

## POLITICS:

# PARTICIPATORY PANOPTICON

Camera phones, webcams, and other mobile network devices have become increasingly commonplace. While the initial use of these devices may have been to trade messages and humorous or embarrassing images among friends, wireless information and sensory devices have acquired greater social—and political—importance over the last couple years. They are the early manifestation of the participatory panopticon, a world in which we record our lives as well as the lives of those around us. Everything is potentially on the record, often from multiple perspectives; not only is privacy a thing of the past but potentially secrecy as well. Such a world isn't necessarily intentional; instead, it's the emergent result of individually reasonable technological and social choices, choices we're making right now.

### TOOLS: LIVING LIFE UNDER A LENS

The participatory panopticon emerges from the intersection of well-established technological and social trends. Digital cameras have gotten smaller, cheaper and easier to use; online storage and wireless networking have become more plentiful and, quite often, free to use; and in much of the world, the dominant information platform isn't the desktop computer but the mobile telephone. Web sites like Flickr and YouTube make it easy for people to share recordings of their lives, and youth-oriented social-networking sites like MySpace are full of casual photos and videos uploaded with little thought.

The next decade will see more people recording just about everything they see—including the activities and words of the people around them. This is more than snapping a photo of an interesting sight, it's the full-time capture of one's surroundings. An already extant early manifestation of this practice, referred to as "life caching," relies on still images from handheld or wearable cameras; as bandwidth and storage continue to get cheaper, life caching will inevitably move to video.

The utility of such tools isn't hard to see. Constant recordings of one's activities, easily accessed through sophisticated indexing and tagging software, would quickly become something akin to a backup memory, augmenting often dubious, error-prone natural memories. Anyone in professional or social positions in which accurate documentation of actions and conversations is important would find these tools of enormous value, as would people suffering from "information overload," a condition in which remembering what's vital and timely amidst the abundant and banal is difficult at best.

### USERS: THE GENERATIONS DIVIDE

The particulars of use will likely split along demographic lines. Aging but tech-friendly populations in the United States, Japan, and Europe will be a major audience, as these technologies (if given a sufficiently easy-to-use interface) will be of enormous value to people suffering from age-related memory lapses. Business, military, and civil security use will be commonplace, as well; the U.S.

military is already experimenting with early forms of these tools, looking at the recording functions as a way of improving after-action analysis.

By contrast, today's MySpace generation will embrace the networking aspects of the technologies, seeing the life caching tools as a means of sharing their life experiences with peers. Recognizing this emerging trend, a growing number of so-called "mobile network virtual operators" (MNVOs), who repackage and resell bandwidth from major carriers, have launched with an emphasis on data, video, and network connectivity rather than voice. These new operators target younger markets. MNVOs may prove to be a catalyst in the emergence of the participatory panopticon, as they can provide wireless networks with features specific to emerging or niche demands.

### POLITICS: SOUSVEILLANCE ON THE RISE

These tools have a well-established political use, as well. Groups like wearcam.org celebrate these technologies as making it easier to "watch the watchmen," and call the bottom-up, distributed network of observation tools *sousveillance*, or "watching from below," in contrast to *surveillance*, or "watching from above." Examples of *sousveillance* abound. The British press calls on citizens to record and upload media-averse politicians delivering speeches in out-of-the-way locales. A quick-thinking subway rider in New York uses her camera phone to take a surreptitious photo of a man exposing himself to female passengers, leading to his arrest. Such examples will become increasingly common.

Historically, surveillance has been a tool for institutions of authority to maintain control; the advent of a *sousveillance* culture suggests that citizens will be better able to keep tabs on the activities of those in power. Corrupt or unethical behavior is more likely to be uncovered, and recordings of particularly egregious abuses could be spread almost instantly. At the same time, such a social trend could manifest as vigilantism, particularly if framed as an anti-terrorism or crime-deterrence program.

