THE FUTURE OF IDENTITY

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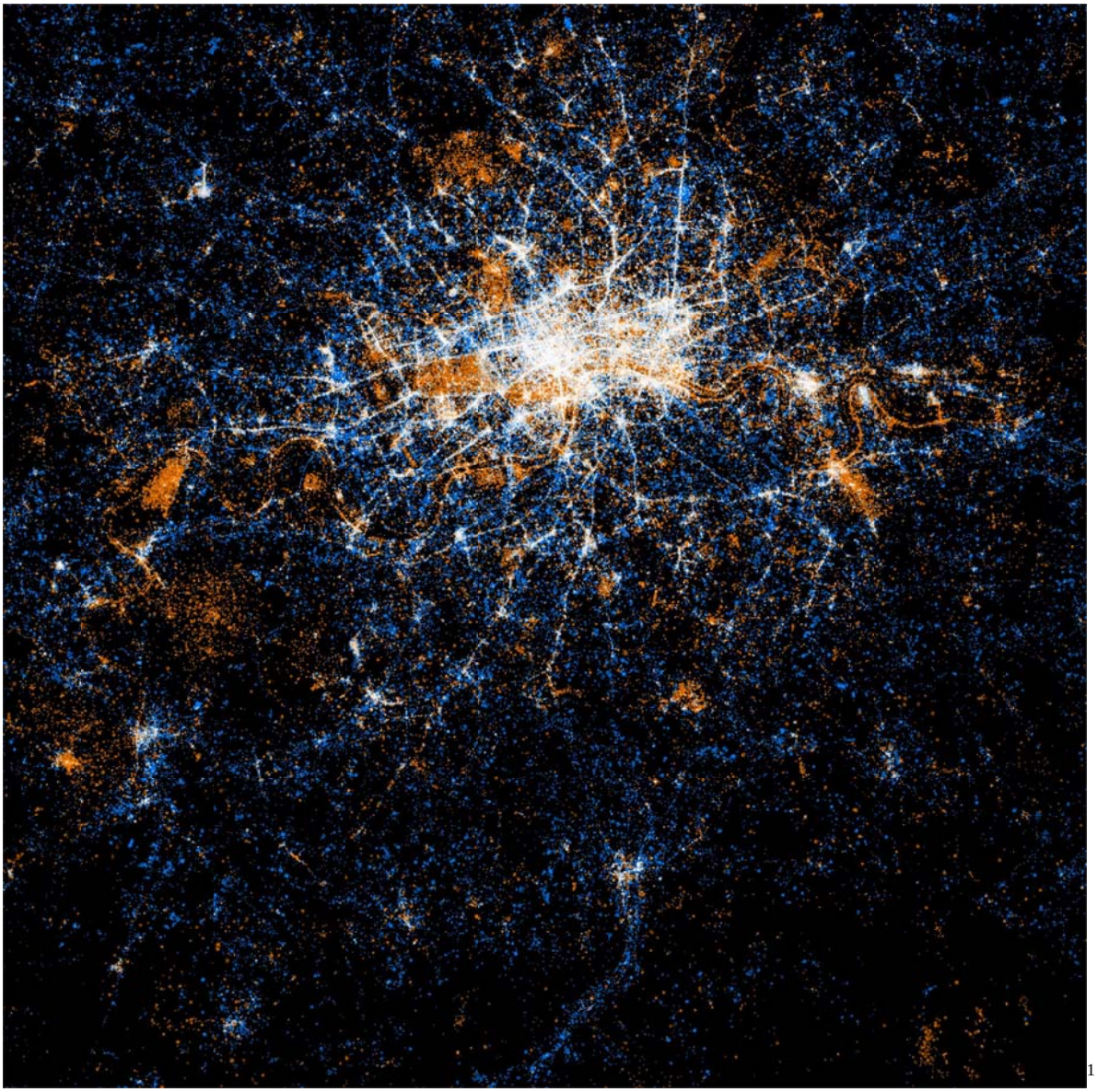 [1]

[1] "See something or say something: London" by Eric Fischer. A map derived from online photographs (orange) and Twitter tweets (blue).

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Executive summary

This paper reviews some of the possible impacts on identity from three broad fields of technological advancement: biotechnology; automation and robotics; and information and communications technologies. It considers a time horizon of 15 years.

Identity is central in human activities. Having a functioning psychological and social identity is essential for wellbeing. Threats to identity are serious threats and often evoke strong reactions. Yet we have multiple, changing identities. Shifting between different social identities in different contexts (jobs, family, friends, etc.) is a necessary part of everyday life. Legal identities are essential for the functioning of modern societies. Increasingly, online identities serve not only to give us access to different resources but also to help us link our different social identities. Technologies that affect how our identities function can have important effects on the individual and on society.

Online identities will be growing rapidly in importance and will raise a plethora of issues. They are sometimes formalizations of social identities but are fundamentally more rigid. This (and the large number of online services) leads to people using multiple identities. Linking multiple identities to a legal identity and across time and domains can cause problems, in the form of breaches of privacy, risks of identity theft, damage to reputations, and reprisals. Gathering identities into **identity metasystems** can solve some of these problems but at the expense of posing new challenges such as border-crossing identity systems of unclear jurisdiction, massive data breaches, and expanding the power of identity providers over the identified and their social interactions.

Virtual worlds – be they online games, **social spaces** or teleconferencing, will grow in reach and use. Users feel strongly about their online identities and want control over them despite weak legal protections. Successful social spaces allow negotiation between users and the maintainers. As online identities become more important it is likely that formal legal protection for them will be needed, yet it will be hard to implement effective enforcement and avoiding strangling social and entrepreneurial creativity.

The augmented world and **exoselves**: In the words of one author, the generation growing up now will "never be alone, never lost, never forget" – the **constant connectivity** holds together social networks regardless of location, **location services** makes everything findable, and **life recording** allows the storage of representations of a large part of life. The resulting extended memory is likely to have significant effects on personal identity: parts of identity will reside in a persistent "exoself" of information and software. Life recording will also likely to synergize with social networking into seamless "**life sharing**". The limits of privacy will be pushed as a generation grows up with this technology. Even if the average person in 2025 is not using full lifelogging, many of the functions being explored today will likely exist in the background of their technology.

Identity technology: Not only humans but objects are gaining persistent, traceable identities. RFID-tags and other methods will give many objects a much richer identity, allowing them to be identified not just as belonging to a category but also as individual objects, possibly without direct touch. Similarly, **biometric identification** and **data fusion** – the combination of evidence from several "senses" – will make automatic remote identification of people easier (especially since they might carry a recognizable constellation of RFID tags and a smartphone). Thanks to rich databases and new probabilistic algorithms, identity resolution (constructing a persistent identity from various records) is increasingly feasible. Such systems can allow wide-ranging transparency and accountability, but also threaten privacy and secrecy. Finding the proper regulation and social norms for a nearly totally identifiable society will be a major process over the next 15 years.

Automation and **robotics** will have broad but diffuse impacts on various aspects of identity, mainly by gradually **changing the nature of work** and impacting labour markets. These effects will represent a continuation of long-term trends that have led to urbanization and to a remarkable growth of the service sectors of advanced economies. Both IT skills and people skills will be in demand on the labour market. **Careers will become**

more fluid, and it will be important for the country to have a work force that is adaptable and that can master new skills as need arises.

A major breakthrough in artificial general intelligence could have extremely profound implications for society and for many aspects of identity; however, this must be regarded as a unlikely possibility within the given 15 year timeframe.

Medicine and personalized health are not only about health but also about the expression of social identities. This function will become increasingly prominent as preventive, diagnostic, and enhancement medicine grow in importance. Eating healthy and exercising – or not – are choices that people make not only because of health effects but also to maintain a certain social identity. Diagnostic medicine (and genomics) will expand the **medicalization of self-conception**. **Enhancement medicine**, too, is focused very much on social identity and self-expression rather than merely on health and biological capacity narrowly construed. It is paramount to consider these identity-related dimensions of medicine if we are to understand how and why people will be consuming health care resources in the future. **Life extension** may lead to new forms of age identities, where people no longer identify with traditional age groups.

Genomics raises many important identity-related issues; in fact, an entire report could be written on these issues alone. Some of the main issues include: (1) changes in self-conception as a result of **knowledge about the personal genome** and how it correlates with life outcomes; (2) general changes in conceptions of human nature and human identity as a result of better understanding genetic causation (advances in neuroscience also act in the same direction); (3) the possibility that genomics will reveal significant differences between ethnic groups (or differences that some will interpret to be significant) - this could have important implications for ethnic identity; (4) **genetic privacy** will become increasingly hard to safeguard, thanks to cheaper gene sequencing and methods such as PCR amplification that allow even a small sample (such as a skin flake or a hair follicle) to produce enough genetic information. This latter implication is especially worth highlighting.

The **medicalization of conception**, **embryo selection**, and (over time) **genetic modification** will have important effects on individuals - most obviously on individuals who would not have come into existence were it not for these procedures, but also on parents whose reproductive lifespan is extended, and eventually on wider society. The more radical possibilities of genetic modification are unlikely to come into significant use within a 15-year timeframe; however, they may become extremely important over the longer term.

Drug-use will continue to be a significant identity-related issue, and it may be joined by new concerns over **novel pharmaceutical neuroagents**. There are speculations that e.g. neuropeptides could be developed that could be distributed as aerosol and used for neurological manipulation.

Invasive **brain-computer interfaces** are unlikely to have widespread impacts on identity within a 15-year horizon. Non-invasive interfaces, such as various brain-scanning techniques, could have important effects if reliable and practicable techniques for detecting deception were to be developed (though this appears somewhat unlikely within the given timeframe). In addition, brain scanning technologies might have effects on public perception through fears about loss of **neural privacy** and as a result of mistaken "**neurohype**".

A long lived, multigenerational society: Longer lifespans will lead to changes in how people regard their identity as aged people, as well as **increased diversity** in how age-related aspects of identity are managed and in cultural expectations. Intergenerational conflicts can erupt if institutions and social norms do not adapt to a generationally, culturally and technologically diverse society.

New technologies may accentuate the **vulnerability** of certain groups: people who are outside identity systems, people who need certain forms of privacy, people unable to handle the growing complexity of identity, people who are victims of identity theft, and people with persistently ruined reputations. Developing methods for **identity rehabilitation** might be important in order to reduce the risk for vulnerable groups.

1. Introduction

This paper reviews some of the possible impacts on identity from three broad fields of technological advancement: biotechnology; automation and robotics; and information and communications technologies. We consider a time horizon of 15 years, with the occasional glance towards development further down the road.

For each of the three areas covered, we briefly review and evaluate technological advances that might plausibly be expected within the 15 year time frame. We then seek to illuminate the potential impacts that these development might have on social identity, and we identify and highlight developments that are of particular relevance for governmental policy and that present novel risks or opportunities for policymakers.

Personal identity being an extremely multifaceted concept, we will not attempt here to furnish an exact definition. We will use the term "identity" to cover a number of loosely related notions, including the self-images and reputational capital of individuals, social and formal identifications, perceptions and prejudices related to social group membership, software representations of identity, and more broadly changing views of human nature. We will accept a degree of indeterminacy in the concept of identity itself, and put the focus on presenting what seems to us the most interesting and policy-relevant insights in the general neighbourhood of the concept of social identity.

The concepts of identity

Identity has many meanings in different domains, and in this report the following are relevant:

Much analysis of identity has been done in philosophy, in particular focusing on identity as persistence of something, as being **definable**, **recognizable** and in particular the issues surrounding personal identity. The philosophy of personal identity is a large field, but some of the key questions include whether there is a **persistent identity over time**, how important **personal continuity** is, the relation between numerical identity (being the same person) and qualitative identity (being similar to a past or future self), the links between our minds and bodies, and whether there even exists a self.

In psychology personal identity is linked to our experience of being someone (a "**core self**") and our sense of being a particular person with a past, future and various attributes (a "**narrative self**"). The narrative identity is gradually built up over the lifespan and plays an important role both in living a meaningful life and fitting into a social context. Both kinds of selves can be impaired or modified in different ways: meditation, certain drugs and the Cotard delusion[2] can change the sense of core self, while amnesia and false memories can transform the narrative self. **Deliberate modification** of the self, using internal and external means is an important part of human life and adapts new technologies rapidly[3]. In fact, it may often be a driver for new technologies – cosmetics, plastic surgery, social media etc.

Psychological identity shades over into **social identity**. Social identity involves aspects such as the different **personas** (social roles) people take on in different contexts, how people identify with **group identities** (as well as sexual, gender, and cultural identities) and how these are used in various forms of expression and affiliation. People maintain a rich structure of social identities, often keeping them separate. Each of these identities has attributes, roles and norms within their social contexts[4].

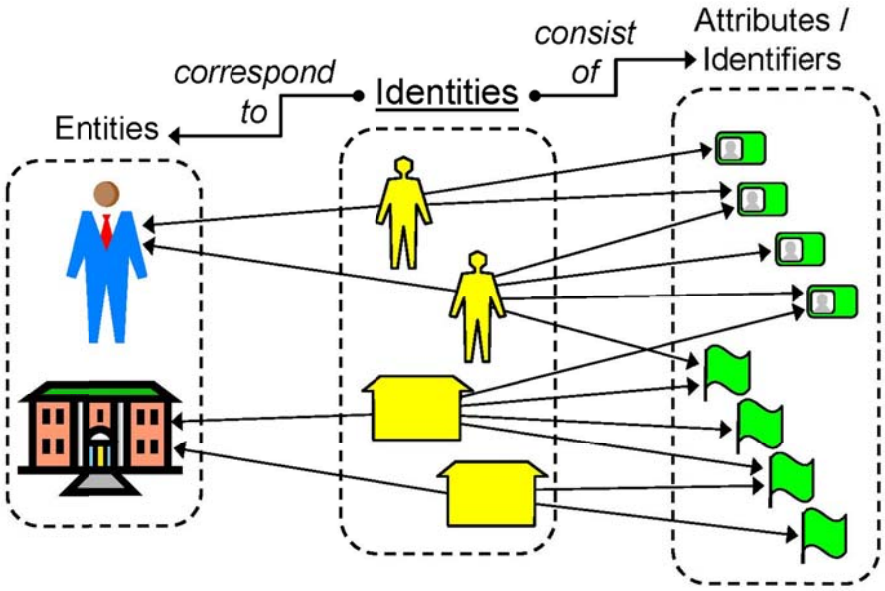
[2] A rare neuropsychiatric disorder where the victim believes that they are dead or do not exist.

[3] Robert J. Weber, *The Created Self*, W.W. Norton & Company, 2001.

[4] Helen Nissenbaum, *Privacy in Context: Technology, Policy, and the Integrity of Social Life*. Stanford University Press, 2009, p. 132

A particular kind of social identity is the **legal identity**, the concept of a (natural) person encompassed by the formal rules of society. An increasing number of people have several legal identities because they live and work in more than one country.

Another important form of identity is **bodily identity**. The assumption that one body belongs to one particular person is often taken for granted and used as the foundation for biometric identification systems. Yet this is not fully guaranteed: psychological identity can change drastically (e.g. fugue states, some religious conversions), biometric properties can sometimes change or be confusing (e.g. people losing their fingerprints or identical twins sharing DNA), and in cyberspace bodies are not available. While the body can be used as a passport for authentication it is also intrinsically linked to many attributes of the person (health, genetics, drug use etc.) and their freedom, making use of bodily identity sensitive in many applications because of the possibility of gaining information or control over the person.



Digital identities are digital representations of real-world entities that link a number of attributes. For example, a computer user's digital identity links a password, an online name, and ownership of various files in such a way that the user can log in to the system using the password and access the files, other users can send messages to the online name and the computer system can keep track of what activities occur related to the digital identity. Digital identities exist within **identity management systems** that keep track of them. **Authentication** is a key aspect of digital (and many other) identities: the ability to assure other entities that one entity really is who they claim to be[5]. This is important since many of the attributes of digital identities can be shared with other identities, although typically within the same system each identity needs to have a distinct, recognizable **identifier**. In the terminology of "the Laws of Identity"[6], **identity providers** supply identifiers and authentication to subjects, which can then be used by **relying parties** (entities that need to know identities, such

[5] Different factors of authentication are used to establish authenticity, typically expressed by the formula "something you know, something you have, or something you are" (for example a password, an ID card, or a fingerprint). Security research has largely concluded that for a positive identification at least two, ideally three, factors should be verified. For an overview of the topic, see Fred Piper, Matt J.B. Robshaw and Scarlet Schwiderski-Grosche, Identities and authentication, Cyber Trust & Crime Prevention Project, UK Foresight 2004, http://www.bis.gov.uk/assets/bispartners/foresight/docs/cyber/identities%20and%20authentication.pdf

[6] Kim Cameron, The Laws of Identity, Microsoft Corporation, 2005,
http://www.identityblog.com/stories/2005/05/13/TheLawsOfIdentity.pdf

as online services). Many local identity management systems can work together to form an interoperable **identity metasystem**, allowing users to manage collections of digital identities.

