The Quantified Self

A Sociology of Self-Tracking

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'Know Thyself'

Self-Tracking Technologies and Practices

The tracking and analysis of aspects of one's self and one's body are not new practices. People have been recording their habits and health-related metrics for millennia, as part of attempts at self-reflection and self-improvement. What is indisputably new is the term 'the quantified self' and its associated movement, as well as the novel ways of self-tracking with the help of digital technologies that have developed in recent years. In this chapter I discuss contemporary self-tracking practices and technologies, from the days of early lifelogging techniques and wearable computing devices with which people experimented in the 1990s to the vast array of technologies that are available today. This is followed by a review of existing empirical research, which has focused on those who take up self-tracking and their experiences.

The emergence of contemporary self-tracking

As I noted in the Introduction, various terms have been used over the years to describe self-tracking practices: lifelogging, personal informatics, personal analytics and the quantified self. Lifelogging is the most established term. The practice of lifelogging, under this name, emerged in the early days of personal computing, as computing engineers in research labs

were experimenting with techniques and technologies (Sellen and Whittaker, 2010). Gordon Bell, an American computer scientist at Microsoft Research, is well known for his long-term lifelogging project. Bell took inspiration from an idea expounded by the American presidential science advisor, Vannevar Bush, who wrote an essay published in 1945 in which he asserted his belief that humans' ability to remember could be enhanced by technology. In this essay Bush introduced his idea of the Memex, a mechanised device in which people could store all their documents, records, books, letters and memos, as well as newspapers and an encyclopaedia. He suggested that people could also wear small cameras on their forehands to capture details of their daily lives and add them to the Memex archive (MyLifeBits, 2015; Thompson, 2006). Beginning in 1998, Gordon Bell attempted to record as many aspects of his life as possible using digital technologies, including all his correspondence and documents (scanning paper documents as well as storing emails and so on), books he had read, photos, home movies and videos, computer files, mementos, meetings, conversations and phone calls. Bell started wearing a camera in 2000 and an early health-tracking armband, BodyMedia, in 2002. He instigated the MyLifeBits project for Microsoft, expanding on this endeavour (MyLifeBits, 2015).

The developers of wearable computing devices were also among the earliest to experiment with monitoring aspects of their lives through these technologies. The first international symposium on wearable computers was held in 1997 and included papers that focused mainly on the uses of such devices (for example head-mounted devices and clothing embedded with sensors) for performing work-related tasks (IEEE, 1997). The symposium also discussed using wearable technologies for the performing arts, identifying emotions in the wearer, assisting people with disabilities, and telemedicine.

The Canadian computing engineer Steve Mann, a contributor to this first symposium, was one of the most prominent advocates of and experimenters with wearable computers in those early days. Mann began experimenting with using wearable computers in the 1970s. By the early 1980s he was using these devices, which to contemporary eyes appear very

chunky and clunky, for recording personal information about his daily activities. Mann founded the MIT Wearable Computing Project at the MIT Media Lab in 1992. From 1993 on he wore a webcam and recorded and broadcast details of his everyday life in a continuous live feed, as part of his Wearable Wireless Webcam project. By 1998 Mann had reduced the size of his wearable recording device considerably and was wearing a pendant containing a camera as part of his attempts to create what he called a 'lifeglog' (a shortened version of the term 'cyborglog' or computerised automated lifelog) (Mann, 1997, 2013).