—Jamais Cascio



IN A WORLD  
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ON THE STREET



TEN-YEAR FORECAST  
Perspectives 2007  
SR-1064  
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## DAVID BRIN

is a scientist and best-selling author whose future-oriented novels include *Earth*, *Startide Rising*, *Uplift War*, and *The Postman*. His non-fiction book, *The Transparent Society*, won the Freedom of Speech Award of the American Library Association.



Jamais Cascio first ran into David Brin in the pages of *Time* magazine 1996, debating the topic of anonymity on the Internet. David posited that it was obsolete and problematic; Jamais argued that it was fundamental and often politically necessary. But now, almost a decade later, he admits that he is more willing to look for ways to use the expansion of mutual transparency for social good. He invited David to join him in this conversation.

**Jamais:** It's interesting to think about how the last decade has shaped my perception of the subjects of online anonymity, persistent visibility, and the networked world. I'm less strident now, I suppose, and more willing to look for ways to use the inevitable expansion of mutual (as well as unbalanced) transparency for positive social ends. How would you say your thoughts on transparency have evolved since the publication of your 1999 book *The Transparent Society*?

**David:** I have had a little humility drummed into me over the last few years. I've learned the hard way that my own aphorism—Criticism is the only known antidote to error—works best when you least expect it! You always need to be alert for when some notion needs a reality check.

I've found that transparency is actually a sub-set of something much deeper called "reciprocal accountability." It is a power that only a few generations have had to hold each other—and the mighty—accountable. It's a very recent invention and we all, especially the mighty, squirm like mad to avoid it. But it is responsible for every step we've taken away from feudalism.

**Jamais:** Can you expand on what you mean by reciprocal accountability? What does that look like, in practice?

**David:** We have long been bedeviled by one of those "devil's dichotomies"—the standoff between Rousseau and Hobbes. The latter said that men are inherently vile, and thus we need constant repression of our base or predatory tendencies by the harsh rod of authority, either from lords or the state or church. Rousseau held that we are angels in the "state of nature" and only corrupted by all that state and religion stuff.

To any sensible person, these crystallized essences seem the purest hogwash! As John Locke sensibly pointed out, humans are obviously complex mixtures of angelic and devilish traits. Some of us behave well if left unsupervised. Others won't. But clearly both Hobbes and Locke were right to criticize the demeaning effects of each others' prescriptions. Too much supervision, and too little, are both recipes for disaster.

Fortunately, Locke—and Adam Smith and Franklin and other figures from the pragmatic wing of the Enlightenment—noticed something cool. Something

that had been discussed by Pericles, briefly, more than two millennia earlier (just before the kings and priests and Platonist philosophers brought the curtain down on a 2,000-year dark age). They noticed that you don't need very much repression from above, in order to curb the nasty tendencies in human nature. By and large, with a little help from a benign state, we can do that job ourselves! If common people are empowered with rights—speech, protest, petition, and recourse to law—they will naturally (and eagerly) pounce upon each others' faults, especially whenever they see someone trying to pull some kind of predatory moves.

In theory, reciprocal accountability is about a benign state helping neighbors to cancel out each others' devils, while the better angels of our nature are free to cooperate or compete joyfully, in markets and other "arenas" of human accomplishment.

Sure, any person reading this will shout and point out a myriad ways in which this process is not working well today! But I must answer in two ways. (1) We got to where we are today precisely because this process has worked pretty well, enough times to change the entire sweep of human existence. (2) Your own rapid objections, seeking to correct my error, are examples of this modern reflex. You help to prove my point.

Ironically, one person used this method to pin me with an apparent exception, an apparent failure of reciprocal accountability and transparency to do the good that I keep yattering about. "What about shy people?" she asked? "Transparency may empower them, like everybody else. But shy people don't want to step forward and skewer others with accountability. They don't want to stop peeping toms and big brothers by 'looking back.' They just want to be left alone."

Try as I might, I cannot come up with a glib answer to that one. Except to say that the world of tomorrow needs to be more than just open and free. It will also, eventually, have to be at least a bit polite.

