

VISION SERIES³

Twenty minds on tech's future

By CNET News.com Staff
December 2, 2002

CNET News.com has assembled some of the best entrepreneurial and research minds in the technology industry to share their views on five rapidly evolving technology sectors: security, Web services, open source, personal technology and wireless communications. The 20 participants in this third installment of our Vision Series peer over the horizon and offer their views of these important areas.

Some, such as Yossi Vardi of ICQ fame, predict a future in which wireless messaging technology erases the artificial boundaries that separate people and machines. Others, such as free-software leader Richard Stallman, envision a world where nonproprietary software one day elbows aside for-profit applications packages sold by the likes of Microsoft. Whether talking about security or personal technology, these luminaries go to the heart of why we are fascinated by technology--because it continues to surprise.

FEATURED VISIONARIES

- ▶ Ken Watson
- ▶ Howard Schmidt
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- ▶ Richard Soley
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- ▶ Bruce Perens
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- ▶ Yossi Vardi
- ▶ Dorothy Denning
- ▶ Bruce Schneier
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- ▶ Richard Stallman
- ▶ Dan Frye
- ▶ Mike Nuttall
- ▶ Steve Perlman
- ▶ Robert Struble
- ▶ Deborah Estrin



Kunitake Ando, Mike Nuttall, Rick Rashid, and Steve Perlman discuss the future of personal technology.

**LIVE THURSDAY
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PERSONAL TECH



Mike Nuttall
No to wearable computers, yes to wearable peripherals.



Rick Rashid
Multi-terabyte hard drives for everyone.



Steve Perlman
Ready for DVRs that store 1,000 hours of content?

Editors: Charles Cooper, Jon Skillings, Lara Ephron
Design: Pam Dore
Production: Mike Markovich

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Kunitake Ando

■ **AGE:** 60

■ **JOB:**
President, Sony

■ **ACHIEVEMENTS:**

Helped to establish Sony Life Insurance; launched Sony's PC business; developed the concept for the "ubiquitous value network," which is the basis of all products created at Sony; and is responsible for a unified manufacturing and customer service system for retailers.

MORE PERSONAL TECH VISIONARIES:

mike
NUTTALL

► No to wearable computers,
yes to wearable
peripherals.

By Richard Shim
Staff Writer, CNET News.com
December 5, 2002

If Sony President Kunitake Ando is right about the near future, people will finally be able to retrieve their personal information from powerful networks that allow anytime, anywhere across a variety of individual devices. The typical desktop computer in that broadband nirvana will bear little resemblance to today's conventional PC.

Rather, Ando sees a personal computer (emphasis on the *personal*) evolving to the point where it actually knows a person's individual tendencies and tastes, functioning almost like a surrogate brain. He also sees more cross-fertilization between computers and consumer electronics to erase the old boundaries dividing television and PCs, perhaps resulting in a hybrid device that, of course, winds up connected to the Internet. The trick for Sony is to time things right so as to be on the cutting edge of the next big thing. But being too far ahead of the curve can be just as bad as being too far behind. For Ando and for Sony--one of the most successful companies in the history of consumer electronics--the rewards could be as large as the margin of error is slim.

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Sony is widely known for the design of its products. What do you think PCs are going to look like in 2005?

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I don't think we're going to see the typical boxes of today. As PC and consumer electronics companies continue to influence one another, PCs will change, especially as there is further integration of components, such as digital cameras. The PC will take on many new roles, such as teacher, agent, guide, and there will be many different designs...something that is very personal and knows what your tendencies are, almost like a brain. Companies will make all sorts of PCs based on hobbies, tastes, creativities and capabilities. Computers will truly be more personal, and not just by name.

Wearable computers are very personal, and the industry has dreamed about those for a while now. Is that something you think will catch on?

We tried a wearable-type device that we called the Glasstron and it never caught on. There is something to be said for timing, though, and that was nearly three or four years ago.

What do you think will be the next area of technology



**steve
PERLMAN**

► Ready for DVRs that store 1,000 hours of content?



**rick
RASHID**

► Multiterabyte hard drives for everyone.

innovation in the next couple years?