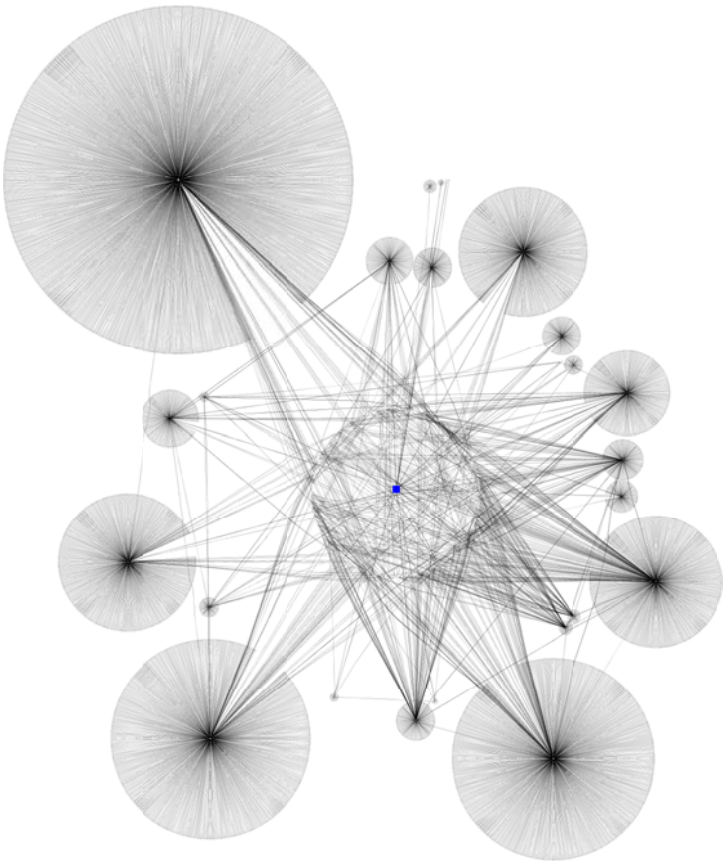
Although the above definitions have been developed to deal with identities in the digital world they have close ties to formal identities in the social world, e.g. the handling of names[7]. As society becomes more reliant on digital processing the distinction between social and digital identities might also diminish. A key issue is whether this allows the digital identities to become as flexible as social identities, or whether there is a risk of social identities to become formal and rigid, forcing us to live in a way we might not desire. There is hence a strong public policy concern that technologies and policies that affect personal identity should allow people to maintain flexible social identities, even if it might be technologically and administratively easier to create systems that forces fixed identities.

[7] Personal names on the surface may appear to be well defined and legally regulated, but in practice they show an amazing diversity (especially in multicultural settings) that make formalizations deeply problematic. See http://www.kalzumeus.com/2010/06/17/falsehoods-programmers-believe-about-names/ for an interesting discussion about the real-world problems of assuming anything about what a personal name "is".

2. Information and communication technologies

The adage "on the Internet nobody knows you are a dog" has always been of doubtful veracity. While modern online media allow a high degree of anonymity and the possibility to set up alternate identities, they also allow new forms of identification, documentation and tracking. Normal intuitions about identity, honed in the social setting of human face-to-face communications and private/public environments, are unreliable online.

Online identities



Social network of contacts and contacts-of-contacts of one of the authors on the photo-sharing site Flickr. While the author has just 25 contacts, they in turn have 4442 contacts. Within this forum identity is mostly defined by shared photographic interests, but it is relatively easy to deduce much personal information from the content of the images, location and time data of where they were shot, and comments made on various topics.

Online identities are becoming increasingly important. Many people in today have a variety of distinct user accounts and online personas. For example, an individual might have a PayPal account, a couple of email addresses, a Facebook or Google+ account, an iTunes account, an eBay account, and subscriptions to various other online products and services, such as the massive multiplayer online roleplaying game World of Warcraft. Many of these identities are interlinked. An email address may be used as a username or password for a number of different online services. A PayPal account will be linked to a bank account, and it might also be tied to an eBay profile, showing the transaction history of the user and the reputation she has acquired as a buyer or seller. The Facebook account might serve to tie together many different communities of which a person is a member, reflecting different aspects of her life – hobbies, sports, friends, family, and work. The World of Warcraft persona may be less integrated with an individual's offline identity, but is at least tied to the customer identity known to Blizzard Entertainment; and the gaming persona may itself have various distinguishable identities as a

participant in guilds and other friendships within the game.Some identities are deliberately fragmented. People regularly try to separate their work email account from their private account, often extending this to phone numbers and other ways of gaining access. Parents often instruct their children to never reveal their real names and addresses online. Online game characters or forum identities may be ways of 'letting off steam', and hence may require keeping them distant from the main social identities of their creator. This is in many ways a natural extension of our existing separate social personas, projected into online media. Maintaining this kind of separation requires not only the right technology but also some social and mental discipline, keeping the personas distinct.

With the proliferation of identities – online as well as offline – growing demands are being placed on identity management systems and on the skills of the citizen. Identity management systems are the software (and institutional) systems that create and keep track of digital identities, as well as connect them to the attributes of their identity (such as resources they can access). These systems can range from simple password protections to complex systems maintaining traceability, data integrity, privacy, preferences, parental and institutional controls and interfaces to other identity management systems. However, unlike social identity management (i.e. how we act among other people) such systems are often inflexible and completely prohibit unplanned uses of identity (which often leads to users finding workarounds that might undermine security) while at the same time missing undesirable activities: they are 'brittle'. There is little doubt that finding better forms of identity management is going to be a major research and investment area over the next decade as more and more people come online across the world and use new kinds of services. There might not just be competitive advantage in the right kind of identity management, but important social effects. For some identities, it is important that they can be tied in a verifiable way to the legal identity of a person. A PayPal account needs to be linked to a bank account, and the user must verify their identity and that they are the holder of the bank account in question. For other identities, the user might prefer that they be dissociated from their legal identity or entirely anonymous. Online anonymity can be an important component of personal privacy. For example, an individual maintaining a blog in which they expresses politically unpopular views, suffering a serious disease, or opinions that are critical of their employer may suffer grave repercussions if they lose the veil of anonymity.

"NightJack": police blogger unmasked

The police blog "NightJack" won the prestigious Orwell Prize for political writing 2009. The blog often expressed critical views related to the police and justice system. The author, a Lancashire detective constable, was unmasked by The Times *after a landmark High Court ruling that stated that blogging was "essentially a public rather than a private activity" and that it was in the public interest to know who originated opinions and arguments. As a result, the constable was disciplined by the police force. This case illustrates the complicated relation between freedom of speech, accountability, anonymity, and risks of reprisals.*

Hiding an identity is an aspect of privacy, but privacy is actually about controlling who can access an identity, not prevent all knowledge of it. Privacy is not absolute – there are sometimes ethical or legal reasons to limit it – but it is often highly desirable that people can control how their identity can be observed or used. Yet, from a practical standpoint enforcing privacy protection can run into the problem of getting the designers of new systems to build it in, making existing widespread systems privacy compliant, handling data that exists in a distributed but collectable form, enforcing the intended protection, avoiding making enforcement so costly that it prevents technological innovation (while Google can afford privacy compliance officers it is unlikely that a small start-up or open source hobby project can), and – perhaps most problematic – making the privacy protection fit the actual social norms of privacy. Given that actual privacy norms vary enormously between groups and develop organically it is likely that any formal system of privacy protection will be lagging social and technological change.

Trouble can also arise from inappropriate linkages between different snapshots of a single identity across time. A teenager may post pictures and make statements that later prove embarrassing – and, as recruitment officers increasingly Google job applicants, even career-hampering. In this case, a problem arises if people regard the earlier online expressions as relevant manifestations of an unchanging character. While information gleaned from researching a candidate online can often be relevant and highly useful, there is also a risk of self-fulfilling prophecies. If the person is shunned by employers because of something they have said or done, they may be unable to establish a track record to rehabilitate their reputation as a good employee. Furthermore, with the increasing persistence of identity-relevant information online, one cannot rely on the past being forgotten; it will, in some cases, instead have to be forgiven[8].

These linkages also include the shadow of the future: in the future much of our present information will be available to people with vastly larger computational resources (making many current forms of encryption or security weak) and different values. While some of the uses they will put our personal information to will be neutral or positive from our perspective, others might not be so benign. Long-lived politicians today have to explain past policies that seemed to make sense at the time they were made but today appear deeply racist; in the future we might be similarly be held accountable for views or activities we currently find entirely moral. Worse, there is no guarantee that this information will not eventually be used by future governments or groups of ill intent. The claim that "if you have done nothing wrong you have nothing to worry about" presupposes that the accepted criteria for 'wrong' will remain the same. The response to this problem might not be to attempt to amplify privacy, but rather to recognize that the need to safeguard open societies and human rights grows with government power over individual lives.

One particularly pernicious current possibility is online character assassination. The practises of libel and slander are as old the human species, but the online world offers new opportunities for their efficient implementation. It is easy to post material online anonymously, and material thus inserted may remain available for a very long time and the proficiency of the search engines will ensure that anybody who looks for information about the victim will be presented with the slanderous assertions. Even if the victim obtains a court injunction it may be difficult to remove the offending material, which might be posted on servers located in foreign jurisdictions. If the false information has spread it may even be impossible for the perpetrator to remove it from the net. There is, however, at least one important mitigating factor: just as the Internet makes it easier to disseminate slander, it also makes it easier to publish a rebuttal and to ensure that it will be seen by the relevant people. Unfortunately smears can be stickier than the truth: developing technologies and habits that help uncover slander is a major challenge for future social technology.

Identity metasystems

[8] The EU Commission draft framework for data protection policies famously states that people have a "right to be forgotten" (or rather, their personal data). The "Social network users' bill of rights" http://cfp.acm.org/wordpress/?p=495 also includes "the right to withdraw". Both documents however assume the personal data resides within the domain of some actor who can obey legal or customer demands. If personal information can be collected or inferred from the other information available online these rights may be of little use. The current legal case against Google in Spain where plaintiffs demand references to them to be removed from the search database is a case in point: even if it succeeds, it will not remove the references from other search engines, or from emerging future tools.
http://news.yahoo.com/s/ap/eu_internet_right_to_be_forgotten

While digital identities within single systems are useful, it is common for people to wish to maintain their identities across many systems and institutions, ideally without having to authenticate themselves in countless different ways (consider the issue of password-re-use). Identity metasystems are interoperable architectures that allow users to manage collections of digital identities. Key roles within the metasystem are identity providers (issues digital identities), relying parties (entities that require identities, such as online services) and subjects (entities about whom identity claims are made, such as users, companies and organisations)[9]. Existing examples are the identification systems sponsored by Microsoft (Passport), Yahoo, Facebook and Google where a single login gives access to many web services. A possible future example would be a metasystem linking a person's legal identity, various email addresses and a bank account so that commercial and government relying parties could transact official business (e.g. paying taxes, making official requests, signing online contracts).

At present few widespread identity metasystems exist. There are economic, technical and legal problems that need to be overcome. A likely scenario is that as society becomes more integrated online the demand for identity metasystems increases (due to the cumbersomeness of fragmented digital identities) and, since there are clear economies of scale, consolidation and competition leads to a few or a single metasystem. These global metasystems could very well be under the control of private foreign companies who would have unprecedented control over digital identity. Government-sponsored metasystems also pose interesting problems, as the globalisation of the digital world would mean many non-citizens would wish to join the national metasystem, essentially becoming digital subjects.

However, past attempts at creating "federate authentication" have often failed, largely due to mismatched incentives between the stakeholders. In particular identity providers need to assume some liability, relying parties need to benefit from the system and users had legitimate worries about a single point of failure – if their master online identity was subverted, they would risk significant trouble[10]. If these issues can be solved (perhaps more a business problem than a technological one[11]) we might see the emergence of global metasystems; if not, online identities will continue to be fragmented.

Sorry, we've spilled your secrets

The October 2007 loss of two disks containing child benefit data is just one example of how large data breaches can occur relatively easily. The discs, containing names, addresses, dates of birth of children, National insurance numbers, and bank details of approximately 25 million people in the UK, were sent by junior staff at HM Revenue and Customs to the National Audit Office as internal mail and were lost. No data fraud or identity theft appears to have occurred as a result of the loss.

In January 2009 a security breach in Heartland Payment Systems (a US company) compromised up to 130 million credit cards. In this case a computer criminal was indicted for the attack, which had a clear profit motive.

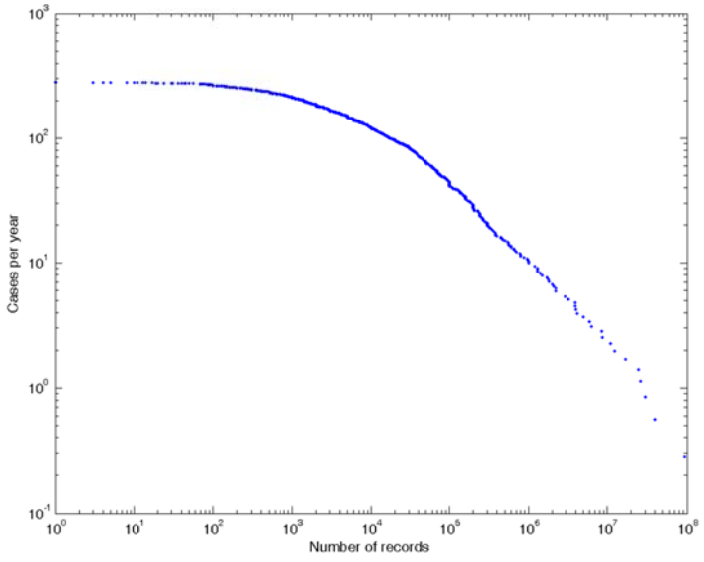
Other data leaks of note are the August 2006 AOL release of 20 million Internet search keywords that could be linked to particular users, the November 2008 leak of full contact details of British National Party activists and the 2010 Wikileaks "Cablegate" of 250,000 US embassy diplomatic cables. Each of these represents the loss of control over important aspects of identity (financial, interests, political views, international association), and were due to simple

9 While this structure was originally proposed by Kim Cameron at Microsoft Corporation (The Laws of Identity, 2005, http://msdn.microsoft.com/en-us/library/ms996456.aspx) and is currently used in various implementations, the concepts of identity providers, relying parties and subjects is useful for our discussion regardless of their origin.

10 Ross Anderson, Can we fix the security economics of federated authentication? http://spw.stca.herts.ac.uk/2.pdf

11 J.D. Lasica, *Identity in the Age of Cloud Computing: The next-generation Internet's impact on business, governance and social interaction*, The Aspen Institute, 2009

Identity providers have a responsibility for managing identities appropriately, especially when they are tied to personal information. But as shown in the figure below, the number of reported incidents where personally identifiable information has been accidentally or maliciously disseminated is very high. Even vast breaches involving tens of million or more people are currently regular occurrences. As larger databases come online[12] and as the number grows of online identities a person possesses, such large breaches will become more common. Identity metasystems might if implemented badly amplify such risks, limiting the usability of global identities and increasing risks for sudden, correlated outbreaks of fraud or sabotage that could affect a society deeply.

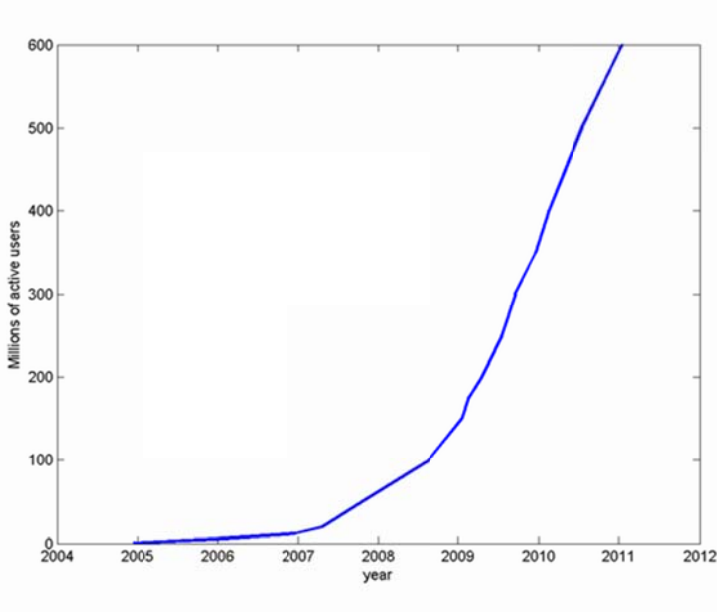


Rate of reported data losses (worldwide) 2005-2009 where personally identifying information has been stolen, lost or accidentally revealed. Data from http://datalossdb.org/

Control over social spaces and identities

Press freedom and ownership of the media are important issues for democracy. Many a dictatorial regime is propped up by subservient state-owned media, and sometimes also by privately owned newspapers and television channels that are controlled by individuals who are close to the regime. With the growing importance of the Internet, online media are becoming essential forums for political debate and activism. Regimes that are under pressure will be tempted to regulate or manipulate these online forums. We will not here discuss the broader issues of censorship, which fall outside the scope of this paper. Attention must be drawn, however, to the issue of the ownership of social space, which is now often concentrated in a few private hands. Approximately one half of the UK population currently uses Facebook (the UK had 26 million users as of July 2010, and this number was rapidly growing). This makes Facebook, a foreign-owned private corporation the current possessor of what is perhaps Britain's largest unified social space for individual and public communication and for the expression of individual identities.

[12] India is planning to issue each of its 1.2 billion citizens with biometric ID, the Multipurpose National Identity Card. http://www.timesonline.co.uk/tol/news/world/asia/article6710764.ece



Active Facebook users[13].

