Twitter Thread by Corry Wang

Corry Wang
@corry_wang

1/ In September 1993, then-Microsoft exec Nathan Myhrvold wrote his landmark memo "Road Kill on the Information Highway", laying out a dozen-ish predictions on the rise of the internet

27 years later, I think it's a super interesting case study. Let's evaluate the predictions -

InterOffice Memo

To: List

From: Nathan P. Myhrvold

Date: September 8, 1993

Subject: **Road Kill on the Information Highway**

Technological changes often have enormous consequences. Microsoft has been the beneficiary of this effect for the last 17 years, and a variety of other companies in the computer industry have either had their day in the sun, or have fallen past the crest of the wave and have suffered as a result. Although the shifting fortunes of companies within the computer industry are naturally quite important to those of us who are participants, the effect on the world at large has actually been rather modest. The confluence of wide area digital communications and ever cheaper computing is going to be a *lot* more traumatic and far ranging than PCs have been. This memo is about some of those changes and how they will effect a number of industries.

2/ PREDICTION #1: The rise of a surveillance society - police bodycams, CCTV, 24/7 personal recording, and deepfakes

GRADE: A-

Pretty close!

Many employers will want to use these recorders as a management tool. Bus and trucking companies have an obvious interest in whether their drivers stay within the law and are on time. The public at large may insist that the police record themselves in the course of their work. This guards against claims of brutality or abuse on one hand, and gathering better evidence on the other. Other circumstances will be more invasive and harder to justify, but it is virtually certain that people will try.

Personal safety will be a big issue as well. There are plenty of situations where you'd rather have Big Brother watching than be left to the mercy of street crime. David Brin's science fiction novel *Earth*, suggested that digital video cameras with wireless links to the police would revolutionize police work and the judicial system. In addition to putting them in street lamps, Brin has them toted by senior citizens, because retired baby boomers will make up a large fraction of society. Since they will also dominate the voting population, the laws of his imagined society are oriented toward widespread use of digital surveillance to protect senior citizens against crime.

One of the biggest reasons will be defensive, using the digital record to protect against litigation and other claims. People who record are open to the possibility of the recording being used against them, but at the same time will be able to protect themselves against spurious claims. If you have a business deal with another party, and they have selectively recorded things (not every meeting etc.) then the best defense is to have a more complete recording yourself. One side effect of cheap computing is that it will be possible to forge essentially any kind of photograph, video or audio. The only such data that will be admissible in court will be those taken with tamper proof hardware that digitally signs it.

If these trends continue it will be gradually become more and more accepted to have these records - both at a corporate and personal level. What today seems like the digital jackboot of Big Brother will one day become the norm. Every year the executive staff at Microsoft have to sign a "boy scout pledge" of business practices which says (in essence) that we see no evil, hear no evil and do no evil. I'm not trying to make fun of this - it is true that our policy is to be good guys - but it doesn't really change from one year to the next. The ritual of signing this annually small testimony to the societal pressure to redundantly reaffirm our values. Twenty years hence the pendulum of public opinion may have swung to the point that people say "What do you mean, you don't record everything? Do you have something to hide?".

3/ PREDICTION #2: Telecommuting, an end to the "tyranny of geography" and gerrymandering

GRADE: B-

Alas, the electoral college still matters today. The WFH prediction hits closer, but turns out it took two and a half decades + a pandemic to get things going

Assuming that the network is there, a person in Redmond or Manhattan or nearly anywhere else will have *equal* access to goods and services presented on the network. Geography doesn't matter any more - if you are on the net you in a virtual world which is not bound by these conventions or constraints.

The implications are enormous - so much so that it is hard to overstate them without sounding silly. *Any information based business or activity will cease to be geographically bound*, which means that the local operators of these activities will die. Nationwide services which are based on the information highway will dominate them every time.

This will occur in various stages over the next couple of decades. The first examples will be pure information businesses, which can simply transfer digital data directly over the network. Software (and therefore Egghead and others) will certainly go this way, as will the local video rental store. The next step up is information used to purchase or deal with physical products - mail order and retailing. This will have a huge effect on local retailing, although it will not eliminate it.