With the more common use of (liquid crystal displays), TVs are changing. At one time, they were the center of home entertainment, but PCs came in and were essentially the gateway to the Internet and took their place. Now the whole industry is trying to make the TV the center again by connecting it to the Internet and add new features such as DVD players. Eventually, it will be connected to the PC, which will really be exciting.

When you talk about TVs becoming the center of home entertainment once again, do you think that they will integrate popular features such as DVD players and digital video recorders?

That is happening already, in Asian countries especially. The biggest change is viewing style. It used to be that people just watched what networks broadcast. Now with time-shifting capabilities, TVs will become more customizable to the viewing habits of consumers. They will remember your favorite channels and programs that you like, so you will just sit down and select what you want to watch.

How do you think cell phones will change?

An important part of the digital revolution is the communications revolution. And a significant aspect of the communications revolution is video. You're starting to see that more in cell phones where cameras are built-in, and we're adding that into many of our devices, even our handhelds.

It seems that more hardware companies are coming up with software and concepts to help drive demand for hardware. Will that continue?

Hardware and software go hand in hand. Hardware can be commoditized very rapidly, with competitors imitating an innovative device. One way to stay ahead is to develop specific software for that hardware, which helps to differentiate it from others. Software can be developed a lot faster than hardware, which also helps. With higher levels of performance, you can have more robust software.

What do you think is going to be the future theme in the

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personal technology world?

The concept that consumer electronics devices can access all sorts of content while connected to a network is the biggest trend, and as broadband rolls out and becomes more commonly available--which will happen by 2005--companies have to make it happen by introducing more types of products.

Two companies that stand out when it comes to innovation in the technology world are Apple Computer and Sony. Apple is a lot smaller than Sony and doesn't have the portfolio of products. Is that an advantage for them?

There are advantages and disadvantages. We respect Apple a lot for their creativity and their emphasis on ease of use. We're going in the same direction. However, they can move a lot faster because they are smaller. We struggle with commoditization. When a product gets popular, others can imitate it, but Apple is going their own way so no one can copy them exactly.

Sony is very familiar with robots because of its Aibo products. What is your vision of the future for robots?

We are hoping that robots will create a new type of industry. Initially, it will be for entertainment and for giving comfort, but we think there is a long-term future for robots, and we are adding new technology to our robots so they will quickly become more intelligent and more useful in day-to-day life.

You were one of the early proponents of the networked lifestyle, the role of networks in the home and their future significance to consumers. Do you think that access will extend beyond the home?

That has always been part of the plan, to be able to access your content from anywhere. Even in our nonconnected devices, like Walkmans and camcorders, the idea was that you could access your individual content anywhere. But now with a PC and network infrastructure, we want to connect all products so you can connect yourself to your network anytime, anywhere on any device. Delivering rich content to devices is a challenge now on narrowband networks, but when broadband rolls out more extensively, that will help out and be a big change compared to the past.

These kinds of connected devices will represent a new concept for consumers, and educating them to the benefits of these devices will likely prove to be a big challenge. How do you think selling devices to consumers will change?

The biggest hurdle is actually the dealers who may not be sure how or even where to sell devices. Do you put something like the Airboard (a combination TV and PC with an LCD screen) with TVs or with PCs? We have faced this problem in the past, and we have managed to educate them. What we don't want to do is make it too hard on the consumer to use the device. We have even created a user-friendly committee within the company to make sure that we

don't run into that problem.

As a country, Japan seems more known for hardware than software. Do you think that will change?

Well, hardware has been the more dominant of the two industries so far, but...we're becoming more active in creating software, particularly when it comes to ease of use.

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VISION SERIES ³

mikeNUTTALL

PERSONAL TECH VISION ■



Mike Nuttall

■ **AGE:** 53

■ **JOB:**
Founder, Ideo

■ **ACHIEVEMENTS:**
Designed the first Microsoft mouse; designed the first 8.5-by-11-by-1-inch notebook, the Convergent Technologies WorkSlate; designed the first Wyse terminal.