Owners are free to regulate social spaces in numerous ways, controlling both what value is created, and freedom of expression and identity[14]. Overt exclusion of certain people or groups (either by moderators removing them or by disallowing them from signing up) is a crude way. There are many more subtle ways the space can be influenced: controls over the kind of content that can be posted, how identities can be expressed or what information can be linked to what other information. For example, some social spaces for kids have attempted to prevent bullying or sexually explicit messages by forcing communication through a limited pre-set vocabulary. Many online games prevent avatars and usernames seen as unsuitable or copyright infringing. The threat that discussion threads, uploaded material, groups or users can be deleted if they are seen as unsuitable also acts an implicit enforcement of what is perceived to be the unstated rules of the owners. This can limit free expression to 'safe' topics without any formal (or legally challengeable) regulation, just the chilling effects of knowing that one's online identity can be threatened by stepping out of line.

This can include controls on what kinds of identities users express. Facebook and Google+ are at this point of writing increasingly demanding that users prove that their screen names correspond to their real names, especially in cases of unusual handles. This is not just linking online identities closer to legal identities; it also precludes deliberately anonymous or fragmented identities.

Users often feel strongly about their online identities. After strong protests from its users Facebook was forced to cancel plans to retain user data even after they had left the network[15]. Rules governing the use of social spaces are likely to be contested, the more so the greater the space's importance to its users.

[13] Data from http://www.facebook.com/press/info.php?timeline

[14] Greg Lastowka, *Virtual Justice*, Yale University Press, 2010, Peter S. Jenkins, The virtual world as a company town - freedom of speech in massively multiple on-line role playing games, Journal of internet law vol. 8:1, july 2004

[15] http://www.guardian.co.uk/technology/2009/feb/19/facebook-personal-data

Legal protections for users of online sites are often weak. To access online software and services, a user is often required to read and approve a long legal consent form that is presented on the screen. Because of the ubiquity of these forms, their length, and their obscure legal terminology, most Internet users have formed the habit of immediately scrolling to the bottom of these forms and clicking the "I accept these conditions" button, without reading or understanding the text. When the software is updated, the user is often required to indicate their agreement to a new consent form. It becomes impractical for the average user carefully to review everything they agree to in this manner.

Rather than relying on these online consent forms, most users probably rely on the reputation of the service provider as the main guarantor of honesty and service reliability. Major software and Internet firms can be expected to be protective of their reputational capital, and may therefore choose to refrain from openly deceiving or exploiting their user base. However, firms that face decline will sometimes choose to "harvest" their reputational capital by reneging on their implicit contract with their users in order to eke out as much profit as possible before their time is up. Again, the 'shadow of the future' is a relevant problem: while current values and practices are acceptable, they might not remain so.

It is interesting to consider whether the same need for maintaining openness, accountability and user rights as holds for governments applies to social space providers. While it can be argued they are merely providing a commercial service controlled by contract law, the importance of online identities and social spaces might be growing to such an extent that they are equivalent to social goods that must be protected by law. If, for example, one's Facebook or Google identity is necessary for living a normal life in society, then being deprived of it might be equivalent to depriving somebody of a driver's licence or

Social Network Users' Bill of Rights

"*We the users expect social network sites to provide us the following rights in their Terms of Service, Privacy Policies, and implementations of their system:*

1. Honesty: Honor your privacy policy and terms of service

2. Clarity: Make sure that policies, terms of service, and settings are easy to find and understand

3. Freedom of speech: Do not delete or modify my data without a clear policy and justification

4. Empowerment: Support assistive technologies and universal accessibility

5. Self-protection: Support privacy-enhancing technologies

6. Data minimization: Minimize the information I am required to provide and share with others

7. Control: Let me control my data, and don't facilitate sharing it unless I agree first

8. Predictability: Obtain my prior consent before significantly changing who can see my data.

9. Data portability: Make it easy for me to obtain a copy of my data

10. Protection: Treat my data as securely as your own confidential data unless I choose to share it, and notify me if it is compromised

11. Right to know: Show me how you are using my data and allow me to see who and what has access to it.

12. Right to self-define: Let me create more than one identity and use pseudonyms. Do not link them without my permission.

bank accounts – acts that properly are surrounded by legal rules and methods of appeal.

Another situation in which users are vulnerable is when the use of a service creates a strong "lock-in". Identity providers are often in a situation to create considerable lock-in for their users. Once an individual has invested years in developing an identity, adding content to their online profile and building a deep network of friends within the system, it becomes costly for that individual to quit or move to a competitor. Due to natural monopolies for social spaces there might not even be a competitor[16]. Governments sometimes seek to protect their citizens against the dangers of such lock-in and the opportunities for exploitation that it creates. Thus, for example, there are legal protections for tenants, who could face a degree of lock-in once they have moved their belongings and settled into a rented property. There is also legislation, aimed at protecting consumers and stimulating competition, that forces cell phone providers to cooperate with customers who wish to switch provider, making it possible for the customer to keep their telephone number. With the growing importance of online identity providers, demands may arise for similar protections for this new sphere of human activity. (An economic analysis or exploration of possible policy options is, however, beyond the scope of this paper.)

The globalized identity

The potential for alienation from the consequences of our actions is not an issue that pertains specifically to robotics or mediated interaction, but is rather a ubiquitous feature of modern life. To some extent, it may be counteracted by the proliferation of reporting and media, including live streaming video from all parts of the world and social media allowing international social relations. Modern man is tied into a network that spans the world. Our actions as voters, taxpayers, and consumers have consequences that reverberate across the globe; and at the same time, we are to an unprecedented degree able to become aware of this fact. The increasingly common perception of people that they are citizens not just of a city and a nation, but also of an international community is an important change in the self-perception aspect of identity. It is possible that developments in media and social networks, as well as ideological movements, will continue to give increasing salience to this dimension of our existence.

Online identities are often already border-crossing: the identity providers are often foreign companies or organisations, and the actual data storage and processing increasingly occurs in widely dispersed cloud computing. This trend will continue and intensify as the world grows more globalized, barriers of language are weakened by improved automatic translation, and people find new kinds of long-range social relations to fulfil their needs and desires. However, this poses challenges for the current legal system since it tends to assume that people have their activities and identities focused in their country of residence. When these become internationalised many aspects of everyday life fall under foreign or international law, potentially causing hard problems. Besides having private citizens possibly unknowingly performing legally relevant acts in foreign jurisdictions (from trade to sedition), a wide variety of identity providers and relying parties will be handling elements of private identity that in the UK and EU enjoy special legal protections (such as medical information: both Google and Microsoft are running electronic health record services), quite possibly in jurisdictions where they lack protection. Recent instances of libel-tourism in the UK where foreign plaintiffs file libel suits in the UK against people abroad that have only tenuous links to the UK (such as an online publication accessible to the UK public) illustrate how identities and activities suddenly have become global.

These issues are by no means new, but the rapid increase in globalized identities means they will likely become a key point in developing future international agreements. It might simply be that a truly transnational internet and national laws are fundamentally irreconcilable: although some conflicts can be handled (e.g. through country-of-

[16] Most social spaces – games, dating sites, networking services - become more appealing the more members can be reached through them, giving the larger spaces much advantage over smaller ones. The exception is spaces based on exclusivity: here the appeal lies in being a member of a small club it is hard to get into.

destination approaches) the eventual choice will be between globalizing law or breaking up the globalization (and hence much of the utility) of the Internet[17].

Would globalized identities shaped by self-selected peer groups mean weaker loyalties to one's country? At present there is no clear evidence for or against this possibility. Modern communications media allow both long-distance nationalism and transnational lifestyles. Historically nationalism appears to have become a weaker motivator in Western Europe for most people: while people appear to enjoy identifying with groups more than ever, this is more about social affiliation and signalling than traditional loyalty to a social group and its institutions. Everyday life and security is no longer dependent on a strong personal stake in the group, but rather on impersonal formal rules that rarely impinge on life. The challenge for the national state might be that it has to compete with numerous other affiliations on the emotional and social side, and is reduced to a guarantor of legal rights and provider of services on the practical side.

It should be noted that a trend towards weaker nationalism on average does not mean it declines evenly. Some groups may become more nationalistic or loyal to various institutions. The real policy challenge may be to handle a mixture of nationalisms and loyalisms rather than a homogeneous population.

Who sets the Facebook rules?

As a global social space, Facebook is faced with many conflicting demands. The "Saudis in the US" group, a group for Saudi Arabian students in the US was split by gender into a male and a female group after some female members wanted the extra privacy. However, not all members agreed on the split and some felt it infringed on their freedom of expression

http://arabnews.com/saudiarabia/article256543.ece?comments=all.

The Facebook decency code bans exposed breasts, which have led to removing photos of breastfeeding and cancelling the accounts of mothers posting pictures. This is somewhat ironic given the less than zealous removal of a paid advertisement with a topless model.

http://www.dailymail.co.uk/sciencetech/article-1102950/Mothers-protest-Facebook-ban-offensive-breastfeeding-photos.html

Overall, one of the great challenges to a service such as Facebook is that it will serve material to people from cultures that will have significantly different codes of decency, and is

The virtual worlds

Virtual worlds have been predicted for a long time, but unlike the early 90's visions of full immersion virtual reality the virtual worlds that are currently expanding in importance are based on fairly traditional ICT hardware. Social media, online gaming, teleconferencing and other software fields are de facto creating virtual worlds right now, and they are increasingly playing a key role in peoples' lives. They are not so much virtual spaces in the sense of collections of 'places' where one might geometrically move around, but rather social spaces: shared environments of interaction. These can be as simple as the text messages used on online bulletin boards where people maintain local identities as discussion participants, over the fanciful characters inhabiting online games, to business avatars used for teleconferencing virtual environments (such as Second Life and Teleplace) or video meetings sustained with teleconferencing (or more cheaply, Skype). In each such space participants have at least one digital identity, more or less strongly linked to their core identity.

These virtual identities, despite possibly being merely a textual description, can still hold a powerful resonance with their users. Julian Dibbel's by now classic essay "A Rape in Cyberspace"[18] describes how users of an early

[17] Uta Kohl, *Jurisdiction and the Internet: , Regulatory Competence over Online Activity*, Cambridge University press, 2007

text-based virtual environment (a "MUD") were emotionally violated when another user forced their virtual characters into humiliating and explicit situations. "…what happens inside a MUD-made world is neither exactly real nor exactly make-believe, but nonetheless profoundly, compellingly, and emotionally true." Maltreatment of virtual characters can matter in the real world, since there is an emotional link to the "real" person.

Virtual worlds have their own rules set by the software and moderators, but also partially emergent from the social interactions of participants. Rules about identity and presentation are often important: what kind of names may be used, how easy it is to get the real identity of users, what kind of avatars that can be used and the proper procedure for dealing with breaches of the rules (Dibbel's essay also describes the aftermath of the incident, where the virtual community debates the proper punishment for the perpetrator and the "constitutional" implications for the virtual environment). Often a good relationship between moderators and users is essential for a successful system, especially as the users need to view the actions of the moderators and owners as legitimate. These relationships are local to the particular social space, yet the participants might be widely dispersed and subjected to numerous conflicting legal, economic and cultural demands.

Online economies are starting to have real-world effects; just as new forms of communication and personal identity-creation are emerging. Online gaming is becoming a massive industry. People are paying real money for virtual objects or characters. It has been estimated that virtual goods – useful only within particular digital realms – were exchanged to the value of over 2 billion dollars in 2009[19]. Due to the demand a secondary market of "gold farming" has developed: workers in developing countries playing games in order to produce virtual goods that are then sold for real world money[20]. People are getting into legal wrangling over the goods – virtual thefts, property rights, inheritance, currencies and taxation are becoming pertinent issues[21]. Even outside games we have a sizeable number of virtual possessions – family photos, emails, texts, blogs, websites, etc.– that have important emotional value to us and form part of our online and real identities. Many are distributed in social spaces or the cloud worldwide, vulnerable to what the space providers do to them. Digital property rights will likely become a matter of popular concern simply because their aggregate value is rapidly increasing.

The augmented world

Current trends in ICT is leading to a world of wireless, global 24/7 broadband connectivity accessible through portable devices and smart environments where many everyday objects have been supplied with networked abilities ("the internet of things").

In the words of author Charles Stross, the generation growing up right now will "never be alone, never lost, never forget"[22]--- the connectivity holds together social networks regardless of location, users are always findable

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[18] Julian Dibbel, A rape in cyberspace, chapter 1., *My tiny life: Crime and Passion in a Virtual World*, Henry Holt Inc. 1998 http://www.juliandibbell.com/texts/bungle_print.html

[19] Tuukka Lehtiniemi, How Big Is the RMT Market Anyway? Virtual Economy Research Network, http://virtual-economy.org/blog/how_big_is_the_rmt_market_anyw

[20] Richard Heeks, Current Analysis and Future Research Agenda on "Gold Farming": Real- World Production in Developing Countries for the Virtual Economies of Online Games, in Development Informatics working paper, no. 32 Institute for Development Policy and Management, University of Manchester 2008,

21 See Castronova, Edward (2005). *Synthetic Worlds: The Business and Culture of Online Games*. Chicago: The University of Chicago Press, as well as http://blog.practicalethics.ox.ac.uk/2008/10/protectionist-deities-vs-the-economy-of-fun-ownership-of-virtual-possessions/.

22 Charles Stross, LOGIN: 2009 Seattle keynote speech. http://www.antipope.org/charlie/blog-static/2009/05/login-2009-keynote-gaming-in-t.html

and know where they are thanks to location services such as built-in GPS, and the devices are increasingly logging and documenting everything that happens.

This later property is powered by three strong trends: our devices are increasingly recording our lives without our deliberate decision, thanks to the ubiquity of cheap digital sensing and recording mechanisms from digital cameras and email over the accelerometers and other sensors in smartphones to the automatic logging of most computer systems. Cheap storage makes it easier to record everything that could ever be of interest than to try to determine what to store. Retrieval is facilitated by improved technologies for search, analysis, presentation, and sharing of the data[23]. The resulting extended memory is likely to have profound effects on personal identity: parts of identity will reside in a persistent "exoself" of information and software.

Some people have taken up lifelogging, the use of wearable computers to capture continuous data from their lives – video feeds, location, physiological information, etc. Some lifeloggers also store and share their life events on public forums, "life caching"[24], while others are living the "data-driven life"[25] where the ability to measure and monitor performance allows them to become aware of or to change their habits. When the idea originated in the 1990's it required cumbersome and expensive special equipment: today many of these functions can be done by amateurs using slightly modified smartphones; and by 2025, it will likely be an application anybody who chooses can activate. Lifelogging offers many benefits: continuous time monitoring of health, a digital memory that complements the natural memory (being photographic, searchable, and shareable), self-monitoring, and possibly producing a cognitive inheritance.

Living the logged life

The Microsoft research project MyLifeBits is an experiment in lifetime storage, where Gordon Bell has scanned the articles, books, cards, CDs, letters, memos, photos, presentations, home movies, videotaped lectures and voice recordings and stored them digitally. His ongoing information flows (phone calls, instant messaging, television and radio) are being added to this database. The project aims at develop software methods of managing this kind of lifetime data, making it easy to capture, annotate, and integrate it with other software.

Gordon Bell, Jim Gemmell (2009). Total Recall: How the E-Memory Revolution Will Change Everything. Penguin

23 For a popular overview, see Gordon Bell and Jim Gemmell, *Total recall: How the e-memory revolution will change everything*, Dutton, 2009

24 http://trendwatching.com/trends/LIFE_CACHING.htm

25 Gary Wolf, The Data-Driven Life, New York Times, April 28 2010, https://www.nytimes.com/2010/05/02/magazine/02self-measurement-t.html?_r=1

At present researchers are beginning to study the "exposome" - the air pollutants, physical activity and diet of people - using life recording devices[26]. Since self-reporting is notoriously unreliable, direct recording might open new possibilities for epidemiology and environmental medicine as well as self-experimentation. A perhaps even more dramatic example is Professor Deb Roy at the MIT Media Lab, who used cameras and microphones in every room in his home to document when and where every word was said in the vicinity of his infant son. Using this massive corpus of data he is able to visualize and annotate the first two years of the child's life, demonstrating intriguing aspects of language development as well as producing a *total* home video[27].

Life recording will also likely to synergize with social networking to seamless "life sharing". The limits of privacy are likely to be pushed as a generation grows up with this technology. Even if the average person in 2025 is not using full lifelogging many of the functions being explored today will likely exist in the background of their technology.

While lifelogging may promise many desirable forms of personal enhancement and self-knowledge, it also has serious privacy implications. It makes personal lives traceable and might challenge many rules on control over personal and public information. A lifelogger walking down a street is making copies of copyrighted information, silently documenting third parties, and possibly acting as a sensor in a distributed network of whose existence he might not even be aware. Police and other authorities might have reason to demand access to part or the whole of life recordings, which might not only raise privacy concerns but actually correspond in the user's experience to an invasion of *mental* privacy. Employer-mandated (or encouraged) lifelogging during work hours might be required in order to avoid liability. Issues of ownership, spreading and use of lifelog data will expand from the current problems with public photography, cellphone tracking, personal data storage and smart meters.

