

TWENTY-TWENTY Vision: 20 YEARS OF TECHNOLOGY

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This expands on previous articles about three types of trends affecting home networks: (1) Technology, (2) Market & Consumer, and (3) Social & Economic. For reference, follow the links at www.hometoys.com/mentors/caswell.

Twenty-twenty Vision can help you build homes that outlast the mortgage, but you must first embrace the unlimited possibilities. Only then can you visualize a version of the future you prefer and set that as your destination.

This article helps you create that vision with historical trends and a look at technological developments that make new things possible. Calculating their probability, however, is an entirely different matter.

Orwell's 1984

Let's start by reviewing key developments from twenty years ago and then look forward twenty years or so.

January 1984 wasn't quite what George Orwell envisioned in his book, but that year serves as a benchmark for how far we've come since. Likewise, some of my predictions may never happen while others will be too conservative.

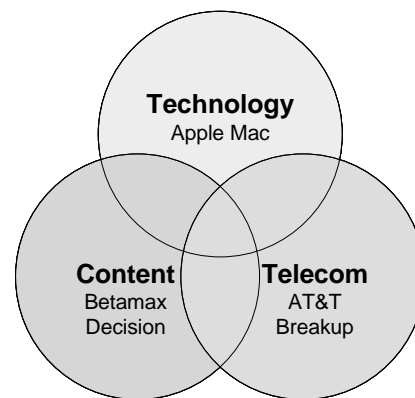
January 2004 marks the 20th anniversary of three key events that shaped our era:

1. Breakup of AT&T – The largest antitrust suit in American history broke up AT&T, created seven regional “Baby Bells,” deregulated the long-distance market, and created competition. No longer would a single carrier monopolize telecommunications, own every phone line, and manage every call.

2. Legalized Video Recorders – Content owners in Hollywood sued Sony and argued that VCRs lead to copyright violations, but the Supreme Court didn't agree. As it turns out, the “Betamax ruling” didn't hurt the movie business and cleared the way for a multibillion-dollar videotape business where Hollywood makes more money from rentals than box office.

3. Launch of the Macintosh – Apple's graphical user interface sparked a major change in how we interact with PCs. And now Apple's new iPod player and iTunes music service are changing digital music too, resolving similar digital rights issues as the Betamax case.

These three landmark events signaled a convergence of computing technology, telecommunications, and content.



Other important technologies from 1984 include the CD-ROM and portable CD players, the camcorder, the laser printer, and IBM's PC/AT, which marked a shift in the company's PC strategy to focus more on large enterprise customers and less on small business and consumers.

Highlights since 1984 include handheld PDAs, GPS navigation, direct broadcast satellite, the Telecommunications Act of 1996, digital & high-definition television, flat plasma TV screens, DVDs, digital video recorders, MP3 players, Auto PCs, wireless home networks,

broadband Internet service, the start of service bundling, e-commerce, and more.

Technology has already changed home design. With hang-on-the-wall plasma displays, we no longer want a large hole in the wall for a 35" direct view TV set. But we do want network connections to stream audio and video from our DVR or media center to TV sets and stereo systems in other rooms. That's just a start of design changes we can expect.

The Internet

The Internet changed how we live, work, play, buy things, communicate with others, and participate in society. For study purposes, it has five major components:

1. *The Network Itself* – media (copper, coax, fiber, wireless), bandwidth, latency.
2. *The Applications we Run* – as the Net gets faster and integrates into cars and homes, access devices get smaller and new apps & user interfaces appear.
3. *The Content we Access* – all information about everybody: our report cards, love letters, arrest records, medical histories, sales receipts, tax reports, surveillance videos, history of web site visits, email, and IM & newsgroup postings.
4. *The Devices that Connect* – from desktops to handhelds and embedded devices – they'll work together over the Net.
5. *The Location and Context* – Internet access from everywhere (office, home, car), where we must consider the context of that location.

By 2024, the very fabric of society will be bathed with Internet access, and what we know about the world around us will depend on the networks.

Gigabit Networks

There's little need for gigabit home networks when most homes dialup at kilobit speeds.

Even DSL & cable networks offer minimal performance with about 1 Mbps downstream and 56 Kbps up. U.S. broadband connections are slow compared to countries like South Korea.

- *Broadband Policy* – South Korea has the highest penetration rate of any nation – 95% of households are covered and 54% subscribe. Korean Telecom offers VDSL (2-40 Mbps) for just \$25/month, and another \$8 adds Wi-Fi access.

Aggressive Korean policies call for ubiquitous broadband access of 155 Mbps to 5 Gbps by 2005. The government has already made direct investments of \$2 billion in a national backbone network, \$600 million to promote digital content, and \$100 million in loans to service providers who deploy new access networks. And they've committed an additional \$30 billion for public/private broadband infrastructure by 2010.

U.S. policy makers must wake up and realize that an aggressive policy will help us compete in the global information economy. And builders and equipment makers should demand and expect performance of at least 100 Mbps and probably much faster.

- *Home Networking Standards* – Faster processors help improve the performance of different media and networking standards.