Much of the focus on information business is placed on mass market retail information, but there is another category that is ultimately even more important - wholesale point to point information - in other words, the work product of most people employed in offices. Telecommunting will allow these people to go to work over the information highway rather than the physical one, and thus be bound only by its constraints. There is still a speed limit on the information highway - but it's 186,000 miles per second[5]. Long distance bandwidth will drop in price until there is very little reason for people working "together" to be nearly anywhere on earth which has network access.

4/ PREDICTION #3: Telco convergence - phone companies become cable providers and vice versa

GRADE: A-

Honestly this one was a bit of a layup, although it took 15 years longer than anyone expected

The clearest example is the race for the "full service network". Cable TV and phone companies each realize that their current business could be subsumed by the other when equipped with a new digital infrastructure. With approximately equal cost, each of them can create a network which serves both voice and video as well as new advanced services.

Initially these networks will be moderately expensive (although still fungible). Over time, the absolute cost and the price/performance ratio - i.e. the dollars per megabyte per second will plummet. Physical installation costs and regulatory barriers will be roughly constant (or may change somewhat) but ever higher bandwidths will keep the price/performance ratio dropping even after the absolute cost flattens out. As long as customers have a use for the bandwidth this means that new network will enjoy a big advantage over older ones.

This poses an interesting problem for a carrier - do you install systems aggressively, even though they will be far more costly and less capable that what is just around the bend, or do you wait until they are cheap? If do you wait, a competitor may have staked out a strong position before you do and own the market. If you rush in, you find that a later competitor can undercut you with newer, cheaper systems. In the past, government monopolies have allowed people to have a certain amount of faith in investing in network infrastructure, but that is far from certain.

In the long run the increase in price/performance still poses a dilemma - how can you keep finding services which will utilize the bandwidth? The situation is similar to that discussed above with CPU cycles and storage. The first answer is richer data types, with high quality video being the key example. Notice however that this poses a big problem with respect to existing services - the fundamental cost of a voice call is tiny on a network built for video. The first generation interactive TV networks will carry switched data at 4 megabits/second, or about 1000 times faster than a comparably compressed voice call. The cost of the video must also be lower; about 50 cents an hour at the most in order to allow a movie to be priced competitively with video rental stores. Voice calls which are tarriffed (for long distance and business calls) are more like $6.00 to $18.00 an hour within the US and far more outside. Future generation systems - both local area and long distance will only widen this gap. An OC-3 ATM network is about 40,000 times faster, and an OC-12 network is 160,000 times faster than voice. As a result, voice costs can't help but trend toward zero as these performance levels become cheaper and cheaper.

Price is not the same as cost of course, but unless regulatory agencies explicitly permit voice to have a different billing structure, all voice calls will be essentially be free. Given any sort of competition at all, existing levels of service will become a lost leader offered to build share for other services. The current telephony world does this with residential voice service in the local area which is given away free in order to create terminals which can be used for long distance. One can easily imagine a situation where all voice services, including long distance, are free if you are willing to sign up to rent a high bandwidth smart video phone.

5/ PREDICTION #4: The rise of online neo-banks

GRADE: C

Three decades later, and physical banks still exist. Neobanks have a presence in emerging markets, UK, and basically nowhere else. Regulatory inertia: officially a thing

Retail Banking & Financial Services

Banking may seem like an unusual industry to pick on, but it illustrates one of the important themes of the information highway. There are 14,000 banks in the United States which cater to retail customers. Their business is based on offering a variety of services - savings accounts, checking accounts, credit cards, loans and so forth.

What is the unique value proposition that these banks offer their customers? The historical answer is geography - most people bank with a firm which has a branch office near their home or commuting path. There are some minor differences in interest rates and other retail banking products which might shift people between two local banks, but hardly anybody is going to find these features sufficiently compelling to make them pick a bank that is 10 miles out of their way as long as their are closer alternatives.

The information highway makes geography obsolete, especially in the case of banking or other financial services which are really just information businesses. The only physical transaction that needs to be done is receiving cash (which itself will one day go away), but automatic teller machines have became the primary way to deal with this. Automatic teller machine networks (note that this use of "ATM" and "ATM network" is quite different from Asynchronous Transfer Mode discussed above) are already threatening the banks. After all, if I have a card issued by a nationwide ATM network, and direct deposit of my paycheck into my account, why do I need a physical bank at all?