Please turn off your exoself during start or landing

February 18 2002 Professor Steve Mann at University of Toronto ran afoul of the tightening of airport security in the wake of 911. Professor Mann is one of the pioneers of wearable computing and has for more than 20 years lived with an extensive rig of sensors, computers, displays, and wiring he uses to document his life. The security guards at St. John's International Airport in Newfoundland required a strip-search that led to electrodes being torn from his skin and the disassembly of many components of his rig, leading to the disruption of his "exoself". This in turn led to psychological problems such as concentration difficulties and behaviour changes, according to Professor Mann .

While in this case the conflict was triggered by the unfamiliarity of his equipment (see also (Borrell 2011) for police concerns over visible devices for measuring air pollution in subways) the increasing use and reliance on cameras, smartphones, RFID-, wifi- and Bluetooth-enabled equipment is creating struggles over who has authority to determine the standards of what augmenting technologies are allowed in a space.

Since many of these technologies are going to be increasingly important for everyday life and personal identity, restrictions are going to be experienced as more cumbersome and

26 Brendan Borrell, Epidemiology: Every bite you take, *Nature* 470, 320-322 (2011) http://www.nature.com/news/2011/110216/full/470320a.html

27 http://web.media.mit.edu/~dkroy/

Travels of one of the authors autumn 2010 to spring 2011, automatically logged without his knowledge by his smartphone.

Even people who are not consciously lifelogging might be *de facto* lifelogging. They might discover how dependent they have become upon external systems for their identities and everyday lives when there is a failure or the intrusion of an official request (say, for *everything* they experienced last month). Given how bad people currently are at backing up or securing their current digital possessions despite their growing value, it is not a stretch to guess that there will be numerous private data losses in the future as people lose control over their extended selves. The demand for being able to insure digital possessions will likely increase.

Identity technology

Identity technologies – technologies for automatic detection and logging of who and what is where – are an essential part of the postindustrial infrastructure. RFID-tags allow marked objects to be identified not just as belonging to a category but also as individual objects, possibly without direct touch. Nanotechnology and low-power electronics will allow very small and cheap identification tags that will be incorporated as a matter of course in manufacturing parts – tagging individual pieces of paper has been demonstrated[28], as well as printing parts of the circuits with inkjet printer technology[29]. Besides allowing tracking and identifying objects this might for example allow objects to be self-documenting, stating their physical and chemical properties so that they can be automatically and safely recycled. In the long run many objects might become entirely trackable, constantly data collecting, self-documenting, easily manufactured and recycled "spimes" – less physical things than persistent virtual objects that can manifest when needed[30].

[28] US patent application 20080068169, http://www.freepatentsonline.com/y2008/0068169.html

[29] Li Yang, Amin Rida, Rushi Vyas, and Manos M. Tentzeris, RFID Tag and RF Structures on a Paper Substrate Using Inkjet-Printing Technology, *IEEE transactions on microwave theory and techniques*, vol. 55, no. 12,p. 2894-2901 December 2007

[30] Bruce Sterling (2005). *Shaping Things*. Cambridge, Massachusetts: MIT Press.

Advances in computer image recognition and measurement are likely to make the identity of objects detectable over distance using camera or laser systems[31] even when they have not be specifically prepared. Similarly biometric identification and data fusion – the combination of evidence from several 'senses' – will make automatic remote identification of people easier (especially since they might carry a recognizable constellation of RFID tags and a smartphone). Thanks to rich databases and new probabilistic algorithms identity resolution (constructing a persistent identity from various records, which may be incomplete or conflict) is increasingly feasible[32]. Such systems are currently used in security, but are likely to spread into commercial and private use.

Sources of error (and deception) will persist, but overall it is likely that in many domains 2025 the identity of actors and objects – as well as implied properties such as ownership – can be automatically monitored with a high precision. Anonymity would require deliberate social/legal decisions, cumbersome workarounds or avoiding many areas of life.

This augmented world poses challenging new possibilities and demands in the force field between transparency, privacy, and secrecy. It allows unprecedented forms of transparency through automated documentation – in everyday life, in government, in business. Privacy is harder to maintain due to the ease of documentation, but might hence be regarded as a far more valuable commodity than today. By a similar token secrecy becomes harder to maintain – even the best encryption cannot protect from nearby sensors documenting passphrases and biometrics, and once something has been leaked into the public it is impossible to erase. To strike the proper balance between these factors in different domains will be a major social, legal and political undertaking for the next decade.

Biometrics and the stolen fingerprint

Biometrics attempts to recognize humans from intrinsic physical or behavioural traits.

Many methods are in use. Fingerprints and palm prints have been used for a long time. Hand geometry has been used for automated identification since the 1980s. Retina scanning has also been commercially available since the 1980s. Newer methods include iris recognition and vein matching on other parts of the body. Face and DNA recognition have been heavily investigated. Less studied are ear shape, heartbeat, brain activity and body odour recognition. On the behavioural side methods for recognizing gait, typing rhythms, handwriting and voice have been developed.

Just relying on a single form of identification is insecure, since many kinds can be copied or confused. This is true even for biometric identification: the fingerprint of German home secretary Wolgang Schauble was published by the Chaos Computer Club in Die Datenschleuder *#92 2008 as a protest against his support for biometric identification, together with instructions of how to use it to fool scanners.*

While an ideal biometric ID should be impossible to falsify, practical and economic realities might lead to use of less secure systems. This case also shows the importance of

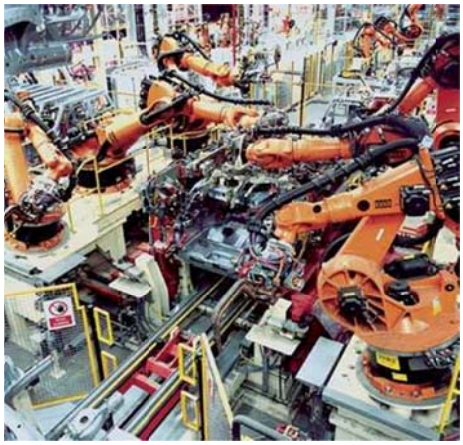
[31] An interesting demonstration is how packaging can be 'fingerprinted' by the speckle pattern produced when a laser scans the individual irregularities of the surface, a pattern that persists after crumpling, scorching, wetting and being scribbled upon. James D. R. Buchanan, Russell P. Cowburn, Ana-Vanessa Jausovec, Dorothée Petit, Peter Seem, Gang Xiong, Del Atkinson, Kate Fenton, Dan A. Allwood & Matthew T. Bryan, Forgery: 'Fingerprinting' documents and packaging, *Nature* 436, 475 (28 July 2005) Russell Cowburn, Laser surface authentication - reading Nature's own security code, *Contemporary Physics*, Volume 49, Issue 5 September 2008 , pages 331 - 342

[32] Jeff Jonas, Threat and Fraud Intelligence, Las Vegas Style, *IEEE Security & Privacy*, November/December 2006 28-34

3. Automation and robotics

Since the industrial revolution, machinery and automation of tasks previously performed by hand have enabled physical capital to substitute for human labour, resulting in dramatic gains in productivity. In the Middle Ages, the vast majority of the adult population of the British Isles were employed in agriculture. Improvements in agricultural productivity freed up labour to work in the new industrial mills of the 18th century. The industrial revolution led to an increase in population and in per capita income, and changed a mainly rural society into a predominantly urban one. All of this has had profound impacts on many aspects of human identity. Over the past half century, the service sector has experienced rapid growth, making the UK a post-industrial economy. According to the Office for National Statistics, the service sector now accounts for 75% of UK Gross Value Added, and for 81% of jobs in the UK. As robotics, automation, and other economically significant innovations continue to transform the labour market, conceptions of human identity will be affected, particularly in relation to work life and education.

A professional identity is more than just a job description: it is a social context that contains roles, relationships and internal values. When working in a capacity we enter a particular social identity. This can be important for self-esteem, but also link to numerous other aspects of our narrative and social identities. Changes or threats to how the profession works are often experienced as challenges of one's identity, leading to resistance or emotional distress.



Automation and robotic technology

A robot is an artificial agent that can perform tasks on its own, based on what it senses of the world. While often depicted as a human-like machine most robots in actual use are non-humanoid and can even be entirely virtual software agents. Approximately 50% of all the robots are in Asia, 32% in Europe, and 16% in North America. Japan alone is home to almost one-third of them, making it the country with the highest number of robots.

Automation means tasks or abilities that can be encoded into software can be reproduced, often at relatively low cost compared to human performance. As new areas become automated, the tasks humans can do shift, affecting both employment and what individuals can do.

Some growing areas of near term automation besides the bourgeoning software business are smart cars (technology is rapidly moving towards augmented driving and self-driving cars, but is facing deep problems in terms of human trust and liability), personal manufacturing (promising everything from enhanced DIY and mass-customization to ephemeralization of many manufacturing industries) and drones (self-driving unmanned vehicles).

Home automation

Household robots and robotic toys will become cheaper and more common. However, physical capabilities of robots affordable to the average household will remain quite limited because of the complexity and price of dextrous, human-scale devices, and hence these may have limited impact on notions of individual and social identity. More capable systems may be developed as prototypes towards the end of the period under consideration, but we are not confident that widely used consumer robotics will be advanced enough to have a profound effect on identity. In particular, we do not foresee any widespread adoption of general assist robots (that one could tell to run some errand) or companion robots (other than possibly for specialized applications such as in eldercare, children's toys, and perhaps niche applications in adult entertainment).

Yet, advances in software, especially natural language processing, may enable many forms of useful software automation that helps everyday life and extends the capabilities of people, such as voice and gesture control of owned equipment. Since many of the most promising forms of language processing relies on statistical learning methods they will be dependent on access to large amounts of data from their users, and may adapt to a large degree to their way of speaking and acting. This makes these advanced interactive systems partial extensions of the self, potentially embodying significant amounts of information about a person and holding both practical, economical (e.g. for marketing) and privacy value.

Autonomous cars

Cars can serve as vehicles of self-expression as well as of transportation, and among the large pieces of machinery that people come into contact with on a day-to-day basis, the car is perhaps the one most closely linked to identity. At the same time cars are increasingly robotic: the different systems are not mechanically linked to the driver but electronically controlled. The development of driverless cars could yield practical advantages in terms of increasing roadway capacity (by reducing congestion through more efficient traffic flow and shorter distances between cars) and in terms of reducing accident rates[33].

However, although driverless cars have long been a staple of science fiction and futuristic scenarios, the introduction of driverless cars in an unstructured environment remains a challenginggoal. While the last decade

33 Cf. http://www.templetons.com/brad/robocars/ and Sebastian Thrun, Toward robotic cars, *Commun. ACM*, 53:4, pp. 99-106

has seen significant progress, no driverless vehicle has yet been approved for use in environments where it would encounter regular human drivers. The DARPA Urban Challenge has demonstrated that robotic cars can work, but it also highlighted how much work remains to be done before the technology is ready for large-scale application. (At least two competitors collided during the challenge, another two stopped in middle of an intersection, and another crashed into a building. Only six of the 35 contestants that entered the race reached the finishing line.) Even if all the technical problems were solved, there would be additional challenges in obtaining regulatory approval for the introduction of driverless cars into the regular road environment[34], and possibly further challenges to gain consumer acceptance. At that point, there would be a further lag before significant portions of the car fleet would have been replaced, since most people purchase cars relatively rarely. For these reasons, it is unlikely that fully driverless cars will be a dominant transport technology within a 15-year time frame[35]. However, cars will grow in sophistication and various assisted driving mechanisms will become more common. Near the end of the timeframe, a transition to robotic cars might be slowly getting underway, with all the complex issues of liability (both for manufacturers and for drivers who decide to go manual), traffic management, privacyconcerns[36], environmental and economic gains, etc.

Unmanned aerial vehicles

One area of robotics which has seen rapid innovation over the last decade is military robotics, including especially unmanned aerial vehicles. Military drones are in constant use in Afghanistan and Pakistan, where they are used both for surveillance purposes and to attack ground targets with missiles. Strictly speaking, the current generation of drone aircraft are not robots, since they controlled by a remote human operator. Defence contractors are however actively researching systems that would be able to operate completely autonomously or have useful "reflexes".

Military drones have already provoked ethical discussion about issues such as responsibility and the potential for collateral damage (as well as concern about the implications of future systems with greater autonomous capabilities).[37] It should be noted that drone technology is already diffusing into law enforcement, posing similar concerns on the domestic level.

One issue that has been highlighted is the potential for psychological distancing and disengagement in the human operator of the drone, which might be situated in a completely ordinary and safe office environment located thousands of miles away from the action[38]. The disengagement can also lead to a shift in locus of control: the operator does no longer regard themselves as the agent controlling the events. Conversely, operators can also suffer from PTSD-like symptoms due to experiences of powerlessness – they can perceive events but not act in any useful way[39]. These problems, of course, are not novel and are not unique to drone warfare. A bomber pilot

[34] The first legal steps are being taken now. For example the Nevada legislature has passed a bill (AB511) authorizing the Nevada Department of Transportation to adopt regulations for driverless cars, likely as a response to Google's push for driverless cars.

[35] Moore, Matthew Michaels and Lu, Beverly, Autonomous Vehicles for Personal Transport: A Technology Assessment (June 2, 2011). Available at SSRN: http://ssrn.com/abstract=1865047

[36] Note that an autonomous vehicle is also a roving sensor battery, and could provide significant information to various parties about anything in their vicinity. The issues discussed in the section about lifelogging apply here too.

37 P.W. Singer, *Wired for war: the robotics revolution and conflict in the 21st century*, Penguin Press, new York, 2009

[38] Lambèr Royakkers and Rinie van Est, The cubicle warrior: the marionette of digitalized warfare, *Ethics and Information Technology*, Volume 12, Number 3, 289-296, 2010

[39] http://edition.cnn.com/2009/WORLD/americas/07/23/wus.warfare.pilots.uav/

dropping bombs from a high altitude is also far removed from the devastation being caused on the ground, and the generals and policy makers that order the war may be at an even greater remove. If future drone systems become more immersive (to counteract these effects and improve performance) another effect might occur: now drone pilots experience themselves as being 'there', and may instead be affected by not being distanced.

Civilian drones are also a likely development due to the potential for small size devices built using widely available technology. They could be used for inspection, telepresence, security, citizen journalism or just as DIY projects[40]. They would obviously spread the issues of security, privacy, safety, distancing, locus of control and responsibility much further than current UAV applications. Setting regulations so that the many socially beneficial uses of drones (e.g. telepresence instead of wasteful business trips) are not blocked out of security fears might be a challenging process, especially if people start to regard drones as extensions of themselves[41].

Professional obsolescence and changing nature of work

There is a long trend of developing machinery to substitute for human labour. In the first wave of substitution, human manual labour was augmented by the power and speed of machines. From the automatic loom to contemporary industrial robotics, mechanical automation has been able to substitute for human manual labour in a wide range of fields, including agriculture, physical manufacturing, transport, and warfare. As a result of such automation, some professions have become entirely obsolete (e.g. weaver, elevator operator) and others have become far less common than they once were (e.g. farmer). In a second wave of substitution, automation has begun to replace human in some more intellectual occupations. For example, word processors have significantly substituted for typists, and computers of the artificial kind substituted for the human "computers" who were once employed *en masse* to perform laborious calculations. At the same time, of course, myriad new professions have been created as a result of automation and other technological progress; and the nature of many professions has also changed as a result.

Because work and profession are traditionally important attributes of individual and social identity, these trends and changes in the character of employment are of considerable significance for the future of identity. People who have spent their carrier working in one profession, and achieving skill and standing in that profession, may perceive that their identity has been undermined or devalued when their profession becomes obsolete, especially when the work they did can be performed by machines. This is most likely to be an issue for those that have taken pride in their line of work and who have invested years or decades attaining a high level of mastery in their profession. Those who mainly see their work as a necessary evil that must be endured in order to earn a livelihood may be less affected *provided* they can secure an alternative source of income.

While automation has often been discussed in relation to robotics and manufacturing, the truly profound effects will likely occur when parts of the service sector can be automated. The service sector currently accounts for around 74% of employment in the United Kingdom.[42] If automation can be done in any way for management or administrative occupations the effects will be far larger than automation of a specific trade since these functions exist in nearly all organisations. This represents a potential hard-to-predict wildcard, likely dependent on

40 http://diydrones.com/

[41] Human body image is surprisingly flexible. It is fairly easy to induce "out of body experiences" using nothing more than a video camera and conflicting bodily stimuli (Bigna Lenggenhager, Tej Tadi, Thomas Metzinger, Olaf Blanke, Video Ergo Sum: Manipulating Bodily Self-Consciousness, *Science* 24 August 2007: Vol. 317 no. 5841 pp. 1096-1099 and H. Henrik Ehrsson, The Experimental Induction of Out-of-Body Experiences, *Science* 24 August 2007: Vol. 317 no. 5841 p. 1048) Since immersive systems for controlling drones have similarities to these experiments it is not inconceivable that at least temporary identification can occur.

[42] http://www.statistics.gov.uk/statbase/Product.asp?vlnk=9333

advances in natural language processing and machine intelligence. Monitoring advances in this direction may give important societal foresight.

Overall, in the presence of improving smart machines we should expect changes on the labour market to accelerate. People are already outliving some professions (and the average lifespan of a company is far shorter than a person's), affecting both the economy and their sense of security. This means that an increased focus on flexibility and retraining will be paramount. Policies protecting occupations may be popular among those influenced, but may put the UK at a competitive disadvantage.