**Jamais:** As I've written about the participatory panopticon, it seems to me that the most profound changes that will emerge from the technologies of transparency have to do with relationships—how we interact with each other. Manners matter when we all have this kind of power, whether we want it or not. So does trust. Privacy gets all of the attention, but the most painful



## JAMAIS CASCIO

is a co-founder of WorldChanging, an IFTF Research Affiliate, and guest editor of this year's *Ten-Year Forecast: Perspectives*. He has been a leading commentator on the participatory panopticon.

RECIPROCAL ACCOUNTABILITY IS ABOUT A BENIGN STATE HELPING NEIGHBORS TO CANCEL OUT EACH OTHERS' DEVILS, WHILE THE BETTER ANGELS OF OUR NATURE ARE FREE TO COOPERATE OR COMPETE JOYFULLY.

changes will have more to do with honesty—or, as you put it, “accountability.”

It's interesting to watch this all emerge. The clash between the pre-panopticon culture and the reciprocal accountability culture will likely be noisy and not always very pleasant for either side. We can see inklings of this with the dismay many older Americans feel about how much teenagers reveal about themselves on sites like MySpace. Dire warnings about employment prospects rub shoulders with moral panics about photos of young people acting like, well, young people. Meanwhile, the folks using these sites, by and large, can't quite see what all the fuss is about. They've internalized a bit of the panopticon culture. Most people writing about this subject seem to assume that, once these young people grow up, they'll be embarrassed by their past exhibitionism. But what if they are not?

“What do you think are the most important dynamics here? Is this technology drive? Is it a result of a growing desire for accountability by those with social power, such as the placement of cameras in police cars to record traffic stops? Or are we backing into it, not quite realizing the impact of things like camera phones?”

**David:** There are so many levels. One is the tendency of all professionals to defend their turf, which is a phenomenon as old as specialization itself. If allowed to take root and metastasize, this natural human drive will result in a myriad barriers erected, telling amateurs and citizens never to do anything for themselves because they are “not qualified.” Certainly this will be applied to the most powerful thing of all, knowledge. And the ability to see. Excuses and rationalizations will abound, for why citizens must not be allowed to see this or that. Eventually, to see anything at all. But, I think it's even better explained at another level. One that I call “the return of the village.”

Seriously, all the stuff you carry in your wallet—credit cards, ID, money—these are all credentials that replace something else that used to suffice in human life, your reputation. During 99% of human generations, we lived mostly in villages and clans and small towns where everyone knew everybody else. That's why most people can identify and “know” about 1,000 to 5,000 people, the maximum number that a gregarious person would have had to know in olden times.

In those days, (as attested to vividly in Shakespeare) your reputation was incredibly important. It reflected your status among those few thousand people who mattered. It determined your ability to buy and sell and to derive the benefits of reciprocal respect, to basically make deals with a hand shake. Modern urban pseudo-anonymity is, by comparison, a recent and uncomfortable innovation, only made possible with countless prosthetic devices. Lenses and cameras that extend vision. Books, libraries, and databases that extend memory. And credentials and money that enhance reputation, turning it into a complex fluid with countless nuanced functions. But they all still boil down to the same thing: “Will all my fellow tribesmen let me have and do and become the things that I want?”

**Jamaïs:** Historically, we haven't done a very good job at making village communities that allow their members to do and become the things that they want. Overwhelming observation has, by and large, been more often used to suppress outside-the-mainstream behavior than to go after the powerful and corrupt. How do you see this emerging world differing?

**David:** You and I are examples of the sort of people who were burned at the stake in almost any other culture. Yet, in this one, we are paid well to poke at the boundaries of the “box.” I'm pretty grateful for that, and for the millions of others like us, who are allowed and encouraged to bicker and compete and criticize. It is a noisy, noisome civilization and its imperfections may yet kill us all. But is so vastly beats all of the neat and tidy ones that came before.

Now we're entering a new era when the village seems about to return. With our senses and memories enhanced prodigiously by new prostheses, suddenly we can “know” the reputations of millions, soon to be billions, of fellow Earth citizens. A tap of your VR eyeglasses will identify any person, along with profiles and alerts, almost as if you had been gossiping about him and her for years.