By Michael Kanellos
Staff Writer, CNET News.com
December 5, 2002

The first Apple Computer and Microsoft mice, the Palm V, the Cisco IP Phone, 3Com's Audrey appliance and the rubber-gripped children's toothbrush from Oral B are some of the products crafted by Mike Nuttall's Ideo. Nuttall, one of three founders of the Palo Alto, Calif., company, says that simplicity is key to a successful product and that integrated devices such as combination cell phone-camera-MP3 players are a step in the wrong direction.

Ideo was one of the first firms to tackle design issues in the computer industry. (The world's first laptop--the Compass, from Grid Computing--came from its predecessor.) And, with \$60 million in annual revenue and 360 employees, it remains the largest and one of the most influential.

**MORE PERSONAL
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What goes into a good design?

It's a balance of technology, business and people. That seems obvious, yet so many companies will forget the people. In Silicon Valley, people just get driven by the technology--because it's possible and because we know how to do it. A good solution looks obvious, but those simple solutions are rarely obvious. A great example of that in terms of design we have done is the first Microsoft mouse, the one shaped like a bar of soap...That product looks like it was bound to happen. It looks natural. There's not much to see, and yet there is not one detail on that product that isn't there for a very, very good reason.

You get some very ergonomic (mice), but often the problem with those very sculptured ones is that you're forced to use it in a particular way, and people don't like that. It might feel very seductive the first time, but it's just a mouse. You should be able to use it in a hundred different ways, move it with your elbow. Keeping it simple allows you to do different things.

So a good product should be simple?

That's one of the things we're always trying to focus on. What is the minimum you need to do? So much of the Valley focuses on "What more could you do? How many more bells and whistles can you add to it?" We find that most people's experiences are that they just like doing the minimum really well. Even these things (he holds up a cell phone)--there are so many things you can do, but I just want to make a phone call.

Five years from now, what do you think will be big?

Gut level: I think wireless is going to have a huge impact. I think it will happen in parallel at the enterprise level and the home level. It will start affecting how people listen to music, how people watch movies. I don't really understand what is stopping greater adoption of broadband, because that is the other thing. Those two things have to go together. I think many people two or three years ago would have predicted that broadband would have high adoption rates. Maybe it just costs too much. Right now in Europe, broadband is available for \$20 a month.

It might take off once Internet access means music, but that particular one is driven by the legal issues. The entertainment industry hasn't figured out a model that makes sense. I think we would all predict that (greater broadband adoption) will happen. It's just very hard to tell whether it's two years, five years or 10 years--the idea of subscribing to music or video, not having one's personal library but having access either on a onetime, multitime or lifetime basis, depending on how you pay for it.



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A good solution looks obvious, but those simple solutions are rarely obvious.

What about future prospects for handwriting and speech recognition?

I think it will happen, but it is very tough (to develop an accurate program) so it is hard to predict when. Many of us prefer to handwrite rather than sit there with a keyboard. However, there is a fairly low

tolerance for failure. Speech might be one of the real drivers of increasingly powerful processors from Intel...They are driven to find need for increased processing power. The car is a great environment for speech, and will probably one of the first to make inroads into speech.

Do you think the idea of an intelligent wardrobe, where a computer is woven into your shirt, will take off?

I see miniaturization but I don't see wearable computers. I think the wearable peripheral (such as hands-free wireless accessories) will take off. I wouldn't have predicted two years ago how quickly people get comfortable speaking into the void walking down the street, but they have. It's remarkable how people have become accepting of that. So I think maybe some visual peripherals, like displays built into glasses. But woven into your clothing? I don't think we're that far. I've never understood that.

So you don't think all these things will converge?

I think we have what you could call a magpie syndrome. We like stuff. We like these little personal things. That is one of the reasons I don't believe in this (idea of) integration. I don't see myself in the future walking around with one of these things that is my computer, my telephone, my PDA, my MP3 player, my camera. Because then what would I buy, what would I buy for Christmas? This is it? This is all I need?

I do seriously believe that if this (device) does it all, it can only do it in a very compromised way. Whereas there will always be demand for great photo and audio quality.