Fluid careers and continuing education

Much government funding focuses on science, technology, engineering, and mathematics (STEM) in the hope of producing new employment opportunities, yet the economy is increasingly becoming service-oriented.

What employers often want are employees that work well with team and have good people skills, that are smart and conscientious, and that have a broad range of experience and a wide range of skills including good literacy and numeracy[43]. A liberal arts education has traditionally been sought not just as a preparation for the job market but also as a way to create a more interesting and well-developed personality. In addition, having a historical and philosophical perspective may provide the recipient with a cultural narrative identity linking them to the environment of their culture. This traditional identity-forming function of education may seem to stand in some tension to the current emphasis on STEM subjects. Perhaps we are minting a generation of overspecialized people who have not gained the necessary social skills and maturity that are needed to fully make use of the constantly changing new economy. Being able to not just acquire knowledge and skills as necessary, but having a big picture of where one is going, could be a crucial competitive trait.

There doesn't have to be a tension: one recent report by the Royal Society sought to describe how STEM has contributed to innovation in the service sector.[44] Its main message was that STEM indirectly nurtures new forms of services beside the more obvious benefits of enabling technologies or building human capital.

It could be that a rethink is needed for what areas need stimulation and foresight in the light of the increasingly fluid market. In particular, it is entirely possible that entire new business sectors can rapidly develop "under the radar", becoming profitable and economically important without the government noticing (a recent example might be the computer games industry, which moved from a fringe software speciality to a major source of revenue, cultural relevance, and economic competitiveness).

Conclusion

Overall, it appears that developments in automation and robotics will have more limited and less direct impacts on identity within the next 15 years than will developments in information and communication technologies. However, indirect impacts can have profound effects by changing the overall structure and ethos of a society. Motorcycles and cars made the population more mobile in the early 20th century, changing their perception about their place in the world and their life chances. A richer society will promote both high expectations of material

[43] http://www.canterbury.ac.uk/support/careers-and-student-development/employability/employability-what-do-employers-want.asp

[44] The Royal Society, *Hidden Wealth: The contribution to service sector innovation*, RS Policy document 09/09, July 2009

security and postmaterialist values. It is hence likely that in the long run automation will affect how we see ourselves, but there is no principled way at present to estimate in what way[45].

[45] This is because cultural evolution has far more degrees of freedom than economic and technological change, in themselves far from predictable domain. It is certainly easy to suggest numerous scenarios, but these mainly express our current preoccupations than embody good analysis of future values.

4. Biotechnology and medicine

Technologies that change the body or its function have high potential to affect personal identity[46]. Over the past 40 years a major synthesis of different branches of biology and medicine has occurred, amplified by computing and modern materials science. It appears very likely that many results of this synthesis will affect life in the future, especially since cultural and demographic factors promote medical solutions to many previously non-medical issues.

Medicine

Preventative and regenerative medicine are of growing importance as health care budgets are strained, populations live longer, and chronic rather than acute conditions become the main medical problems.

Regenerative medicine, triggering the body's own repair mechanisms or culturing replacement tissues outside the body, touches on the identity-affecting issues of transplantation and artificial implants[47] but may circumvent some of their problems such as scarcity (at the price of invoking the controversies of stem cell therapy instead). Effective preventative medicine requires the acquisition of high-quality epidemiological data, something that is both supported by widespread personal augmentation and digital medicine but also involves issues of data ownership and commercialization. Methods of preventative and regenerative medicine also closely mirror performance enhancement in sport, putting further pressure on the distinction between acceptable therapy for the public and for athletes.

A growing issue is medical privacy, as health care records are becoming digital (and hence easily copied), possibly owned by the patients, while methods (and demands for) drug-testing and genetic sequencing are advancing. It is increasingly possible to gather medical information without consent or through apparently innocuous queries. A case in point is using search engine queries for detecting flu outbreaks[48]. While this is data on the population level, other projects are investigating queries indicating STDs or multidrug-resistant TB, where detecting high risk individuals from the queries might be possible and relevant from a public health perspective yet carries significant effects for the identified individual. The "inferential promiscuity" of medical data, combined with the growth in online globalized data sharing, better data mining methods and new forms of medical sensors suggest a situation where different views on medical integrity, national laws, globalization, and rapid technological change will produce major stresses on current policies.

Personalised health

Personalised health fits in with the individualistic trend in society, increasing customisation of technology and services, a plurality of views of what constitutes health, clients considering themselves as health customers rather than patients, and emerging technology that allows both individual diagnosis and treatment. In turn, it drives interest in patient ownership of medical records (allowing them to easily move between health providers), lifestyle or enhancing medicine, and prediction of future health.

Rapid advances in microtechnology have profound effects on the healthcare system. Cheaper, networked, multi-purpose sensors are emerging, turning everyday objects into potential measuring devices and enabling simple

[46] For an overview, see for example David DeGrazia, *Human identity and bioethics*, Cambridge University Press, 2005.

[47] In the early days of transplantation and prosthetics concerns were often raised about how they would affect personal identity. Most of these concerns were unfounded, although some unease still remains with face transplants: J S Swindell, Facial allograft transplantation, personal identity and subjectivity, *J Med Ethics* 2007;33:449-453

[48] Jeremy Ginsberg, Matthew H. Mohebbi, Rajan S. Patel, Lynnette Brammer, Mark S. Smolinski & Larry Brilliant, Detecting influenza epidemics using search engine query data, *Nature* Vol. 457, 19 February 2009, doi:10.1038/nature07634

patient monitoring and telemedicine. Microfluidic lab-on-a-chip systems might produce "labtops" doing the same work as a hospital lab, but portable by GPs and delivering test results rapidly. Rapid gene testing allows pharmacogenomic targeting, so that the right drug is prescribed to the right patient at the right dose. These systems allow radical decentralization and customization of many parts of healthcare.

However, vastly better diagnostic systems can also lead to overdiagnosis: with a sufficient number of measurements at least one will be statistically abnormal. For example, a measured trait such as a blood protein may be counted as abnormal if it is outside the range found in 95% of people. With one measured trait there is a 1 in 20 chance that the person will show an abnormal result. With 10 measurements of different traits the chance of at least one worrying finding will be 40%, and with 30 measurements 79%. Further checks will be needed to tell whether these findings are actual indications of something wrong or merely individual variation.

Worse, medicine is becoming better at detecting conditions than at treating them, producing a growing group of fairly healthy "sick" people. Healthcare expenditures are rising, and it is uncertain whether personalised health will reduce or increase them. In particular, there is the problem of splintered treatment markets: if conditions are split into a number of sub-conditions there is a risk that we end up with a multitude of orphan conditions, too rare to merit development of cost-effective treatments yet with active patient groups demanding it.

Health has become an important part of personal identity, and many people not only strive for health for its practical benefits but as a way of expressing self-control. Keeping a proper diet, exercising, self-medicating or taking charge of one's healthcare needs in one way or another are ways of shaping personal identity (and signalling it to others). Different groups have very different health identities and the gap will likely widen, both in regards to what kind of health they strive for (maximal performance, great sense of well-being, being 'normal', …) and in what ways they try to achieve this (NHS authorities, alternative medicine, online support groups, self-medication, …). From a public policy perspective, clarity in what kind(s) of health will be publicly provided (and why) will be important for guiding patient expectations and democratic decisions on the health care domain.

Genomics

Carlson.

Methods of sequencing genomes are rapidly falling in price and becoming more accessible. Over the next decade personal genomics will become widespread and create several policy issues. In our culture there is a not uncommon view of the genotype as being a form of 'true self', something that not just shapes one's life and contains traces of ancestry, but actually embodies some form of essential 'genetic identity'. While this view does not work well philosophically (despite being used in international human rights declarations[49]) genetic information does link strongly to important personal attributes such as health, ancestry and identifiability.

Cheap personal genetic testing and sequencing available as mail-order breaks the genetic diagnostic monopoly of the healthcare system, leading to patients aware of some of their genetic risks or strengths. This will affect the information difference between them and insurance companies, health care providers and other bodies. On one hand there is a risk of pre-employment genetic screening or insurance companies discriminating against people with disease-promoting genetic variants (e.g. increased risk for occupational asthma or cancer). There might even be some selection for particular genetic variants, for example in sport[50] or for reduced risk of occupational illness. On the other hand, if insurance companies are prevented from or unable to take part of the information, there is also risk of adverse selection, where people with 'safe' genes do not buy health insurance (increasing the cost for the rest) or people with risky genes buy extra insurance (reducing the margins for insurance companies). The ethics and legal issues surrounding asymmetric genetic information is outside the scope of this report, but is already a major topic in bioethics[51].

It will also contribute and drive the demand for personalised health care. How people will interpret their genetic identities is uncertain. On one hand our individual genomes influence much of our biology and are easy to link to cultural ideas such as traits or personal essence being "in the blood" or even that there is some sort of genetic destiny. On the other hand the relationship between genes and how life turns out is far from deterministic: most genetic variants at most give a slight predisposition towards certain states, and the interaction between genes, environment and life choices can be complex. It is possible that over the next decade the flood of genetic information will lead to many erroneous beliefs about what can be deduced from the data, which then gradually get turned more realistic by experience. This may suggest a future need for public education about genetic information and testing[52].

While much discussion has dealt with individuals gaining genetic knowledge about themselves and whether other institutions (employers, insurance companies, police etc.) have a right to learn about this, personal genetic testing also raises the possibility of gaining genetic knowledge about other people. Each individual leaves countless skin flakes and hair follicles behind every day. Thanks to methods such as PCR amplification even a small sample is enough to produce genetic information. It is hence likely that it will be hard to safeguard "genetic privacy" from non-institutional nosiness. The genetic risks of public figures may soon end up in the hands of tabloids and bloggers.

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[49] N N Gomes de Andrade, "Human Genetic Manipulation and the Right to Identity: The Contradictions of Human Rights Law in Regulating the Human Genome", (2010) 7:3 SCRIPTed 429, http://www.law.ed.ac.uk/ahrc/script-ed/vol7-3/andrade.asp

[50] Matt Scott and Paul Kelso, One club wants to use a gene-test to spot the new Ronaldo. Is this football's future? *The Guardian*, Saturday 26 April 2008 http://www.guardian.co.uk/football/2008/apr/26/genetics

[51] Béatrice Godard, Sandy Raeburn, Marcus Pembrey, Martin Bobrow, Peter Farndon and Ségolène Aymé, Genetic information and testing in insurance and employment: technical, social and ethical issues, *European Journal of Human Genetics* (2003) 11, Suppl 2, S123–S142

[52] For a proactive stance on education about genetic tests, see the report "Increasing options, informing choice" by the Human Genetics Commission, 6 April 2011, http://www.hgc.gov.uk/Client/document.asp?DocId=315&CAtegoryId=10 While this only deals with preconception genetic screening, many of the issues of education to help people make informed choices and avoid stigmatization are relevant for other forms of genetic testing.

Another issue with personal genomics is sharing of genomes. While genetic and medical information is sensitive to healthcare institutions, individuals may choose to make their information public for a variety of reasons. For example, a number of researchers such as James Watson and Steven Pinker[53] have already made their sequences public, and the Personal Genome Project has recruited several thousand volunteers to have their genomes sequenced and made public[54]. Policies attempting to safeguard genetic privacy will have to deal with some individuals relinquishing it. Public sharing of genomes can enable new forms of epidemiology and open research, but also pseudoscientific uses or attempts at defining genetic group identity, "genetic nationalism". It will likely be hard to prevent people from testing themselves or forming misconceptions, but educating against serious fallacies might be possible.

There is also the possibility of significant individual/group differences in behaviour traits (such as cognitive ability) being discovered. At present the academic and political views tend to downplay the relevance of genetic differences to social outcomes, which nicely fits with the values of liberal democracy. As genomics advances politically problematic findings may crop up, apparently challenging the view that all people are equal. For example, intelligence appears to be influenced by hundreds of genes, each only contributing less than a 1% of the total variation[55], making testing for 'geniuses' or smarter groups of people unlikely. However, these early studies have not been large enough to detect the effect of *rare* variants that might have big effects. The Beijing Genomics Institute is currently investigating a large number (1000+) of high performing students, and might discover relatively rare alleles with significant effects or geographic/ethnic differences[56]. Handling the opportunities and conflicts of such results would require special foresight, in particular recognizing the ethical difference between persons and their genomes.

The medicalization of conception

Thanks to contraception sex and reproduction have been separated. The next step is the increasing use of reprogenetic technologies[57], technologies that reduce the role of the vagaries of biology in reproduction. Fertilisation can be controlled in a large variety of ways, and given present trends reproductive technologies are going to become both much more powerful and likely more widespread in the near future.

Gender selection through sperm sorting is already in use, undermining regulations seeking to prevent gender selection[58]. IVF ("test tube babies") is used to deal with an increasing range of fertility problems, and also acts as a cornerstone technology for a number of other technologies with more problematic implications such as PGD (which allows selection for or against traits/illnesses), embryo freezing, cloning and generating sperm or eggs from stem cells. Although such technologies do not allow radical changes to the genetic endowment of children, they do allow some control and have fewer of the drawbacks of germline interventions (see below).

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[53] Steven Pinker, My genome, My Self, *The New York Times*, January 7 2009

[54] http://www.personalgenomes.org/

[55] Craig, I. and R. Plomin (2006). "Quantitative trait loci for IQ and other complex traits: single-nucleotide polymorphism genotyping using pooled DNA and microarrays." *Genes Brain and Behavior* 5: 32-37.

[56] *The Economist*, The dragon's DNA, Jun 17th 2010, http://www.economist.com/node/16349434

[57] See for example Lee Silver, *Remaking Eden*, Harper Perennial, 1998 and Ronald Michael Green, *Babies by design*, Yale University Press, 2007

58 http://www.parliament.uk/documents/post/pn198.pdf

Britain has a relatively low rate of fertility treatment compared to other European countries due to limited NHS funding for treatment (circa 1.5% of all babies born in the UK are born after IVF or ICSI[59]). It is likely it will increase in the future due to high demand and/or that the number of couples going abroad for treatment will increase.

Such fertility techniques are relatively costly, an emotional burden and sometimes invasive, but parents are often highly motivated to have "their own" children. Given the willingness of people to go abroad to conceive if they cannot get the right treatment at home, control over fertility technology is going to be an international issue (obviously complicated by radically different ethical and cultural views even in neighbouring countries). From a personal identity perspective being born from fertility techniques does not appear to have had any untoward effects on IVF babies[60]. Given that children born this way are by definition desired children this might be expected. A larger concern might be the increasing medicalization of reproduction itself, which means parents will turn to medical authorities (and hence, to the government) for assistance with it.

Another important trend may be the change of reproductive span – people are postponing birth due to education, professional choices, and possibly longer lives. This is limited by menopause and concerns about increased risks for complications at higher parental age. With embryo freezing this can partially be ameliorated, but further increases the demand for reproductive technology. Older parents are not in themselves a problem, but we should expect to see different family structures and hence a change in family identity. For example, longer lifespans seem to lead to "beanpole families" with just a few members of each generation but more generations present, while delayed childbearing would reduce the number of generations present and increase the variance of ages of cousins and other parts of the family network. The social effects are hard to predict, but will likely include a further weakening of social bonds to relatives compared to bonds to friends and neighbours. Social institutions relying on strong family bonds will hence be weakened.

Genetically modified humans

Genetic modification is increasingly a standard technology in biomedicine and biotechnology. In the long run this may be a key technology that will change human nature profoundly. However, over the next 15 years its direct impact on personal identity or the human species is likely to be minor. This is largely because of the slow conversion of complex scientific discoveries into usable technologies, as well as the long human generation time: the designer babies of today will just be teenagers in 2026.

Germline genetic engineering, the modification of the genetics of a fertilized embryo, is possible but poses risks to the developing organism in terms of higher risk of abnormal development or spontaneous abortion[61]. Animal models of e.g. improved memory, extra photopigments, slowed ageing, lower cancer and obesity risk, increased strength and running endurance exist [62]. But few, if any, appear to be so radically useful that they would motivate the sizeable extra effort and risk of genetic modification. This is likely to discourage *most* attempts at modifying human embryos in the timeframe since parents are unlikely to want to risk significant side effects or

59 http://www.hfea.gov.uk/2588.html

[60] Henny Bos and Frank van Balen, Children of the new reproductive technologies: Social and genetic parenthood, *Patient Education and Counseling*, Volume 81, Issue 3, December 2010, Pages 429-435, Karin Wagenaar, Mirjam M. van Weissenbruch, Dirk L. Knol, Peggy T. Cohen-Kettenis, Henriette A. Delemarre-van de Waal, Jaap Huisman, Behavior and socioemotional functioning in 9-18-year-old children born after in vitro fertilization, *Fertility and Sterility*, Volume 92, Issue 6, December 2009, Pages 1907-1914

[61] The success rate, the number of embryos that express the new genes, is also a disappointingly low 10% at present. Several fertilized eggs would be needed modified and tested to ensure the birth of a modified child.

62 http://www.aleph.se/andart/archives/2007/11/top_10_genetic_enhancements.html

multiple IVF cycles unless the benefits are perceived as great[63]. The benefits to the child might also not accrue until they are adult, at which time other technological enhancements might provide cheaper and more convenient ways of achieving the benefits. However, as discussed above, other forms of reproductive technologies hold more significant promise.