In the long term, the notion of depositing money "in" an account is pretty silly. A single transaction clearing service should be able to contract with both me and my employer so that my salary automatically flows out to fixed expenses (mortgage, utilities), or into various short or long term investment accounts. Most purchases would be handled with a card (or digital wallet) which was able to combine the features of a credit card ATM card and digital checkbook.

6/ PREDICTION #5: "Newspapers are in probably the worst situation of any form of print media"

GRADE: A+

Frankly I was shocked by the prescience of this section. Newspapers were once local advertising monopolies. The internet broke that monopoly

Print Based Media

One of the groups most concerned about becoming roadkill are the people involved in wide spread analog information distribution - newspapers, magazines and books. Each of these will suffer a somewhat different fate.

Books are actually the best off of the bunch. I believe that print based books will continue to be published for the next 50 years, and possibly longer although by the end of this period the volume will be far smaller than today. Books have a number of things in their favor versus the information highway alternatives which other forms of print media do not have.

Customers *pay* for books. This may sound like a silly distinction, but in most other print media *advertisers* pay for a great deal of the cost. Advertising revenue is far more fickle than direct consumer demand, and information highway has many features which will be very tempting for advertisers. Inroads that the highway makes in these areas will hurt other media, as discussed below, but this will leave books unscathed.

Another advantage to a book is that they are long and, with a couple of exceptions, they are not suitable for random access. People tend to read them all the way through, rather than browsing selectively, or starting in the middle. This has two consequences for competition with the highway. The first is that the quality of the display is very important. You might put up with a computer display to check stock prices, or see the latest news, but choosing to read the next Tom Clancy thriller on line will mean signing up to reading several hundred pages on the computer, PDA or television. Current display technology is *not* good enough for people to do this because of limitations in resolution, contrast, weight and power consumption. Ultimately this will be solved, but it will give books five to ten years longer than other more casually consumed print material will have.

The second advantage to length and uniformity is that most books do not benefit as much from indexing, retrieval and filtering. On line newspapers or magazine articles can be browsed, filtered and indexed on a computer in ways which are far superior to print. This is also true of some kinds of books, particularly reference books such as dictionaries or encyclopedias which will rapidly move to the highway. Novels and most non fiction books do not benefit as much from this technology. It might help you find the book, but once you have found it you will read for a long time before searching again - the ratio of retrieval to reading is low.

Newspapers are in probably the worst situation of any form of print media. I expect newspapers to be published for very long time, they will *not* disappear overnight. They will face some huge challenges however. In fact, many newspapers are already experiencing problems because of the long term effects of competition from television.

The biggest problem with newspapers is their reliance on advertising revenue. The current budget for newspaper advertising is (in adjusted dollars) half what it was in 1950. The obvious reason is that

7/ PREDICTION #6: "Television broadcasters are some of the most likely fodder for roadkill of any of the current media companies"

GRADE: B+

Pretty much right, but 21 years too early. Broadcasters kept growing until 2014

Broadcast Television Networks

Television broadcasters are some of the most likely fodder for roadkill of any of the current media companies. Some form of broadcast TV will continue on for the next 20 to 30 years, but its pivotal role as the leading form of mass media is already declining due to competition from cable and other factors. Their decline will be long and slow and may take the next two decades, so this isn't an overnight phenomenon, but by the time that they realize it the window of oportunity for changing anything will have long since passed. The role of TV networks in the world will be tremendously effected by the information highway, yet they are doing very little about it - like a dazed rabbit caught in the headlights of an oncoming car.

As in other areas discussed in this memo, the trend is already well under way. Cable TV relived the pressure on channel space, and thus enabled special purpose television. Prior to this the opportunity cost of time on one of the three major broadcast networks was so high that the networks were forced to cater to the same set of customers. It made more economic sense to pander to the lowest common denominator and pull in the most viewers, even if that wound up making the networks quite similar and the shows quite moronic. Each had a similar line of up shows and none of the stood for a particular set of viewers or values. Each of them wound up having specific areas where they would happen to create a long term asset which would run for

8/ PREDICTION #7: The internet will expand the market for Hollywood content. Also, Blockbuster is toast

GRADE: A

The iron law of media investing is that over any long enough timeframe, value inexorably accrues to the content owner

Hollywood

The motion picture industry has developed a very predictable reaction to technology. In the past 50 years there have been a number of technological innovations - talkies, color films, television, VCRs and cable TV. In each case the initial reaction was the same - the new breakthrough was the work of the devil, an evil force which would destroy the industry. These fears have never proved out, and in fact just the opposite has happened. Each change caused a large expansion of the market for feature films and greatly increased revenues.