It's seriously scary prospect and one that is utterly unavoidable. The cities we grew up in were semi-anonymous only because they were primitive. The village is returning. And with it serious, lifelong worry about that state of our reputations. Kids who do not know this are playing with fire. They had better hope that the village will be a nice one. A village that shrugs a lot, and forgives.

**WATCHING ON THE MOVE:  
FROM HAND-HELD TO WEARABLE**

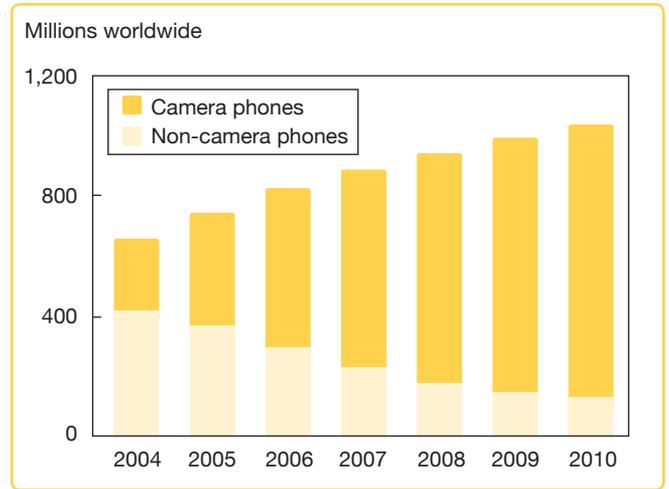
The first commercially available mobile phone with a built-in camera appeared in early 2000, in Japan; and by 2003, camera phones outsold plain digital cameras worldwide. Even if the lenses were small and the image quality most-generously described as “moderate,” camera phones held a singular advantage over other kinds of cameras: the ability to snap a picture and send it immediately to other people. While this feature is most often used for casual social interactions, the combination of immediacy and connection has also been used to great effect by emerging citizen media networks, as well as by everyday people finding themselves in remarkable situations (as exemplified by the widely seen images from the London Underground taken by survivors of the July 7, 2005 bombing).

Increasingly, mobile phone use is less about basic voice communication than the integration of data, images, and *continuous partial attention* — a concept from Linda Stone, founder of the Virtual Worlds Group at Microsoft Research. Buddy lists, location information, multiple “checking-in” text messages, and the like allow users to remain connected to and on the periphery of awareness of their friends, family, and colleagues. As the bandwidth for connection among networked individuals increases, so too will the complexity of this information.

The next step in the evolution of these technologies looks to be life caching—using camera phones and similar technologies to document the sights and sounds of one’s day, and making the observations available to friends, family, and colleagues. Taking advantage of rapidly increasing storage and network capacity, life caching is less about the conscious recording of particular events than about the passive documentation of one’s environment. The vast majority of captured images and sounds will be of little value, but passive acquisition allows a greater chance of catching serendipitous events.

A handheld device is fine for occasional phone calls and quick pictures, but less useful for full-time applications such as life caching. “Wearables” are more promising, and current developers are taking two different approaches: medallions and glasses. Medallions, exemplified by Microsoft’s prototype “wearcam” (part of its highly ambitious MyLifeBits project) is worn around the neck, recording images at chest-level. Glasses, such as the commercial DejaView Camwear, put recording systems on a pair of glasses, so the camera follows head direction. In both cases, the devices are—for now—large and obvious, with limited power and storage capacity. Within the decade, however, we will see much smaller versions with far greater capabilities, likely including recording devices small enough to fit invisibly in glasses, earrings, and other accessories.

**1 CAMERAS WILL BE IN NEARLY ALL MOBILE PHONES BY 2010**



Source: InfoTrends, [www.wirelessmoment.com/statistics\\_camera\\_phones/index.html](http://www.wirelessmoment.com/statistics_camera_phones/index.html)

**2 WEARCAM MEDALLION CAMERA**



This Necklace Dome is a sousveillance device designed to mimic surveillance cameras used in public spaces.