Somatic genetic engineering ("gene therapy") where an existing person has the genes of some cells altered, has had practical problems in fulfilling expectations, but might develop well over the next decade. Beside therapeutic uses it might be used for enhancement, for example as "gene doping" in sport. This might be cause for health concerns, but does not seem to alter the core self or social identity significantly differently from other forms of enhancement.

Biohacking and biosecurity

Synthetic biology is a rapidly emerging field, drawing both on the advances in biotechnology and the engineering approach to creating controllable, modular systems. It also often draws on the open-source ethic, seeking to give more people access to modifying biology. While this might be of democratic, scientific, and economic benefit, it also implies that potentially dangerous biotechnology will be in more hands. For example, current biohackers are designing modified lactobateria intended to produce vitamin C in the gut[64]: it would not be too hard to use the same mechanism to produce drugs or poisons. Modification of highly infectious agents may raise even greater biosecurity concerns.

Advances in neuroscience may produce substances that affect cognition in manipulative ways. Neuroagents (intended to affect the cognitive abilities of the enemy)[65] are already part of some chemical arsenals, and there is much interest in "less-lethal weapons". Peptides such as oxytocin have some pro-social effects, raising the spectre of chemically supported social cohesion[66]. While full-blown mind control is unlikely, attempts at influencing the minds of the public might occur or be a concern. Conversely, identities based on altered states of mind already exist and more specific neuroagents might enable new forms of 'drug cultures' to form.

Issues of biosecurity such as the risk of bioterrorism and pandemic defence affect people's concerns and views of themselves. The relative benefit of privacy versus perceived risks of biothreats will be hotly debated.

Life extension

[63] It is not unlikely that there will be some "designer babies" born over the next 15 years in the world regardless of these concerns. They are however likely to be rare, and will mainly affect policy by being the focus of initial moral outrage and concern.

[64] Phil McKenna, Rise of the garage genome hackers, *New Scientist*, 7 January 2009

[65] Malcolm Dando, Biologists napping while work militarized, *Nature* 460, 950-951 (20 August 2009)

[66] While often claimed to make people loving and altruistic, it can also strengthen in-group cohesion and competition with people outside the group. See Carsten K. W. De Dreu1, Lindred L. Greer, Michel J. J. Handgraaf, Shaul Shalvi, Gerben A. Van Kleef, Matthijs Baas, Femke S. Ten Velden, Eric Van Dijk and Sander W. W. Feith, The Neuropeptide Oxytocin Regulates Parochial Altruism in Intergroup Conflict Among Humans, *Science* 11 June 2010: Vol. 328 no. 5984 pp. 1408-1411

Life expectancy has been increasing at a fairly steady rate[67]. However, rising uncertainty about future mortality rates have raised concerns among actuaries[68] – the worry is not higher mortality but unexpected longevity. Societies worldwide are transitioning towards a more 'grey' state even without any direct interventions against ageing: if any direct interventions are found this process will likely accelerate. A rapid growth in the knowledge about the causes and biology of ageing has also led to successful artificial modification of lifespan in experimental animals: human applications at some point cannot be ruled out. Life extension might emerge from basic biomedical research, as a "longevity dividend" project seeking to lower healthcare costs by attacking a fundamental cause of many diseases[69], as a direct research focus, or as side effect of other research.

A change of expected lifespan has profound social and individual effects. While the actual spread of any such therapy across society might take a long while, adapting to the implications also will take time. In some cases adaptation can be done ahead: reducing ageism on the job market or in institutions, indexing pension age to life expectancy or health expectancy can be done without assuming life extension will be developed and will have beneficial effects in any case.

[67] Jim Oeppen and James W.Vaupel, Broken Limits to Life Expectancy, *Science*, 296, pp. 1029—1030 10 May 2002

[68] http://www.the-actuary.org.uk/697893

[69] S. Jay Olshansky, Daniel Perry, Richard A. Miller, Robert N. Butler, In pursuit of the longevity dividend: what should we be doing to prepare for the unprecedented aging of humanity, *The Scientist*, March 2006

People and cultures have definite views on what it means to be of a certain age and what social roles they have – teenager, adult, middle aged, retiree, etc. These identities can change, as with the "invention" of the teenager in the 20th century[70]. Changes in life course will likely lead to reinvention of what these ages mean. Today the elderly are increasingly separated into a young-old (65-85), old (75-85), old-old (85-100) and even an elite-old (100+) category[71]. A large population of fairly active elderly are challenging the view of old age as a passive state, often regarding themselves as subjectively decades younger than their chronological age[72]. Some people refuse to accept ageing (social or biological) aiming at "amortality" and fuel the demand for life extension as well as the dissolution of fixed age categories[73]. Institutions and policies based on fixed assumptions about the desires and needs of different age groups will be challenged as people's identities change.

Life extension may prove to be a disruptive technology even if it does not fully appear on the scene. Coming to terms with mortality and setting up a plan for one's life is important for maturing as a person. Many people have invested much emotional capital in their narrative of their future and changes in the outlook can be profoundly unsettling, even when the changes are hopeful or positive[74]. The irony is that many dreaded changes might be less stressful than fervently desired ones. Managing expectations for the future is important both for the individual (in order to avoid disappointment and maintain hope) and for society (in order to balance between hype and dogmatism). Foresight-wise, it might be important to monitor state of the art in life extension so that imminent progress does not surprise decision-makers and the public.

Human enhancement

As a side effect of developments in current curative and preventative medicine methods of enhancing human performance have become increasingly available and show growing power.

Cosmetic enhancement has been a large industry for a long time, and is now increasingly joined by sexual enhancement and personality enhancement (both pharmacological and psychological). Lifestyle medicine aiming at improving well-being and particular life-choices is increasingly accepted, if not regarded as legitimate as curative medicine. Sports enhancement is generally regarded as problematic but the border between performance optimizing sports medicine and illicit doping is blurry. Cognitive enhancement, currently an off-label use of treatments developed for therapy, is in use by healthy students and faculty despite concerns about safety, efficiency and legality[75].

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[70] A common idea in western culture is that in a slowly changing society old people are experienced and can embody useful, socially accepted wisdom, while in a rapidly changing society they can be out of touch, and possess obsolete knowledge and values. However, such theories of the aged are strongly culturally influenced (c.f. Jake Harwood, Howard Giles, Robert M. McCann, Deb Cai, LilnaBeth P. Somera, SikHung Ng, Cynthia Gallois and Kimberly Noels, Older adults' trait ratings of three age-groups around the Pacific rim, *Journal of Cross-Cultural Gerontology*, 16:2, p. 157-171 2001). The actual advantages and disadvantages of age are likely far more complex and individual.

[71] The chronological ages used here are somewhat arbitrary, overlap and different groups – not to mention different elderly! – are using them in different ways.

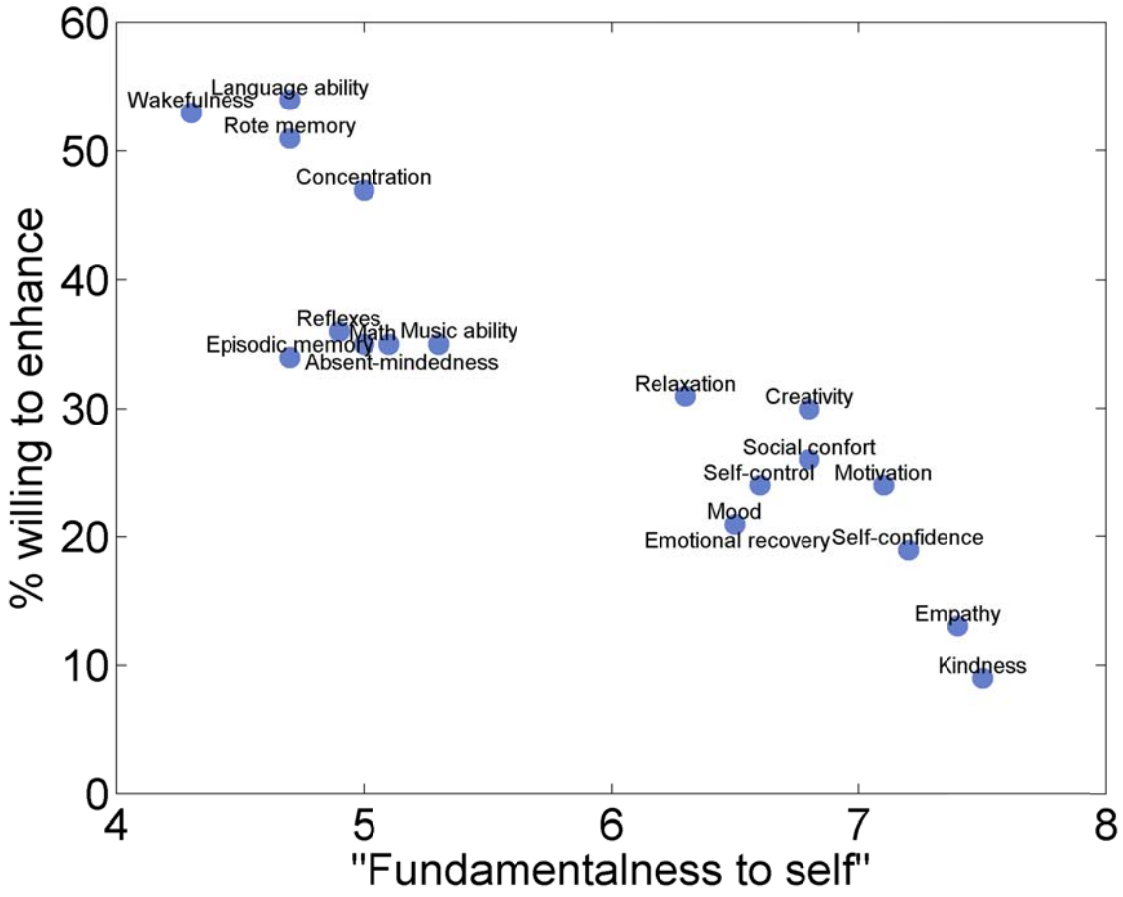
[72] Peter Öberg and Lars Tornstam, Youthfulness and fitness - identity ideals for all ages? *Journal of Aging and Identity*, 6:1, p. 15-29, 2001

[73] Catherine Mayer, 10 ideas changing the world right now: amortality, *Time Magazine*, Mar 12 2009

[74] Aubrey D.N.J de Grey, Life Span Extension Research and Public Debate: Societal Considerations, *Studies in Ethics, Law, and Technology*: Vol. 1, Issue 1, Article 5. 2007 http://www.sens.org/node/507

[75] Roy Jones, Kelly Morris, David Nutt, Cognition Enhancers, Foresight Brain Science, Addiction and Drugs project, 2005 http://www.bis.gov.uk/assets/bispartners/foresight/docs/brain-science/cognition-enhancers.pdf, *Human Enhancement*, ed. Julian Savulescu and Nick Bostrom, Oxford University press 2009

Enhancement includes both improving some existing trait – beauty, self-confidence, endurance or ability to stay awake – and entirely new capabilities such as new senses[76] or changes in appearance that do not correspond to traditional beauty (such as the often deliberately outrageous modifications done in the body modification community). The latter category of extensions are often more closely linked to a desire for self-expression or self-creation than the former, which can often be mainly instrumental: people drink coffee or take a self-esteem course in order to be more alert and feel better, while a split tongue or major tattoo is intended to express or modify the self[77].



Willingness to use a hypothetical enhancer among surveyed students, compared with ratings of how 'fundamental to the self' the different traits were regarded. Data from (Riis, Simmons & Goodwin 2008)

However, people are likely not too interested in enhancement that affects core identity. An illuminating study[78] asked one group of students to rate various traits for how central they were to their sense of self, while another group were asked if they would take a pill that improved these traits. It turned out that there was a strong link between traits being judged as less central to the self (such as alertness, memory ability and language ability) and

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[76] E.g. "magnetic vision" through implanted magnets, http://news.bmezine.com/2004/02/06/the-gift-of-magnetic-vision-the-publishers-ring/

[77] Robert J. Weber, *The Created Self*, W.W. Norton & Company, 2001

[78] Jason Riis, Joseph P. Simmons, Geoffrey P. Goodwin, Preferences for enhancement pharmaceuticals: the reluctance to enhance fundamental traits, *Journal of Consumer Research*, 35, 495-508, 2008

willingness to enhance them, while people were unwilling to enhance traits seen as central to the self (such as empathy and kindness). While the study needs replication, the conclusion is not entirely surprising: we want to improve ourselves, but not change who we think we *really* are. Enhancements that seem to amplify our ability to live the lives we have chosen are going to be more popular than identity-changing enhancements.

Some enhancements might even appear to produce a "better" identity. Some patients quoted in Peter D. Kramer's *Listening to Prozac* (1993) expressed the view that their enhanced selves were their 'true' selves. Molly Young, a student who used the cognitive enhancer Adderall while at university, described her experience as: "Adderall Me and Ideal Me were nearly the same person, and I saw no reason not to dabble in my best self."[79] Under what conditions such self-enhancements actually are authentic self-creation rather than merely the delusion of improvement has been debated in bioethics for some time; the answers are by no means straightforward[80].

Too confident for your own good?

The problem with enhancing apparently useful traits without getting useful results extend beyond biomedical enhancement.

Boosting self-esteem is widely seen as a positive goal and pursued through a variety of psychological and social interventions, from self-help books to government courses.

Yet there might not be an actual benefit to the individual or society from just improving how they feel. Defending an unearned feeling of superiority is a common reason for aggression and bullying. Most boosts to self-esteem also have few lasting effects. Having an accurate self-assessment – and the ability to handle it – is more important than feeling good for building actual self-esteem.

Enhancement is here to stay, but at present there is little consensus on when it is appropriate or safe. It is problematic to regulate since it does not fit into current frameworks of medical regulation (or insurance)[81]. The disease-focused regulatory framework used for medicine will be increasingly challenged by people seeking to improve their well-being (especially in a health care system where people are more customers than patients) or work performance. Treating a sizeable fraction of academics as drug users or 'doped' might be problematic[82], especially if some forms of enhancers provide intellectual and economic benefits to society. Conversely, workplace or cultural pressures to enhance might become excessive. Criteria for proper enhancement use need to be developed, but there is a lack of relevant information about benefits and risks, as well as a lack of integration with changing social norms. Research into the safety and efficacy of enhancers is needed to create policies that reflect real-world practices and promote health.

Implanted identity chips

[79] Molly Young, Kickstart my heart, *N+1 Magazine*, 23 Jan 2008, http://nplusonemag.com/kickstart-my-heart

[80] See for example the contributions in Enhancing Human Traits: ethical and social implications, ed. E. Parens, Washington DC, Georgetown University press 1998, David Degrazia, Prozac, Enhancement and Self-Creation, *The Hastings Center Report*, 30:2 (Mar-Apr 2000) pp. 34-40, and Enhancing Human Capacities, eds. Julian Savulescu, Ruud ter Meulen, Guy Kahane, Wiley-Blackwell, 2011.

[81] Nick Bostrom, Anders Sandberg, Cognitive Enhancement: Methods, Ethics, Regulatory Challenges, *Sci Eng Ethics* (2009) 15:311–341

[82] An informal poll of the scientific journal *Nature* found that about 20% of the respondents had tried cognition enhancing drugs: Brendan Maher, Poll results: look who's doping, *Nature* 452, 674-675 (2008)

Implantable RFID transponder chips already exist and can be used to identify individual humans: a radio signal is received by the transponder, which returns a signal identifying which chip is present. The motivation to approve them for human use (they are widely used for identifying domestic animals) was at least in part to help identify and track elderly with dementia and children, but they can also act as medic alert bracelets linking the person to their medical details in a database and access control in building complexes. While there is no shortage of paranoid fears over the technology there are also a number of amateurs who voluntarily implant transponders as part of 'body hacking'. Transponders are used for VIP access to nightclubs (the futuristic nature of the implant adding to the sense of exclusivity), to control gadgets or even produce music.

While RFID implants may appear sinister, the creative amateur uses suggest that the key issue is rather who controls implantation and access to their information. They are ethically problematic if required for work or otherwise imposed on people, because of their invasiveness, possible health risks and privacy eroding effect (since they cannot easily be turned off)[83]. While the chips might appear to provide a convenient way of establishing identities it has turned out that many models are relatively easily copied or removed, providing an illusory security. Implanted chips are hence likely to remain a form of technophiliac self-expression, while other identity technologies (see the earlier section) allow identification without implants.

Infected by a computer virus

Researchers at Reading University have experimented with implanted RFID transponders on themselves.

One interesting experiment done by Dr Mark N. Gasson involved deliberately placing a computer virus inside the data of his implant, so that if his tag was read by the building system it would infect it. He made himself the first human infected with a computer virus. While a useful reminder of the security issues of this emerging technology, Gasson also points out that it blurs the boundaries of the body of the user. The body of the user includes the transponder, but also in a sense the field of information it projects. Rights of bodily integrity might include the right not to have one's implants be infected by foreign software.

Mark N. Gasson, Human Enhancement: Could you become infected with a computer virus? 2010 IEEE

Brain-computer interfaces and other implants

A set of technologies that are likely to advance significantly over the next decade are methods of reading and interpreting brain activity, interfacing the nervous system to computers and to integrate implanted devices with the body's functions. The current drivers are largely medical needs and basic neuroscience research, although there is some interest from military groups and as experimental computer interfaces.