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↑ I was sure 25 years ago that a record collection would no longer be necessary. It is starting to be that way today.
- Mike Nuttall

WORST
TECH.PREDICTION

↓ I thought that Go (a pen computing start-up) was going to be a huge success, as did a lot of VC money.
- Mike Nuttall

Internet appliances like the Audrey (3Com's Web-browsing appliance tailored for the kitchen countertop) were supposed to be a great success, but they didn't sell well. Why is that?

The idea of sitting at your kitchen table browsing the Internet is too early. It's really dangerous when you get your crystal ball out--is it two years from now or five years from now?--but somewhere within that time frame those products like Audrey will find great success. It will be triggered by--and this is why the timing is so difficult--higher adoption of broadband and, more importantly, home wireless networks.

What about the flexible display?

We're a long way from the rollup electronic newspaper. The e-ink I think will find some uses in large displays where you need relatively few pixels. I think it is going to be a long time before you can do good color. Everything that I have seen that's at all readable is in black-and-white. But I do think there are lots of interesting display technologies out there.

Does anything in particular excite you?

It may be off the subject, but I think power--people wanting to get off the (electricity) grid--is an interesting phenomenon that some new technologies will enable. Fuel cells might. It's not that you want to go live out in the mountains. It doesn't even matter if it is more expensive. It's just self-sufficient, not getting that bill every month.

In the tech industry, who best understands design?

Steve Jobs. Probably more than anyone else in the computer industry. He's been able to market good design and get more value out of good design than almost anyone in the industry. He turned Apple around. I recognize they still only have a small market share, but they are alive and they are doing well...He has the strongest in-house design group of anyone in the industry.

**And finally--white, blue, black or silver:
What is the color of the future?**

Silver has become the dominant, successful color. It has replaced black. We see silver in phones. Silver notebooks have been very successful.

I think we're going to go back to people demanding more variety. It's not personalization as much as wanting products to reflect one's personality. They are personal things. It's not quite the Nokia thing of being able to buy this and change the covers, but the ability to buy something that reflects a personal decision. Apple has had some success in doing that. I think everyone else will have to dabble in that.

I wouldn't have predicted two years ago how quickly people get comfortable speaking into the void walking down the street, but they have.

But for the office, beige. Beige gets an awful rap, but...if you are the IT group, you don't want people complaining that they don't like their color. They want a red one. Somebody else wants a blue one. It's a nightmare. You sort of want these things fairly quiet in the environment. So you've got your printer and your fax machine and your keyboard and your flat panels. You have this sort of consensus that they are going to be beige. Actually, environmentally it works fairly well.

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3

rickRASHID

PERSONAL TECH VISION ■



Rick Rashid

■ **AGE:** 52

■ **JOB:**

Senior vice president of research, Microsoft

■ **ACHIEVEMENTS:**

Designed and implemented several network operating systems, including Mach. Co-developed one of the earliest networked computer games, Alto Trek.

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▶ Ready for DVRs that store 1,000 hours of content?

By Richard Shim
Staff Writer, CNET News.com
December 5, 2002

Rick Rashid gets paid to spend his time thinking about new technologies that might be cool—even if they don't turn into products anytime soon. That's OK with his boss, Bill Gates, who wants the former Carnegie Mellon University computer science professor to concentrate on the future. As head of Microsoft's research organization, Rashid oversees some 700 people working at five labs across three continents. From his vantage point, Rashid dismisses suggestions that personal technology has hit any kind of innovation wall. He envisions a future in which disk drive capacity of a terabyte is routine and user interfaces possess active intelligence.

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What do you think will be the biggest changes in the way people use their computers today and say, five years from now?

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I'm not certain it will be widespread in five years, but the biggest change in computer usage on the horizon will be the advent of "ubiquitous" computing. Just as the interconnecting of computers to each other through the Internet changed the way people used their computers, so will the interconnecting of smart devices in the home and office change the way we think about computing in our lives. In most major metropolitan areas, you should be able to have constant connectivity from your PC, laptop, tablet, PDA, etc., to the Internet and through the Internet to any of the devices that you own.

Will there be any difference in the relationship between devices and the people using them?