Source: <http://wearcam.org/domewear/neclacedome.htm>

**3 DEJA VIEW'S CAMWEAR HAT AND GLASSES**



A small camera mounted to a hat or glasses allows the wearer to capture all of life’s moments.

Source: <http://stores.skipjack.com/dejaview/Detail.bok?no=27>

## WATCHING YOUR HEALTH: FROM THE BODY TO THE PANOPTICON

Wireless mobile devices are not limited to cameras as sensory input, and even today it's possible to find mobile phone add-ons to measure inputs as widely varied as UV radiation and bad breath. Add to these a host of on-body sensors that can gather real-time data on such things as body chemistry and functioning—plus the ability to use network computers for processing and analysis—and a clear forecast emerges.

An aging population and the increasing drive for individuals to be aware of their own (and their family's) health will put handheld and wearable devices on the frontlines of health care. Current mobile health devices require the active participation of users, but passive detection of body temperature, signs of sickness carried in the breath, and even systems trained to listen for coughs and sneezes will make the phone a commonplace if limited medical monitor. Depending upon the affliction, doctors will be able to provide advice or even treatment using phones as mobile telemedical units. In fact, Swiss researchers in 2004 found that dermatological diagnoses made using camera phone images were nearly as accurate as in-person diagnoses.

Beyond continuous monitoring of individuals, mobile health devices and sensors will prove to be powerful tools for large populations during pandemic disease outbreaks or natural or human-made disasters. We have already seen examples in China in late 2002 and early 2003, where information about the locations of SARS outbreaks was passed along via text messaging. The addition of mapping capabilities, GPS, chemical sensors, and better camera hardware to mobile phones will make amateur information gathering and dissemination in a future emergency much more compelling, detailed, and timely.

Camera phones and other networked mobile sensors will have a more prosaic benefit as well. Currently, services such as MyFoodPhone offer nutritional advice based on camera phone photos of meals; as recording becomes a passive activity, such services will lurk in the background, ready to offer suggestions as needed. Similarly, experimental use of camera phones as ad hoc barcode scanners while shopping points to a world in which consumers can pull up detailed nutritional data. This ability to keep track of the world around us to safeguard our health—whether in extreme or daily situations—may end up being a major driver of the participatory panopticon.

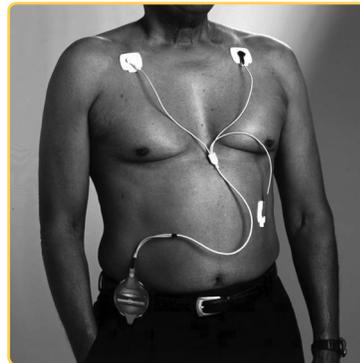
### 4 MYFOODPHONE FROM SPRINT



MyFoodPhone is a camera phone/food journaling service that links individuals with nutrition coaches and advisors. Users can take pictures of meals with their any camera phone and e-mail the pictures to their journal to get feedback from their advisors.

Source: <http://www.myfood-phone.com/index.aspx>

### 5 CADRIONET AMBULATORY CARDIAC MONITOR



CardioNet provides a cardiac monitoring service with real-time analysis, automatic arrhythmia detection, and wireless ECG transmission. Physicians access the telemetry data from the monitoring center to make diagnoses and treatment decisions.

Source: [http://www.cardionet.com/media\\_08.htm](http://www.cardionet.com/media_08.htm)

## WATCHING THE WATCHMEN: FROM SURVEILLANCE TO SOUSVEILLANCE

Perhaps the most disruptive aspect of the participatory panopticon will come in the world of politics.

Advocates of sousveillance suggest that nearly ubiquitous mobile networked cameras will give us a powerful tool for “watching the watchmen”—for enforcing accountability of public officials by creating a broadly accessible record of their actions. Nondigital examples of video recordings used to catch official misbehavior, such as with the Rodney King incident, underscore the power this kind of watchfulness can possess. The Rodney King beating was captured on a single camera; the camera phone version of “Rodney King” will likely be captured by dozens, from myriad perspectives. In principle, the millions of people worldwide carrying camera phones that can record and upload video constitute an army of transparency.