Brain-computer interfaces can either be invasive, requiring implantation inside the body, or non-invasive, requiring only external equipment.

Invasive BCI

Invasive BCI (multielectrode arrays, optogenetics) may prove very significant to the life quality of relatively small groups of disabled people, but are unlikely within the timeframe of this report to become safe, cheap, and easy

[83] Kenneth R. Foster; Jan Jaeger, Ethical Implications of Implantable Radiofrequency Identification (RFID) Tags in Humans, The *American Journal of Bioethics*, Volume 8, Issue 8, 2008, Pages 44 – 48. More advanced chips can be made user controllable, or external devices can act as privacy managers for the chips on or in a person: Melanie R. Rieback, Bruno Crispo and Andrew S. Tanenbaum, RFID Guardian: A Battery-Powered Mobile Device for RFID Privacy Management, *Information Security and Privacy, Lecture Notes in Computer Science*, 2005, Volume 3574/2005, 259-273

enough to be of much interest to use by healthy people. Implantation of devices within the nervous system will likely remain risky, require expensive medical services, and have somewhat unreliable functionality. Furthermore, learning to use such interfaces (or fine-tuning them to the individual brain of patients) will require significant effort, something healthy people are unlikely to be willing to muster but is in the interest of or even necessary for many disabled people.

A successful example is cochlear implants, allowing deaf people to hear by sending processed auditory information through electrodes in the inner ear. By now over 7000 people in the UK are using them[84] and they are generally regarded as working well enough; yet users need to undergo both surgery and a period of adaptation so that they can interpret the signals[85]. The implants have also highlighted another important effect of new treatments for certain patient groups: the possibly changed capabilities might have complex social consequences. In the case of cochlear implants there are concerns for the future of deaf culture and how they will affect the existing community (including to controversy over whether deaf children to deaf parents should be given implants or not). Other forms of brain-computer interfaces, especially if they affect people's ability to communicate or function in society at large, may have similar social – and hence identity-shaping – effects.

Personalized prosthetic leg, painted by Stuart Vimpani for "Captain Cripple".

However, the advances in prosthetic technology as well as the emergence of movements such as the Open Prosthetics Project, designer prosthetics, sensory substitution, and famous paralympians may lead to not just increased acceptance but a view that such extensions are potentially desirable forms of self-expression and enhancement. One of the key drivers is that increasingly technology allows the democratization and individualization of bodily transformation. The open prosthetics movement aims at "producing useful

[84] http://www.deafnessresearch.org.uk/factsheets/cochlear-implants.pdf

[85] For a personal account of the experience, see Michael Chorost, *Rebuilt: How Becoming Part Computer Made Me More Human*, Houghton Mifflin, 2005

innovations in the field of prosthetics and freely sharing the designs"[86]. It uses an open source approach that was codified and refined within the software community, strengthened by the development of globalized telecommunications allowing users (even when physically distant) to form collaborative projects. Development of personal manufacturing technology[87] also makes it increasingly possible for such groups to not only design prosthetics but to build them. This in turn allows extreme customization, allowing designs to fit the individual and idiosyncratic needs of different users. The "Pimp my Arm" discussion[88] allow users to communicate needs and ideas, not just in terms of basic function but also extensions beyond replacing normal function: prosthetics that "receives and displays text messages from friends, plays mp3s and videos or perhaps acts as a flamethrower." As noted by designer Hiromi Ozaki,

> "It seems logical to think that the design of something so immediate – our body- could be accessible and modifiable by ourselves, but how will those designs evolve outside of science, medicine and military? How will the amateur culture manifest in the design of bodies, will we begin to see prosthetics designed for extremely personal uses, for comfort, obsession, crime, sleaze, curiosity and pleasure?"[89]

Ethicists have been mainly concerned about the ethics of implants that modify identity, especially by changing personality[90]. Personality could be directly affected, or indirectly affected if the implants for example allow increased cognitive abilities that change their perspective on life – obviously this can be a *positive* change in many situations. From a medical ethics perspective, the patient's sense of personal identity and mental continuity is more important than other people's views. But psychological identity is a dynamic structure that needs to be actively maintained. Memory is clearly important for this and memory-affecting technologies can have effects on identity by influencing the narrative

The transparent brain

There exist several non-invasive methods for monitoring brain activity:

EEG is the oldest method, using electrodes on the scalp to record average brain activity. Commodity EEG systems intended for games and mental training exist.

MEG uses the magnetic fields produced by the brain. It shares the time resolution of EEG and can localize activity better, but requires very sensitive magnetic sensors and shielded rooms.

NIRS stands for near infrared spectroscopy and makes use of the fact that the human body is fairly transparent to infrared light, and that different levels of blood oxygenation can be distinguished. NIRS is more portable than some of the other imaging methods but can only image activity on the brain surface.

PET, positron electron tomography, and SPECT, single photon emission computed tomography, makes use of injected radioactive tracers that collect in brain regions that are being used. They require expensive stationary scanners and administration of tracers.

fMRI, functional magnetic resonance imaging, uses strong

86 http://openprosthetics.org/

87 Neil Gershenfeld, *FAB: the coming revolution on your desktop – from personal computers to personal fabrication*, Basic Books, New York, 2005

88 https://groups.google.com/group/openprosthetics/web/pimp-my-arm?pli=1

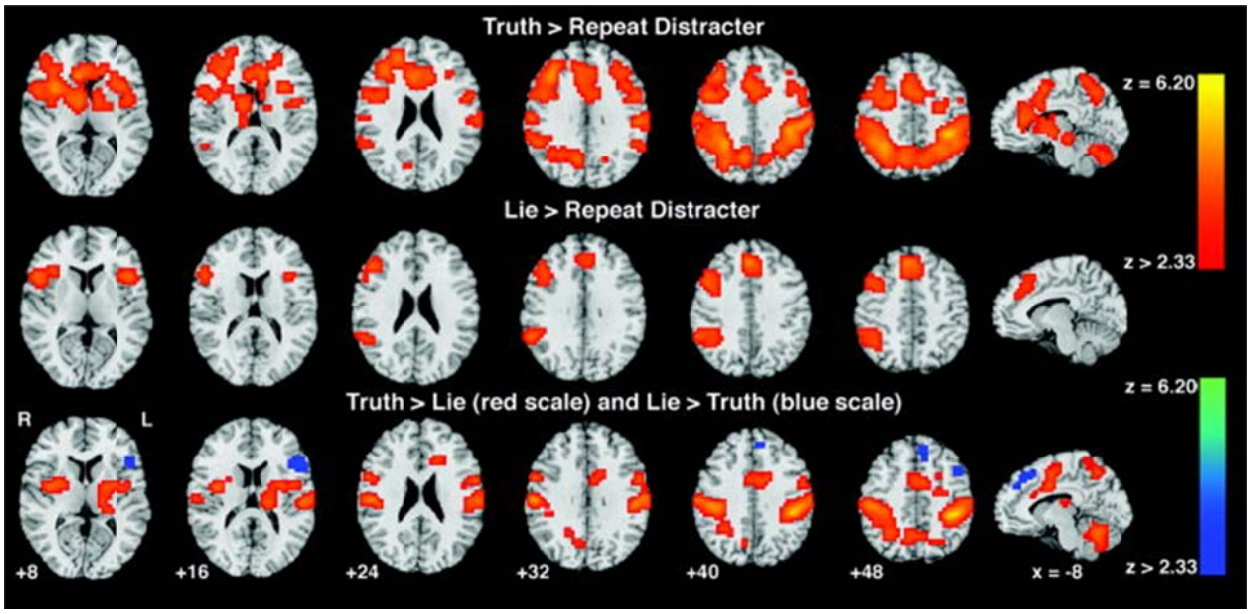
89 http://www.sputniko.com/works/sputniko/penis-cybernetique

90 S.O. Hansson, *Implant Ethics*, J Med Ethics 2005, 31 519-525

identity[91]. But identity also hinges on interaction with one's environment and other people, so implants or other treatments that affect abilities to communicate and interact with the environment will affect identity[92]. Even the non-neural customized prosthetics described above have an important identity creating role in allowing self-expression and gaining control over one's daily life.

Non-invasive BCI

Non-invasive BCI (EEG, MEG, NIRS, fMRI, etc.) is relatively limited due to bandwidth, noise, and resolution issues. Typically, there is a firm trade-off between how much information per second can be acquired, the reliability and user controllability of this information, and whether it can be recorded from the right brain areas. While portable EEG devices for computer interface are already sold, it is unlikely that they will be very popular beyond novelty use due to the difficulty of use (except, as above, for helping disabled people communicate or control equipment). There are no technologies on the current horizon that would enable deep high resolution scanning in a portable way.



Areas showing more activation when test subjects were telling truth (top) or lying (middle) compared to a distraction task. The lower row shows brain areas where activity suggests that the subject is being truthful (red) or untruthful (blue). From Daniel D. Langleben, James W. Loughead, Warren B. Bilker, Kosha Ruparel, Anna Rose Childress, Samantha I. Busch, Ruben C. Gur, Telling truth from lie in individual subjects with fast event-related fMRI, *Human Brain Mapping*, Volume 26, Issue 4, pages 262–272, December 2005

However, in controlled settings non-invasive BCI is likely to be increasingly widely used to discover not just medical or scientific information but for other purposes, such as neuromarketing, deception detection, biometrics, and personal identification or characterization.[93] For example, by detecting particular brainwave patterns corresponding to processing known or relevant information versus patterns for unknown or irrelevant information, it might be possible to identify whether a subject recognizes or knows something about certain pictures. Such systems have already been used in criminal cases in the US and India, despite strong criticism

[91] S. Matthew Liao, Anders Sandberg, The normativity of memory modification, *Neuroethics*, 1:85-99, 2008

[92] J. Clausen, Moving minds: ethical aspects of neural motor prostheses, *Biotechnol J.* 3(12) 1493-1501, 2008.

[93] John-Dylan Haynes & Geraint Rees, Decoding mental states from brain activity in humans, *Nature Reviews Neuroscience* 7, 523-534 (July 2006)

from experts[94]. Other studies have decoded which drink test subjects preferred by measuring brain activity[95], levels of pain in a civil lawsuit plaintiff[96], viewed images[97], racial attitudes[98] or political orientation[99].

It might be possible to identify which individuals can perform optimally in demanding environments such as athletics or military combat[100], or might behave in a discriminatory way[101]. This suggests that some neurotechnologies might be used for selecting people for jobs, in turn raising worries of "neural discrimination". If the method is actually accurate in estimating future performance this selection is legitimate, but given the past track record of faddish job selection methods and the wide range of human neural variability there are good reasons to be sceptical until strong evidence is found.

These possibilities raises issues of both "neural privacy" and "neurohype" – people's right to maintain a private mental sphere, and the tendency to use results or technologies with weak scientific support (see below).

Turning off critical thinking

Neuroimaging (like much science) is held in high esteem, and claims that a conclusion is supported by neuroscience are often accepted uncritically. A good example is a study by David P. McCabe and Alan. D. Castel , where versions of a fictional scientific article without illustrations, with irrelevant bar charts or with irrelevant brain images were shown to undergraduate students who were then asked to rate the soundness of reasoning in the articles. The general effect of the irrelevant brain images was to increase the ratings of soundness, despite them having nothing to do with the argument.

While a more critical view of neuroimaging evidence will no doubt develop as society gains more practical experience with it, this process will be slow and in the meantime many overconfident individual and collective decisions will be based on weak neuroscientific evidence.

David P. McCabe, Alan D. Castel, Seeing is believing: the effect of brain images on judgments of scientific reasoning, Cognition, 107:1, pp. 343-352, April 2008

94 http://www.nytimes.com/2008/09/15/world/asia/15iht-15brainscan.16148673.html?_r=1. See also Dickson, K. & McMahon, M. Will the law come running? The potential role of 'brain fingerprinting' in crime investigation and adjudication in Australia. *J. Law Med.* 13, 204–222 (2005). See also Ganis G, Rosenfeld JP, Meixner J, Kievit RA, & Schendan HE (2010). Lying in the scanner: Covert countermeasures disrupt deception detection by functional magnetic resonance imaging. *NeuroImage* PMID: 21111834 which demonstrates that is possible to train oneself to counter a putative deception detection scan.

95 Sheena Luu& Tom Chau, Decoding subjective preference from single-trial near-infrared spectroscopy signals, *Journal of Neural Engineering*, 6:1 0160032009

96 Greg Miller, Brain scans of pain raise questions for the law, *Science* 9 January 2009, 323:5911, 195 2009

97 Miyawaki, Y. et al (2008). Visual Image Reconstruction from Human Brain Activity using a Combination of Multiscale Local Image Decoders. *Neuron* 60: 915-929.

98 Phelps, E. A. et al. Performance on indirect measures of race evaluation predicts amygdala activation. *J. Cogn. Neurosci.* 12, 729–738 (2000).

99 Zamboni G, Gozzi M, Krueger F, Duhamel JR, Sirigu A, Grafman J., Individualism, conservatism, and radicalism as criteria for processing political beliefs: a parametric fMRI study. *Soc. Neurosci.* 2009;4(5):367-83.

100 Martin P. Paulusa, Eric G. Potterat, Marcus K. Taylor, Karl F. Van Orden, James Bauman, Nausheen Momen, Genieleah A. Padilla, and Judith L. Swain, A neuroscience approach to optimizing brain resources for human performance in extreme environments, *Neuroscience & Biobehavioral Reviews* Volume 33, Issue 7, July 2009, Pages 1080-1088

101 Allen R. McConnell and Jill M. Leibold, Relations among the Implicit Association Test, Discriminatory Behavior, and Explicit Measures of Racial Attitudes, *Journal of Experimental Social Psychology*, Volume 37, Issue 5, September 2001, Pages 435-442. Strictly speaking, the Implicit Association Test is not based on a typical brain-computer interface, just automated measurement of reaction times to words and images. However, detection of micro-behavioral variations poses the same kind of concerns about neurohype and mental privacy as BCI. In addition, it looks at behavior rather than conceptually uncertain mental states, and can sometimes be made more unobtrusive (e.g. by embedding in other software).

Cognitive technology, neural privacy, and neurohype

While brain interfaces and imaging are the most dramatic examples of how the brain is becoming more transparent there are many other fruits of cognitive science that might prove useful.

There is growing interest in using cognitive science in social domains. There are many calls for using it to improve education[102]. Happiness research has been claimed to be relevant for guiding public policy[103]. Neuromarketing attempts to ground marketing in neural responses, while neuroeconomics looks at how economical activities are reflected in the brain. The neuroscience of ethics attempts similar understanding of how ethical thinking and decision-making is done in the brain. Such research might lead to improved understanding of decision-making, as well as better methods of manipulating it.

Human decision-making has many biases and quirks due to our evolutionary past and the practical limitations of thinking, some which lead to systematic mistakes that impair our ability to live happy lives[104] or cause significant economic losses[105]. "Nudging", exploiting cognitive biases or other aspects of human decision-making in order to achieve certain ends, is currently popular as a component of "soft paternalism" where people are biased towards desirable choices but in principle free to choose differently[106]. Better manipulation techniques are however morally problematic because they circumvent the conscious, (partially) rational decision-making of people, raising issues of how responsible they are for decisions they have made under the influence of effective persuasion. Is my decision truly mine if it would not have happened unless a particular nudge had come by? Can I foist responsibility onto the people or organisations that deliberately influence my behaviour?

Over the next decade cognitive technology will improve and various applications will mature. However, there is a significant risk that many such applications will be based on mistaken ideas or overhyped technology.

Materialist/computationalist folk theories of mind appear to be growing in popularity, largely due to the flood of emerging neuroscience and the apparent explanatory power of it. Neuroimaging is often seen as giving direct evidence of mental states. This can lead to mistaken beliefs (both among the public and in government) about what is known about the mind and the individual, its implications, as well as how much it can be changed. Blaming brain states ("my serotonin is too low", "school children are not developing their mirror neurons enough to be empathic") can medicalize policy discussions without contributing much. At the same time, better understanding of the basis of human behaviour could possibly produce important insights that might affect policy – but such insights could clash with traditional values or folk psychology. For example, effective treatments for criminal recidivism might appear like rewarding criminals, running counter to concepts of fairness and retribution.

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[102] Usha Goswami, Neuroscience and education: from research to practice? *Nature Reviews Neuroscience* 7, 406-413 (May 2006)

[103] Richard Layard, *Happiness: Lessons from a New Science*, 2nd ed., Penguin 2006

[104] Hsee, Christopher K.; Reid Hastie (2006), Decision and experience: why don't we choose what makes us happy?, *Trends in Cognitive Sciences* **10** (1): 31–37

[105] Estimates of the cost of mistakes in the oil industry due to cognitive biases suggests they can run into hundreds of millions of dollars per project. M.B. Welsh, S.H. Begg,and R.B. Bratvold, Modeling the Economic Impact of Cognitive Biases on Oil and Gas Decisions, SPE Annual Technical Conference and Exhibition, 11-14 November 2007, Anaheim, California, U.S.A.