Ethernet, which appeared in 1985 at 10 Mbps, has since evolved to 100 Mbps, 1 Gbps and 10 Gbps already. Some people recommend using cat.5e or cat.6 cabling for gigabit networks, but faster chips will soon that that speed to cat.5 cabling.

HomePNA (using phone wires) and HomePlug (using power lines) are two no-new-wires home network standards that appeared around 1998 with 1 Mbps performance. HomePNA 3.0 now supports 128 Mbps, and the pending HomePlug AV spec will also support speeds up to 200 Mbps.

Even wireless standards are pushing past 100 Mbps with proprietary Wi-Fi extensions available at 108 Mbps. Twenty years from now, wireless should easily reach gigabit speeds and could replace all need for cabling. Until then, install cat.5 cabling (or better) where feasible.

- *Convergence of Services* – Service providers that survive industry consolidation will offer a “triple play” bundle of voice, data and video services – available at lower cost, with greater performance, more function, a single monthly bill, and a single support line to resolve problems. They’ll need home networks to connect TVs, PCs, stereos, and phones.

Applications Online

The “network is the computer” when apps move online, and Web-advertising makes most of them free, where all you need is a browser – on a PC, TV, PDA, or phone.

- *Shared Apps & Files* – Move the apps and files online, and you get remote access to everything (pictures, music, floor plans...) from anywhere. You can share what you want with family, friends and business acquaintances. Forget about installing software and keeping it up to date. Data managed by a trusted service guarantees its security and safety, and even if your house burns to the ground, those treasured photos, movie clips, recipes, and tax records are still there – for as long as you like, and shared with whomever you like.
- *Speech & Agents* – What happens when machines listen, speak and appear intelligent? Smart agents act on your behalf, either because they are taught (rules-based agents) or because they learn on their own (through sensors that recognize temperature, motion, voice commands, and even faces).

With smart agents and speech recognition, machines and humans can work side-by-side, speaking to one another. The latest systems no longer sound like robots and instead sound like anyone you want. They’ll soon be able to

hold a conversation in natural language with a large vocabulary, answering questions and performing tasks.

Since microphone distance is an issue for speech apps, you might need a microphone array with digital signal processing to eliminate noise, echoes and reverb so voice commands are understood when you’re far away or close by. Or you could simply wear a wireless Bluetooth headset with speaker and microphone.

The increased use of speech recognition is driven by smaller devices without keyboards, and enabled by faster processors and more memory. I don’t think speech will be the primary interface, however, just an optional one. That’s because sometimes we want quiet, like when we’re working late and don’t want to disturb others, or when it’s easier to hit a switch than say “lights out.”

Digital Content & Rights Management

Broadband networks with a mix of voice, data, and video help eliminate redundancy and dead space, including the idle time when no one is talking on the phone, the dead space between words, or TV channels that no one is watching.

- *Compression* – Digital content is easy to compress and decompress (codec) and helps to further eliminate redundancy. It can be either “lossless” (for data apps) or “lossy” (for pictures, music and video where users notice little difference).
- *Music & Radio* – Digital compression improves broadcast radio, whether it’s the new HD Radio format, satellite, or live streaming via Internet, and faster processors make for even better compression so networks can carry more interesting content.

The MP3 music codec made it easy to send music through the Internet over relatively slow connections, but it raised concerns about intellectual property. Apple’s iTunes music service has since found a way to protect the

rights of artists and record labels while also making it easier to buy and download music.

For homes, this means consumers will want easy ways to distribute music to speakers anywhere.

- *Digital Video & Television* – The digital video recorder and its ability to bypass commercials destroyed the old advertising model; so new business models are needed. We can expect a mix of video-on-demand, subscription services, personalized ads, and product placements with hotlinks to buy or just find out more.

T-commerce is a term describing personalized ads that match viewer interests so they're more effective. Interaction adds the ability to find more information and buy online while advertisers gain a way of knowing who is interested. Nearly every home in 20 years will have highly interactive digital television, but you may still want to just sit back and watch passively.

Even when everyone can record video and publish online, a few large media companies will provide most of what you watch, because few people have enough talent or funds to make compelling programs.

MPEG-4 is a fairly new video codec that needs far less storage and bandwidth than MPEG-2. Rather than 3 Mbps to send DVD-quality video, MPEG-4 needs only 750 Kbps to get nearly the same quality. And instead of 20 Mbps for HDTV, MPEG-4 needs just 2-3 Mbps.

Terabit PCs with Lots of Storage

Moore's Law describes a semiconductor trend where transistor density doubles every 18 months so products keep getting cheaper, smaller and faster with no end in sight. That trend will soon put high-end PC power on your fingertip.

- *Embedded Computing* – As technology disappears into everyday devices (light

switches, smoke detectors, doorknobs, appliances, jewelry, eyeglasses, clothes, toys and other consumer electronics), we move from the 1975 mainframe era of hundreds of people sharing a single computer to an era of embedded computing with hundreds of processors per person.

- *Wireless Networks* – You won't need to run cables to the smart toilets and windows since wireless networks complement your structured wiring. Even though wireless is the best option for mobility and will eventually support all of the apps you can imagine, wiring will still be the most reliable, secure, and best performing option in 20 years.