Citizens armed with camera phones will fall into a middle ground between activists and journalists. Already, camera phone users have been able to document momentary lapses, mistakes, and corruption on the part of officials, as well as offer first-on-the-scene recordings of events such as plane crashes and terrorist attacks. Such cases will become commonplace as technology improvements make high-quality passive recording easy and social adaptations make constant documentation of one’s surroundings a broadly accepted, even expected, behavior.

In parts of the world with corrupt and abusive governments, the participatory panopticon will start to tip the balance to favor aware citizenry. At present, camera-using activists face a dangerous period between making their recordings and passing the tapes to friendly organizations: if the tapes are discovered, the activists face dire consequences. The proliferation of wireless networked cameras, however, allows video recordings to move from camera to friendly organization in a matter of seconds. The best-known video-enabled human rights group, WITNESS, has a Web site specifically designed for uploading video.

The uncertainty for the next decade is how those in power will respond to technologies of mutual transparency, or in David Brin’s terms, “reciprocal accountability.” In societies with traditions of free speech and politics, the strongest push-back against these technologies may come in the form of intellectual-property controls. Given the abundance of copyrighted material (both audio and visual) that surrounds us in our daily lives, the ability to passively record the world may be stymied by hardware restrictions—already under discussion—that limit or prevent the background recording of copyrighted content. If participatory panopticon systems are built to respect “digital watermarks” or other signifiers of intellectual-property controls, we should expect to see such restrictions abused by corrupt officials, abusive police, and others seeking to carve out an area of secrecy in an otherwise transparent world.

## 6 CITIZEN REPORTERS: CNN’S I-REPORTS



Source: CNN I-Reports, <http://www.cnn.com/exchange/>

CNN encourages viewers to send in their photos and videos of breaking news stories.

## 7 WITNESS: SEE IT, FILM IT, CHANGE IT



Source: WITNESS, <http://www.witness.org/>

WITNESS uses video and online technologies to open the eyes of the world to human rights violations.

## WATCHING YOUR REPUTATION: FROM FRIENDLY ADVICE TO THE WILD WEST

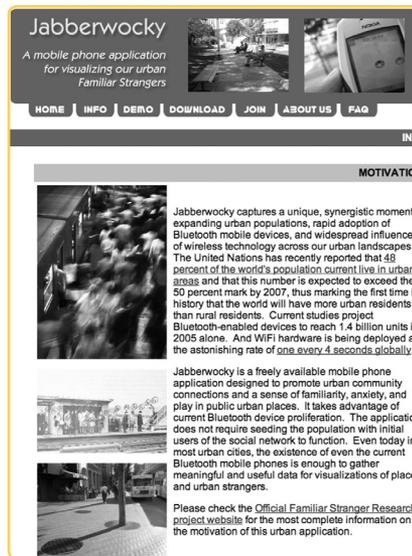
The role of reputation networks will almost certainly become a controversial part of the participatory panopticon as it evolves. Now commonplace online, reputation networks allow users to identify friends, pass along recommendations and warnings, and give ratings to the photos, commentary, or other offerings of peers in the reputation system. Product recommendation software such as Amazon's is another example.

At present, camera phones and similar mobile technologies can serve as tools for a crude reputation network inasmuch as they allow users to send a picture or message to friends asking their opinions of a given product, event, or person. Phone manufacturers or network providers sometimes highlight this aspect of camera phone use in their marketing, illustrating how quickly and easily one can get feedback from friends about a potential date. Arguably, this form of reputation network adds a technological element to otherwise traditional social group activities, augmenting their reach but not providing substantive new capabilities.

The participatory panopticon version of this practice, however, will take advantage of the automated tagging and indexing done by life-caching software. One's personal system will check its recording index, looking for otherwise-forgotten references to a name or face, retrieving useful references or contexts. New faces or names can be similarly checked out by one's broader social network in a semi- or fully automated way, looking in particular for warnings or strong positive recommendations. As with current peer-to-peer cryptographic systems, this reputation network may offer varying levels of trust, restricting how much information about one's contacts to pass along—or even how much to rely on the recommendations of a given peer.