[106] Richard H Thaler, Cass R Sunstein, *Nudge: Improving Decisions About Health, Wealth, and Happiness*, Yale University Press 2008

There are many examples where new technology has been sold to government in the UK and elsewhere without having much scientific foundation, especially in regards to deception detection[107]. Resistance to overselling might be low because agencies lack the scientific knowledge to judge claims, and once the system is in use it will acquire a veneer of respectability by association as well as create incentives for suppliers and the agency to claim it was an effective investment. Often the real function of such technology is indirect: by (inaccurately) purporting to have a way of finding out the truth the authorities can increase the likelihood of a subject telling the truth. Since neuroimaging purports to reveal information about the mind and nature of the tested person (what they "really" know, prefer or think) this makes it extra sensitive. An important policy issue is how to ensure that acquisition and use of new neurotechnology will be based on evidence and science, and not just convincing marketing.

Mental privacy is harder to breach than it might first appear because it is not just a technological issue but a fairly involved philosophical problem: the relationship between the subjective contents and working of our minds and our brain activity is complex and conceptually unclear. While we can be confident in great strides in neuroimaging over the next 15 years, there is far less reason to think that these advances will lead to corresponding breakthroughs in the philosophy of mind. This matters because without a firm link between measurable *brain* states and morally/socially important *mind* states, the conclusions drawn from the imaging will lack validity. In the light of the concerns about overconfidence in neuroscience this could lead to problematic abuses where people or groups are discriminated by brain states that will later prove to be irrelevant.

Effective brain imaging methods could make previously private mental states accessible. Detecting deception, preferences and emotions does raise important ethical concerns – in order to function as individuals people need the freedom to consider options and their life freely, even if their actions are morally and socially constrained. Safeguarding the proper use of "mind reading" technology through regulation will be important since it purports to reveal aspects of our true selves.

107 For example, the UK Border Agency's pilot project for DNA and isotope testing for nationality: John Travis, Scientists Decry "Flawed" and "Horrifying" Nationality Tests, U.K. Border Agency Docs and Expanded Reactions, *Science* 29 September 2009 http://news.sciencemag.org/scienceinsider/2009/09/nationality-tes-1.html, the use of voice stress analysis to fight absenteeism, http://blog.practicalethics.ox.ac.uk/2008/05/a-pipeline-to-truth-fighting-absenteeism-with-voice-analysis/ , various forms of electronic voting, deception detection and biometrics.

5. Wildcards

This report has examined mostly technologies that can be reliably predicted, simply because they are already in increasing use or likely results from present research and trends. However, it should be noted that such extrapolations often miss surprising new developments. In fact, given past experience with how technology affects society, we should view it as highly likely that over the next 15 years there will be at least one major transformative technology that will surprise society (and, in retrospect, its importance will appear entirely obvious).

A particular example of a wildcard would be human-level artificial general intelligence, software that can perform most intellectual tasks that humans can. AGI is a game-changer, since it could potentially very rapidly make automation far more powerful and lead to massive geopolitical, economic and social changes as a consequence. At the same time there is no clear way of estimating progress towards the goal: the past 50 years of research has not provided many useful benchmarks. The possibility remains as a problematic (albeit low-probability[108]) wildcard that might occur with relatively little warning.

A reliable deception detection system would be another wildcard. At present the mainstream forensics and cognitive science community have little expectation that such a system could be achieved, as evidenced in the discussion earlier in this report. However, this mainstream view might turn out to be mistaken and a system that gave reliable enough results could appear. Such a system would have radical impacts far outside the obvious law enforcement applications, but exactly how this would affect business, politics, employer-employee relations and social views on ethics is hard to predict. For example, would voters demand to see evidence that politicians truly intend to implement their promises? Would random checks of citizens for harbouring antisocial plans be regarded as desirable? Would restrictions on private use of deception detection be accepted?

Radical life extension is another wildcard. A set of breakthroughs in slowing human ageing could occur, and even with the transition from laboratory to medical practice taking several decades the effects would be important even in the early years. Even if nobody expects life extension but it does occur at some point within (say) the next 50 years, several current cohorts would have a far greater mean lifespan than is currently estimated, since they will benefit from the technology once it arrives. This in turn strongly affects pension planning by increasing the financial risk. Future unpredictable technologies can hence have a potential impact in the present, mainly by increasing the uncertainty about many estimates.

Nanotechnology is, perhaps surprisingly given how often it is mentioned in futurism, less of a wildcard (within the 15-year timeframe), and is better viewed as a driver and enabler of many abovementioned technologies. Nanotechnology will play important roles in many technologies but is not expected in itself to change human identity or society strongly in its early forms. Rather, breakthroughs in nanotechnology speed the pace and the power of other technologies.

Wildcards are hard to plan for, but serve as a useful reminder to planners to retain adaptability to unforeseen and rapidly developing circumstances. Policies that are robust – they work in many possible futures and not just the one expected or desired – are preferable over policies that require certain narrow conditions. Evidence from the research into cognitive bias show that humans typically are overconfident in their own ability to predict the future.

Conversely, expected technologies also cast a "shadow of the future" into the present. Even if a technology does not yet exist, it can be sufficiently plausible or merely expected to affect policies. For example, we currently think we have good reasons to expect much faster computers in the future and hence plan some projects on this assumption. If there is a belief life extension is going to arrive, choices about pension planning would be

[108] Interestingly, even the probability is hard or impossible to estimate. Different experts come to wildly differing estimates and have not shown any tendency to converge.

affected. While wildcards challenge our ability to adapt, expectations are often self-fulfilling prophecies. Managing hype and disappointment is of increasing importance in a media- and communications-saturated society.

6. Some general issues

Generational issues

People live will live longer lives, and will expect to live long lives. This makes them somewhat more long-term oriented[109] and willing to postpone phases of life such as getting a job, forming a family, or retiring. Typically the variance of health and wealth increases with age: some will have accumulated savings, others will be poor, some will be spry, and others have major medical needs. Already age-centred identities appear to be on wane: there is no longer one expected way of being teenager, middle-aged, or elderly. People are inventing new kinds of age-identities.

Longer lives also mean that people from more generations will be living in the same society. They will have dissimilar backgrounds and cultural assumptions as well as different formative experiences. While the difficulty that older people have in learning new technology is often exaggerated, it is not surprising that people of different generations have different social needs and motivations that influence whether they adopt (or abandon) a technology. Since many identity technologies are tied to particular media technologies (such as handwritten signatures, phone numbers, email addresses, Facebook identities, etc.) different patterns of media use will affect what kinds of identity technologies different generations will use or find acceptable. Assumptions that all of society (even ignoring multiculturalism) shares the same intuitions about acceptable levels of e.g. privacy will likely fail. Disagreements between and within generations about which norms are appropriate in different social contexts are also likely.

It is hence important for government and other institutions to be as neutral as possible about what media are used for identity purposes if they want to ensure that all generations will have equal access to their services. How to accommodate the growing diversity of social opinions within an open, pluralistic society is another major challenge for political philosophy and decision-makers.

In a long-lived society, wealth transfer between generations becomes more uneven. Young people tend to have less wealth than older people, and as they age they accumulate capital until they retire. Inheritance from parents occurs increasingly late in life, at which point they give extra capital to people already fairly self-sufficient. In addition, older people – so long as they remain healthy and vigorous in mind and body – sometimes have accumulated human capital (education, skills, social network, impressive CVs, etc.). If they are not seen as impaired due to ageism, poor health, being likely to retire soon or being 'behind the curve', they have some potential advantages on the labour market over young, untried people. Better health means that people can work longer before they retire. These disparities might drive increased inter-generational conflict and demands for new forms of equalisation.

The vulnerable

In any situation vulnerable people are, by definition, disproportionally likely to suffer distress. Vulnerability is typically linked to lack of resources (economic, social, or medical), making them unable to withstand stressors. In the case of identity we can identify several forms of vulnerability:

Identityless people have no formal identity or rely on identities that are not widely recognized. This group includes illegal immigrants, the homeless, and people with no identity documents. Since access to many social functions requires stating an identity, such people are excluded or are forced to rely on others to provide access (and hence become vulnerable to the demands of these gatekeepers).

[109] Fabio Mariani, Agustin Perez-Barahona, Natacha Raffin, Life expectancy and the environment, *IZA Discussion Paper* No. 4564, November 2009, http://ftp.iza.org/dp4564.pdf

Gaining the necessary social identity tokens (a phone number, an address, an email address) often requires demonstrating other identity tokens: bootstrapping a legal and social identity is a major project. If there is a consolidation of identity providers and digital identities, this will tend to benefit the insiders, while the identityless outsiders may become even more excluded.

People who are vulnerable in some other social domain (for example by suffering an illness such as AIDS, having been incarcerated in the past, holding unpopular views, or belonging to a sexual minority) can be harmed if new identity technologies makes it hard or impossible for them to maintain the necessary separation between these aspects of their life and other, public aspects. Again, strong links between different social identities due to new technologies can easily lead to harm.

People who are limited in their ability to handle the multiple social, online, and psychological identities assumed in the modern world will conversely be impaired in navigating the system. This includes people with diagnosable mental impairments but also likely many 'normal' people who for various reasons are inflexible in identity management. Both groups are limited in the range of technologies and institutions they can use and how they can use them for their own purposes.

Victims of identity theft have had parts of their legal or social identity hijacked by others. The takeover can range from someone sending false messages in their name (merely threatening reputation and social links) over being subject to economic swindles to being falsely accused of serious crimes. More consolidated identities pose a potential single point of failure giving evildoers access to a broad range of the person's life. The cost of repairing such an identity can be substantial. Unconsolidated identity systems may pose more possible points of failure, but are less likely to totally ruin a social identity. Unfortunately it can be harder to cancel and restore information in such systems.

People with ruined social identities have a harder time to recover today than in the past, since the cloud can easily follow them - thanks to globalized media, reliable identity tracking, and long-term data storage. Migrating to a remote location might not help if the locals can easily google why the newcomer moved in. There is a risk that some people will become global pariahs. Recovering reputations and identities – especially ones lost through no fault of one's own – will be an important form of social rehabilitation.

The future of identity

Having a personal identity – being someone, with a past and a future – and having a set of social identities – being someone to other people – is an important part of the human condition. Limitations to this ability are fearsome threats to most people. It can be argued that our fear of death is actually a fear of identity loss. Many people regard as the worst part of Alzheimer's disease the gradual loss of narrative identity of the sufferer. Loss of reputation has motivated people to murder and suicide. People are willing to undergo major trials – whether participating in *Big Brother* on TV, study for a Ph.D., or undergo gender reassignment surgery - in order to gain an identity that is meaningful to them.

Future technology is unlikely to change this over the next 15 years. Even with truly radical future technologies it is unlikely that humans will want to use them if they involve unwanted changes to their identity[110]. Instead, people will be interested in technologies they think will *enhance* their identities: broaden their social network and burnish their reputations, amplify personality traits they feel are valuable, and allow them to do things they consider to be expressive of their "true selves".

[110] See Jason Riis, Joseph P. Simmons, Geoffrey P. Goodwin, Preferences for enhancement pharmaceuticals: the reluctance to enhance fundamental traits, *Journal of Consumer Research*, 35, 495-508, 2008, and the discussion about whether it would be good for Joe Bloggs to become Joseph Haydn in Nick Bostrom, Why I want to be a posthuman when I grow up, Medical Enhancement and Posthumanity, eds. Bert Gordijn and Ruth Chadwick (Springer, 2008): pp. 107-137.

This is in line with the growth of self-expression values found by the World Values Survey: as societies become better-off, the emphasis shifts from economic and physical security to subjective well-being, self-expression, and quality of life[111]. We should therefore expect growing interest in technologies and institutions that help manage, manipulate, and protect our identities. At the same, time rising expectations and demands will also make many people more critical of existing institutions, finding them unfit to meet their needs. Allowing public participation and maintaining trust is increasingly necessary not only for public institutions but for enterprises and technologies.

Future public policy will need to take into account some of these expansions of personal identity: in a world with technologically enhanced identities, people are likely to be as fiercely protective of their digital assets, online reputations, "exoselves", and biomedical enhancements as they are of physical possessions and bodily integrity today. While there is a trend towards a high degree of openness about personal information, especially among younger generations, the desire is still to maintain control over this information. People may freely share much of their lives, but strongly react to attempts to exploit it or manipulate it in ways they do not approve. Technology amplifies the many very human inconsistencies in how we treat our identities.

111 http://www.worldvaluessurvey.org

7. Concluding remarks

Personal reflections by Anders Sandberg

Over the next 15 years we are going to see the first generation that have lived their whole life in a network society reach maturity. To them the social Web 2.0, reachable at all time and anywhere, is the normal medium for social interactions. Whatever their values and views on identity will be, they will have developed within and as a response to rapidly changing new media. To them identity management will be second nature, and they will likely invent radically new ways of holding and seeing their identities.

But the timescales of societies are much longer than a decade or two. In 15 years time most people currently in a career will still be in one (if not necessarily the same). Most institutions will not have changed radically, if at all. A new political generation will have risen to power but embody views they developed 10 years ago. Many people will still hold views on how things should be set in the 1940's and 1950's. We will be living in a society that stretches over a far greater range of values and visions than ever before.

In the long term, radical change is in the cards. The ways in which societies function are limited by information technology just as they are limited by available food, energy and space. At the very least the recent information technologies will allow entirely new ways of organisation, just as writing enabled formalized civilizations and printing parliamentary democracies. The new possibilities will demand radical changes in existing institutions or lead to the formation of new institutions that attempt to supplant them.

Significantly disruptive technologies are on the horizon beyond the next decade; while we cannot guess today which wildcards will play out it would be highly unlikely that nothing happens. The next 15 years might be the calm before the storm, a period where many technologies that will eventually change the human condition will be taking their first modest steps.

Personal reflections by Nick Bostrom

The biggest story in this area over the next 15 years will probably be the continued improvement of information technology.

Progress in information technology will drive the trend towards a more transparent society. It will become increasingly feasible to implement surveillance systems that operate on a massive scale and that automatically keep track of where people have been, whom they have met, and what they have done, said, or written. In response to threats to the social order (such as following a high-profile terrorist attack), there will be calls to give the police and intelligence agencies expanded remits to monitor the population and to act pre-emptively on the data they gather. If the surveillance powers of the state are expanded in this way, they need to be counterbalanced by an equally empowered citizenry. The transparency must be two-way: not only from-above-to-below but also from-below-to-above. People need to be able to watch their watchmen. Thus, it may be important to protect private "sousveillance" efforts – for example when citizen turn their cameras on the police to document abuse; or when whistleblowers reveal misuses of power; or when groups of private citizens seek to build their own surveillance networks to pool their own recordings and information.

Another important dimension of information technology is its impact on social space and online identity. Social interactions and public debate are increasingly moving online, giving potentially huge power to (private or foreign-owned) corporations such as Facebook and Google. Recent events e.g. in the Arab world have demonstrated the leverage of social media in organizing popular movements. However, network effects and scale economies might dictate that a tiny number of social spaces will grow to encompass an overwhelming majority of the users. It may be necessary for governments to keep a watchful eye to prevent monopolistic practises by firms that own such spaces. At the same time, it could be an important objective for foreign policy gently to encourage the unfettered use of social media and networking sites around the world, as a means of empowering the citizenry and promoting democratic reform.

Another big story will be advances in biotechnology and genetics (especially towards the end of the 15-year time horizon). On the one hand, there will be growing concerns over bioterrorism and irresponsible use of synthetic biology. On the other hand, human genetics will make significant strides, and the day when embryo selection or genetic engineering are used on a large scale to enhance cognitive and other human capacities will draw closer.

Appendix: Potential challenges to public policy from to identity-affecting technologies (summarized from the text)

- Technologies and policies that affect personal identity should allow people to maintain flexible social identities, even if it might be technologically and administratively easier to create systems that forces fixed identities.
- Increasing individualization of health concepts and expected care. Individualized healthcare may prove costly or hard to provide through state health care systems.
- Expanding use of enhancement and lifestyle medicine will put pressure on the disease-focused medical regulatory framework. "Health consumers" may turn into "well-being consumers".
- Genetic privacy may prove hard to maintain in the face of widespread, cheap testing technology.
- Public education about genetic information and testing are needed in order to avoid misconceptions about genetics and to promote informed decision-making.
- Public institutions will have to adapt to a longer-lived population with changing self-images of different age groups.
- Acquisition of, and decision-making using, rapidly developing technologies such as neurotechnology and biometrics need to be based on evidence and science, not just marketing.
- Increased focus on adaptability and retraining due to automation and other causes of rapid change in the labour market.
- The importance of online identities and use of social spaces may grow to such an extent that that they should be protected by legal rules and methods of appeal.
- Identity technologies are likely drastically to expand surveillance capabilities.
- The limits of privacy will be pushed by a generation growing up with life recording and "life sharing" technology.
- Globalized, diverse citizenry are likely to have multifaceted, possibly weak, relationships with the state in which they reside, and to have widely divergent views on acceptable use of identity technologies.
- In a world of remotely identifiable objects and persons, anonymity and secrecy become hard to maintain.
- Consolidation of identity providers may tend to increase social exclusion of identityless outsiders.
- Some people may be harmed if new identity technologies make it hard or impossible for them to maintain the necessary separation between certain aspects of their life.
- Developing methods of identity rehabilitation may be important in order to reduce the risks for vulnerable groups.
- Foresight requires continual monitoring of progress in potentially disruptive technologies such as life extension, reliable deception detection, psychological manipulation through neuropeptides, and artificial intelligence.