- *The exploding PC* – More and more PC functions are moving into networked appliances, and printers, gateways and hard disks already connect to Ethernet. That way PCs, DVRs, game consoles, media centers, and other devices can all use them.

With ultra-fast broadband access, these PC functions can move onto outside services, but it's not clear what will be stored locally or remotely. It is clear that you'll have lots of storage available.

- *Disk Storage* – The desktop PC of 1984 had a 20 MB hard disk, a 16-bit processor, a clock speed of 8 MHz, and a retail price of over \$5,000 (in 1984 dollars). Today's desktop is 250 times faster and has 2000 times more storage with a 40 GB disk.

If we still have desktop PCs twenty years from now, which I doubt, they'll each have terabit processors and 2 petabytes of storage, given the current trend.

What would you do with 2 petabytes? Store a million feature-length movies? How about recording everything you hear, see, read, and write each day, so you can recall it later from your wearable computer, heads-up display, and wireless network? Never forget a face or name or birthday or anniversary.

- **Solid-state Memory** – The capacity of postage stamp size, non-volatile flash memories will increase to 1GB this year and soon hold feature-length movies, but that's just the beginning. Researchers are developing an inexpensive, fast, low-power, and non-volatile memory device that can replace flash, DRAM (dynamic RAM), SRAM (static RAM), and embedded memory in system-on-a-chip processors.

MRAM (magnetic random access memory) uses magnetism to store data instead of electricity, so contents remain when power is off. MRAM is faster than static RAM and can be dense enough to replace the hard disk. MRAM devices will also use far less power, be more reliable with no moving parts, and eliminate the delays of saving data to disk, shutting down, or booting up.

- **Remote Access & Security** – Following the mantra of “any content, anytime, anywhere, on any device,” wireless devices can control home apps and access home files. However, builders must understand the security issues.

I've seen multi-million dollar homes where the systems integrator provided wireless access to the home security system without knowing how easy it is to break the weak security of Wi-Fi and gain access to the home and its contents.

- **Displays Grow Large & Small** – Since large TV displays keep getting thinner, forget in-wall cubbyholes and think about getting power and network cables to wall-hung TVs.

As mobile displays get smaller for wearing on eyeglasses, large TV displays will get much larger – even wall-sized and building-sized. We may find that the 1080p HDTV format, which looks great on 70” displays, is not good enough for walls, so we may need new formats and faster networks.

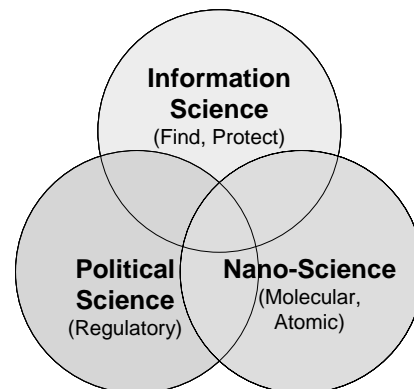
- **Media Server** – It's not clear what sort of converged device will become the dominant media server, managing collections of music,

movies, photos and Internet content. If it's a PC, it goes in the home office; and if it's a set-top box, it goes in the family room. Either way, we'll want to send content to any PC, TV or stereo and control the content from there.

Convergence at a New Level

The last 20 years were about the convergence of computing, telecom and content; but the vision of an e-society with anywhere access to all human knowledge depends on pushing the technology drivers and removing the inhibitors, including complexity, security, social, economic, and political barriers.

That's why I envision a new set of convergence spheres that bring together Nano-Science, Information Science, and Political Science.



- **Nano-Science** – The nanotech evolution is shrinking semiconductor features to molecular and atomic dimensions, and that will extend Moore's Law well into the future.

With individual components self-assembled from molecules, and with nanometer connections, the circuits will be much smaller and more powerful than anything made from silicon. They may also be so inexpensive to make that they're essentially free, and with this scenario, the value comes from programming the circuits.

The result for homes will be hundreds and thousands of intelligent devices that work

together, assuming that other barriers are removed and standards allow.

- *Information Science* – Believe me, your financial transactions, written opinions, love notes, inquiries and disclosures are already online somewhere and there to stay. How will you find them when you want them, and secure them so others can't?

As we collect more information, we must learn more about the nature of information itself so we can use machines to search and parse the data and deliver useful knowledge and insight.

- *Political Science* – The most difficult problems – universal broadband access, copyright, free expression, social networking, due process – have technical issues but aren't really technical problems. They depend more on politics, business models, policy, changes in laws, and other factors.

Who will be the new political and business leaders? What companies, industries and nations will dominate? The business leaders must innovate more and rely on gut instinct, and the policy makers must have the courage to avoid political pressures from powerful lobbyists and focus instead on public good.

Education will become an even more important factor as students struggle to keep up with evolving science and consumers find it difficult to adopt technology and accept change.

Closing

The future isn't what it used to be and is coming faster than ever. We can't just study the past, extrapolate trends, and learn about what's possible. The greater challenge is in knowing the right things to do, so we must also study changes in consumer behavior, lifestyles and attitudes, and social, political, demographic and economic trends.

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