Reputation networks will be the “wild west” of the participatory panopticon, as they'll rely on relatively advanced technology (especially regarding indexing, searching, and potentially facial recognition), and pose many dilemmas around the control of information. Laws concerning libel, privacy, the accuracy of personal information databases—and even ownership of opinions—will need to be re-examined in the light of this technology and its use. Perhaps more importantly, this manifestation of the participatory panopticon will underscore the ways in which social technologies can shake up—for better or for worse—existing relationships and cultural norms.

## 8 THE JABBERWOCKY APPLICATION FOR MOBILE PHONES



Source: <http://www.urban-atmospheres.net/Jabberwocky/info.htm>

The Jabberwocky application tracks “familiar strangers”—people you have passed in daily life but have never actually met. Using digital tags and digital scents, it creates a subtle familiarity index for people in your environment.

# WHAT TO DO

## MARKETING:

### BUILD ECONOMIES ON REPUTATION

In a world where individual behavior can be measured and monitored in lots of different ways, reputation will become an increasingly important “currency”—a way of valuing the social capital of an individual, a company, or perhaps even an entire community. Complex sets of reputation data and equally complex reputation analysis tools may well begin to shift the way markets and even entire economies behave. For example, new pricing models may emerge for health products (and insurance), linking them to healthy behaviors—better behavior gets steeper discounts. And as intangibles are increasingly incorporated into accounting schemes for both communities and corporations, reputation tracking will become a key accounting skill. (See “Finance: Intangible ReformS” for more details on alternate capitals.)

## TECHNOLOGY:

### EXPECT A PANOPLY OF COUNTER-PANOPTICON TOOLS

Even as people embrace a more public and documented life, the demand for counter-surveillance (or sousveillance) tools will likely expand at all levels—from institutions to individuals. The same companies and practices that provide the context-aware environments of the future may find themselves also developing and marketing tools to block some of that context awareness. From surveillance-secure rooms or buildings to tools that can create ad hoc “invisible” spaces, people will turn to technology to address some of the problems that rapidly changing social norms and behaviors cannot. Over time, a complex etiquette of privacy is likely to emerge, not unlike the shifting etiquette of cell phone use.

## COMMUNITIES:

### EXPLORE EMERGING MEANINGS OF “PUBLIC”

Communities are built around the idea of “public”—public spaces, public goods, public identities. Much of the management of communities involves brokering shared agreements about what is considered public and what is not. As the practical experience of privacy is altered by the participatory panopticon, both the meaning of public and the tools for managing what is considered public will shift. The result will likely extend far beyond questions of privacy to basic assumptions about private ownership.

## WHERE TO LOOK

For a look at how “truth” is determined in science, democracy, courts and markets, see Brin’s article in the American Bar Association’s *Journal on Dispute Resolution*, “Disputation Arenas: Harnessing Conflict and Competition for Society’s Benefit” (August 2000).

<http://www.davidbrin.com/disputationarticle1.html>

## WHAT TO PONDER

The implications of the panopticon technologies regarding secrecy and accountability could be dramatic. A world in which someone could be capturing and uploading what you say or do at any time is a world in which it has become much more difficult to get away with lies and misrepresentations. Politicians surrounded by media and citizen cameras at every speech already live in this world; as these tools spread, accountability-by-visibility could begin to apply to people with much lower profiles, including local officials, law enforcement personnel, shopkeepers, business colleagues, and even one’s own spouse or partner.

At the same time, the technologies may also be used to lie in new ways—to give video proof of events that never happened or to “Photoshop” the context, for example. Early examples are celebrity porn sites that appear to show x-rated views of celebrities. Many viewers may not even care whether the photos are “real” or not. To say that such a media environment demands a new level of critical thinking skills perhaps understates the problem; what may be needed is an entirely new way of dealing with uncertainty. (For relevant Perspectives, see “Culture: Digital Natives, Civic Spaces” and “Science: The Next Revolution?”)