Devices will become more adaptive to their owner and their environment and more directly under their owner's control--no matter where the owner is. These devices would be able to communicate with each other and with your home/office PC and laptop and would have a common notion of who you are and what your preferences and needs are at different times.

Speaking of the future, Microsoft's initiative for an auto PC based on Windows never went very far. Was that a case of a concept being too early, or is it something that still could work?

The idea that when I get into my car it knows about me and my schedule, the traffic and how to get through the traffic, that notion is a viable notion. The question is, when will we get to the point where we have all the right pieces to make it work? I think it will take another couple of years.

What's behind your optimism?

The automakers would tell you that it's a case of iterative refinement. We already have 30 or 40 processors in the automobile that are connected on a fiber-optic network. It's clear that the car will have

more centralized intelligence knowing more about you. It's just a question of getting to the point of picking the interface and the right forms of communication.

Devices are becoming increasingly intelligent. How do you think that trend will evolve?

Part of what I see happening is an integration of the user interface across all these different devices. Right now, people's lives are very compartmentalized as far as computers are concerned--there's me in my office, there's me in my home, and there's me in my car. These are all different versions of me as far as these devices are concerned. The job of all these computing devices is to really help users solve their problems and deal with the tasks they have and not to think of these as all separate experiences.

Devices will become more adaptive to their owner and their environment and more directly under their owner's control--no matter where the owner is.

Can you provide an example how that would work?

This would be part of what we're calling "attentional UI," which means how to manage the user's attention and how to give the user better knowledge about what's happening. We're seeing it a bit in PCs where, for example, when a friend or colleague gets online and connects to instant messenger, you get a nonintrusive alert. Or with e-mail, where a small icon pops up when you have a new message.

But we're really just starting to use the real estate on the screen in a good way. In the highly connected, highly networked world, where there is a lot of information flowing, the tendency has been to have more event-driven kinds of interfaces. We've done some work in research here where you can put an events window on your desktop showing different events like weather, traffic and current news, and my schedule. This is always on my screen on the side of it, and when something changes, I'll see that and see what changes.

And what about in other devices? People interface with a broader number of devices, such as cell phones and handhelds, and these devices have to figure out where something like an e-mail has to go. If I were in front of my screen at my computer, I'd rather see the message there. If I'm away from my screen, I'd like to see the message on my phone or handheld.

One of the things we've done is to effectively try and track what you are doing throughout the day so that your devices can recognize where to get the information to you. So you can take advantage of your calendar and your computer to try and build a model of what you are likely doing at any point in the day. We don't use that information now, but your computer should be able to tell if you are in

front of it by keystrokes or mouse movements. Using that sort of simple location information, your computer can decide how and where to best present updates or alerts.

How would these devices be connected? These are all distributed processing problems, and what we need is an infrastructure to help us overcome that—building an ecosystem of computing devices that can communicate, interact, and share basic information and can globally perform a task instead of thinking of them as individual islands.

BEST
TECH.PREDICTION

↑ In the 1970s, realized the importance of loosely coupled distributed systems based on the exchange of self-describing data. Today that's being commercially realized in the form of Web services.
- Rick Rashid

WORST
TECH.PREDICTION

↓ I thought interactive TV would happen sometime in the last decade.
- Rick Rashid

Regarding the attentional UI, all this stuff about weather, news changing on my desktop already happens today. It's already there in my.yahoo. So, is the take-away here that the technology gets validation only if it's part of Windows?

No. The point of the attentional-UI discussion is this notion that information and notices can find you wherever you are in whatever circumstance. The fact that the underlying system knows something about you means it can get information to you in a form that makes sense in the circumstances.

So, it doesn't need to be Windows-specific? The underlying

operating system could be based on Linux or something else?

Other people could do things like that. The concept is that increasingly, the compartmentalized nature of peoples' computing experience will be broken down.

What are your thoughts about how storage and hard drives are likely to develop?

We're probably two years away at most from a single hard drive with a terabyte capacity. We can have that now, but it's not necessarily cost-effective or elegant. That means that a person is close to being able to save every conversation or photo that they've ever had from the time they're born to the time they die on a terabyte of disk storage.

How much is multiterabyte storage on an average PC going to cost?

