way of thinking; have confidence in your investments if they meet specified criteria.

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Editorial and research support by Rachel Van Emon and Jeffrey Thomson.

[1] Clayton Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business School Press, 1997.

[2] George Gilder, *Microcosm: The Quantum Revolution in Economics and Technology*, New York: Simon & Schuster, 1989, p. 11-13.

[3] "Time Well Spent: The Declining Real Cost of Living in America," 1997 Annual Report, Federal Reserve Bank of Dallas, p. 2.

[4] ibid, p. 7.

[5] The topology of a network describes, pictorially, the configuration or arrangement of the network, including its nodes and connecting lines.