This rosy picture may well happen once again. Movies are likely to be popular for at least the next 20 years, and probably far longer. The information highway is a great way to deliver films - in fact a far better one than the current schemes. Hollywood's fortunes will continue to improve as the highway takes a larger share of film distribution.

Movie theater attendance is continuing to drop, to the point that theater revenue is no longer the largest source of revenue for most films. The good thing about theaters for Hollywood is that the price is relatively high, and the margin is good - typically about 50%. Despite this, the current trend is likely to continue and theaters will become a smaller and smaller phenomenon, although they are unlikely to become completely extinct. In fact stage plays are a good model - they are still around despite movies, television and other art forms. Plays no longer hold the same relative position as a medium of mass entertainment, and one day the same thing will be true of movie theaters. They will be expensive places where people purists, aficinados and those with nostalgia go for a special night out.

Blockbuster and other video rental stores are currently the largest source of revenue in absolute terms. Their business is almost certain to go away as the information highway provides large libraries of films on line. However unfortunate this is for video store owners, it is a boon to Hollywood because the current video rental business is based on selling the tapes to the stores rather than directly participating in the rental income. Video on demand on the highway will be done as a share of revenue which is far more lucritive for the film's owners. The death of the video store will greatly increase the bottom line to Hollywood.

9/ PREDICTION #8: Traditional PCs will be replaced by lightweight, low-end internet terminals

GRADE: C+

Say what you will about low end disruption, but after all these years I still don't want to use a Chromebook

I believe that the same thing will happen again with PCs playing the role of mainframes and minis, and the computing platforms of the information highway taking over the role of the challenger.

The technical needs of computers on the information highway, or IHCs are quite different than for PCs. The killer applications for IHCs in the early years will include video on demand, games, video telephony and other distributed computing tasks on the highway. It is hard to classify this as either higher tech or lower tech than the software for PCs, because the two are quite different. Most IHCs will certainly need to be cheaper than PCs by an order of magnitude and this will inevitably cause them to be less capable in many ways, but some of their requirements are far more advanced.

Another way to say this is that the rich environment of software for PCs is largely *irrelevant* for IHCs. Windows, NT, System 7 and Cairo do *not* solve the really important technical problems required for IHC applications, and it is equally likely that the early generations of IHC software won't be great platforms for PC style apps. This isn't surprising because they are driven by an orthogonal set of requirements.

The IHC world will almost certainly grow faster than PCs, both in business terms and in price/performance. The PC industry is already reaching saturation from a business perspective. Technically speaking, the industry is mired in hardware standards (Intel and Motorola CISC processors) with growth rates that are flattening out relative to the state of the art - just as the 360/3090 and VAX architectures did. The Macintosh and Windows computing environments may be able to survive the painful transition to new RISC architectures, but they will lose time and momentum in doing so.

PCs will remain paramount within their domain for many years (we'll still have a computer on every desk) but IHCs will start to penetrate a larger and larger customer base on the strength of its new and unique applications. The power of having the worlds information - and people - on line at any time is too compelling to resist. For a long time people will still have a traditional PC to handle traditional PC tasks - in precisely the same way that they have kept their mainframes and minis for the last 17 years. One day however people will realize that their little IHCs are more powerful and cheaper than PCs - just as we have finally done with mainframes. There will be a challenge for the IHC software folks to write the new systems and applications software necessary to obviate PCs, just as we had to work pretty hard to come up with NT, but this battle will clearly go to the companies who own the software standards on IHCs. The PC world won't have any more say about how this is done than the companies who created MVS or VMS did about our world. Of course, some of the VMS *people* were involved, but as discussed above it is very hard for *organizations* to make the transition.

10/ In retrospect, most of Myrhvold's predictions were pretty good. His call on the print media was spectacularly right. His calls on TV, Hollywood, and telcos took a while, but ultimately happened. Telecommuting and 24/7 surveillance are still shifting in realtime...

11/ The one catch? Timing

Nearly all these predictions took 15-20+ years to play out. WFH is still 25+ years in the making. Nothing in the memo (except shorting newspapers) would've been investable on any reasonable timeframe

Predicting the future is easy. Making money is hard!