Basically, the cost of drives stays more or less the same in each generation, independent of the fact that they get bigger. I can walk into a CompUSA store and buy a 250GB drive for \$299 after rebate. When the 160GB drives were first out, that's about what they cost.

Most of the cost is in the electronics and the spindle. As the electronics and the technology improve, the cost of drives in each new generation will stay the same. When they finally introduce "tera-sized" drives, my guess is it should be about the same cost as high-end drives today.

And in the range of affordability for most computer buyers?

That been the case, and I don't see any reason why it should change from 10 or 15 generations of previous computers.

We're probably two years away at most from a single hard drive with a terabyte capacity.

Speech recognition, which got talked about a lot at Microsoft a couple of years ago, doesn't seem to get as much mention these days at the company. Will it get put back on the agenda or is it off on the horizon now?

We are moving ahead on it. Most of the focus is on improving the underlying technologies--and they are getting better.

How far off from the "Star Trek" scenario, where Scotty can start talking and the computer recognizes him?

The "Star Trek" level simplicity was just a little bit on the odd side. Their computer could figure out when you were talking to it and when someone was talking to the others. That's a little far-fetched. Right now, we have a number of key elements in place, and speech recognition engines are getting very good at well-defined tasks. A lot depends on your belief about how people want to interact with computers.

For instance?

If you're a good typist, you can type faster than you can talk. And you are more precise when you type than when you speak. What you'll probably see is speech talking a role in settings where it's appropriate, such as in specialized situations where people are interested in using speech--such as with a tablet computer, where there is no keyboard. If someone's a good typist, there's no reason to use speech unless there's something wrong with their hands. In five to seven years, this will happen. But people will use the interface that makes sense for them.

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Steve Perlman

■ **AGE:** 41

■ **JOB:**
CEO, Rearden Studios

■ **ACHIEVEMENTS:**
Co-founded WebTV Networks, which Microsoft purchased in 1997; co-founded Catapult Entertainment; founded Moxi Digital, which merged with Digeo in 2002; founded Rearden Studios. Holds 45 patents.

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By Richard Shim
Staff Writer, CNET News.com
December 5, 2002

Like many other inventors, Steve Perlman has been in hot pursuit of a device that will seduce the masses. Two of his inventions, WebTV and the Moxi Media Center, have offered glimpses into the potential power of combining two mainstream products--in this case, the computer and the television. Consumer demand for such a machine has so far failed to meet heady expectations, but Perlman remains certain that the day of the set-top box will come.

A holder of 45 patents, Perlman believes technology advances will bring a dramatic change in home entertainment before the end of this decade. By then, he says, consumers will be able to buy devices with multiterabyte-size hard drives that store 1,000 hours worth of video and music. He cautions, however, that this may also usher in a new age of piracy.

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There's an ongoing debate about whether the PC can ever supplant the television to become the main receptacle for entertainment. What do you think will happen?

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Although the PC is the ultimate general-purpose computing device, its characteristics don't correspond well with what people want in a home-entertainment system. And so far, the cable and satellite vendors have refused to allow digital decoding on a PC, so the PC requires a complex hookup with (infrared) blasters and such, creating a very clumsy experience.

As a case in point, I challenge you to get any MP3 jukebox to rip CDs and play music without ever hiccupping or causing your system to freeze up. It's even worse when you try to play video clips. You can imagine if that freeze-up happened during the last 15 seconds of last year's Super Bowl.

What themes will shape the future of consumer electronics devices?

Storage and, specifically, hard drives...Before the end of this decade, the run-of-the-mill disk drive that consumers can buy will be able to store all the recorded music in the world. The challenge will be figuring out how to protect this content, getting people to pay for this stuff and improving the navigation of it.



rick
RASHID

► Multiterabyte hard drives
for everyone.

How will having significantly more storage change things?

As an example, a big-enough hard drive in a DVR (digital video recorder) can download and store a bunch of new pay-per-view movies overnight. So when you go to your set-top box the next day, you can play whatever you choose--instantly--without having to download content and stress a network. The ones you don't watch, you don't pay for.

Increasingly, you're going to find local disk drives used for that purpose: to aggregate a whole bunch of content--some of it free, some of it you record off channels you subscribe to, some of it for pay. With 1,000 hours of content on a DVR, you're going to have more speculative recordings of both videos and music.

Morpheus and
Napster are a
glimpse of what
the world will be
like when you
have
multiterabyte
disk drives.

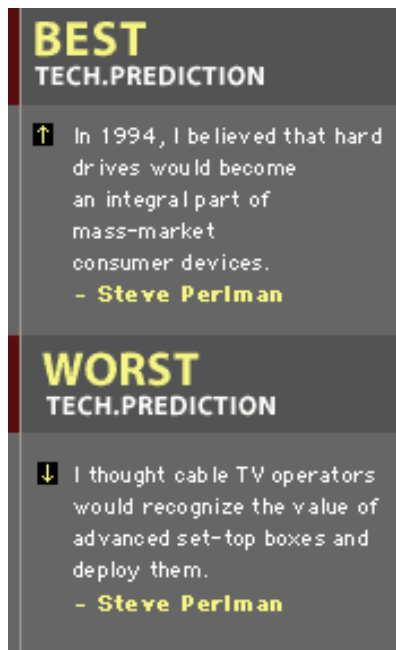
What do you think navigation will look like on devices using these huge hard drives?

Morpheus and Napster (file-sharing networks) are a glimpse of what the world will be like when you have multiterabyte disk drives. You can think of Morpheus as a multiterabyte disk drive that you have at your disposal.

How will people manage these large hard drives full of data?

You have to have the information tagged robustly and consistently because no matter what (search methods) you build, it doesn't matter a bit if you don't have common reference points. Companies and industries need to settle on what those points should be, so that the industry can build one common database.

Once you have that, creative people begin thinking of any number of ways--from searching content alphabetically to querying (a system for an item)--to keep track of content. And then speculative recording gets more refined and can better match your tastes.



What's the next step for content once storing it becomes less of an issue?

From a (movie-making) point of view, you get to: "How do you make it easier and essentially cheaper to make?"...We're working to create complete, synthetic characters and make them look as real as we can.

We have a long way to go. No one has created a believable foreground character, but they have done background characters. To get a close-up of a face, clothes, hair, sweat--that's quite an effort. If we can create these realistic-looking characters and settings, we could

save huge amounts of money on film production. In fact, we could get to the point where we've created a new kind of independent film, one which is completely computer-generated that looks like live action.

Two products that I think may get some traction are Intel's media adapters and Media Center PCs. And I suspect these things are probably going to lead to a Napster-like experience for video. You'll end up with just a lot of pirated content out there.

How do you think computing interfaces will change?

A leap for computing interfaces would be changing the way we think about how we interact with a device. With a PC, you have to go through a number of layers before you get to the document you want to use. Something we worked on and prototyped at Apple (Computer) under the code-name Pink--but it never came together--was document-centric or media-centric computing. The idea is that you sit down at a computer and a document comes up, which has different applications that apply to different parts of it.

How would that work?

If you're using a spreadsheet, then the code in the operating system to deal with spreadsheets comes up. If the document is text, then the code to deal with text comes up and so on. We see wisps of this come up in different places. You can bring up a column-editor in Word that's kind of like Excel, and they sort of talk to each other in a way. With HTML and Internet Explorer, you begin to see those things. But we should have a document (interface) and companies should be developing plug-ins for this interface. You shouldn't be going through applications; the applications should be behind-the-scenes doing what they need to do. I think it is ripe to happen but never will because of the state of the market.

What is the biggest myth about consumer electronics that will be dispelled in the next couple of years?

That the historical success of a category defines the viability of future products in that category. For example, MP3 players were introduced five years ago with marginal success. No one thought much of the category. Then the (Apple) iPod came out last year with an excellent design, and it was a roaring success, proving that the category was just waiting for a good version.

A leap for computing interfaces would be changing the way we think about how we interact with a device.

The same is true with DVRs. So far, rollout has been slow, but that's because no one has yet formulated a great DVR product. You can tell it will be a huge success because people adore their DVRs.

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