Artists and designers have experimented with lifelogging and wearable technologies for several decades. In 1974 Andy Warhol began a 'time capsule' project that continued until his death in 1987. It involved placing items that crossed his desk into cardboard boxes: books, catalogues, letters, photographs, newspapers and magazines, invitations and so on. By the time he died, he had accumulated over six hundred filled boxes, the contents of which have become archived and preserved at the Andy Warhol Museum (Allen, 2008). On Kawara, a Japanese conceptual artist who lived most of his adult life in the United States, spent decades noting down details of the people he met each day, the places he visited and the books he read. He developed a massive archive of these details that he enshrined in bound volumes. During an 11-year period, Kawara sent a postcard each day to friends and colleagues, recording the time he had awoken that morning and his geographical location. Each day for almost half a century – from 1966 to 2013 – Kawara also produced a 'date painting' recording each day's date; the 'date painting' was often accompanied by a storage box that usually contained a cutting from a newspaper published on that date. Another conceptual artist, the Italian Alberto Frigo, has embarked on a long-term lifelogging project that began when he was 24 and has spanned more than a decade thus far (Frigo, 2015). He plans to continue until 2040, when he turns 60: hence the title of his project, '2004–2040'. The project involves photographing every object that his right hand uses, as a way of monitoring his everyday activities. Frigo has also begun recording many other aspects of his life: details of his dreams, the songs he listens to, the external surroundings in

which he moves each day, people he meets, new ideas, cloud shapes and the daily weather.

Developments in small-scale computerised technologies in the 1990s inspired many designers to experiment with wearable fashion and other objects that could be worn on the body, such as jewellery. Several of these designs involved methods of tracking and displaying elements of the wearers' bodies. An area of human–computing research also developed in this era, called 'affective computing' or 'affective wearables', which concentrated on working on wearables that were embedded with sensors designed to read users' emotional states and communicate them to others (Picard, 2000). The design arms of companies such as the electronics company Philips developed such prototypes. In 2008, for instance, Philips released a prototype called Fractals, digital jewellery or scarf arrangements that were designed to be a hybrid between clothing and jewellery. These objects sensed bodily changes of the wearer as well as the proximity of others' bodies, using LED (light-emitting diode) configurations to display the data that they gathered (Ryan, 2014).

Perhaps the most public face of self-tracking these days is the Quantified Self website. The term 'quantified self' was invented in 2007 by two *Wired* magazine editors, Gary Wolf and Kevin Kelly. They went on to establish meeting groups for interested people and then set up the official website (see Quantified Self, 2015c) and its associated Quantified Self Labs – a collaboration of users and toolmakers who are interested in working together to share technical expertise and experiences of self-tracking. The Quantified Self website provides discussion forums, supports regional meetings of members and two annual international conferences (QS Global in California and QS Europe in Amsterdam), and publishes a blog in which various aspects of self-tracking are explained and the strategies and findings of members about their own self-tracking efforts are publicised. An academic research institute, named the Quantified Self Institute, has also been established in the Netherlands by the Hanze University of Applied Science in collaboration with the Quantified Self Labs. According to the Quantified Self website, as of July 2015 there were 207 quantified self 'meetup' groups in 37 countries around the world, with a total of over 52,000

members (Quantified self meetup groups, 2015). Many of these groups hold regular meetings involving 'show-and-tell' discussions of how members have been engaging in self-tracking activities. Most of the groups are in the United States, but there are also many in Europe, ten in Asia and two in Australia.

As a journalist specialising in digital technologies and as co-founder of the Quantified Self movement, Gary Wolf has played a major role in announcing the quantified-self ethos and outlining its development. He wrote an initial article seeking to explain the concept of the quantified self for *Wired*. It was entitled 'Know thyself: Tracking every facet of life, from sleep to mood to pain, 24/7/365' (Wolf, 2009). Wolf's first paragraph described some of the numbers he has collected on his own life. These included the time he rose from bed each morning, how often he woke during the night, his heart rate, blood pressure, the time he spent exercising in the past 24 hours, his caffeine and alcohol consumption and his narcissism score. He went on to claim that '[n]umbers are making their way into the smallest crevices of our lives' due to the digital devices that can now collect detailed, continuous data on everyday practices, social interactions and bodily functions (ibid.).

Later in this article Wolf described the genesis of the Quantified Self movement. He recounted how, two years earlier, he and Kelly had begun to notice that many acquaintances of theirs were gathering quantitative data about themselves: 'A new culture of personal data was taking shape. The immediate cause of this trend was obvious: New tools had made self-tracking easier' (ibid.). Wolf wrote that he and Kelly then decided to establish a website bearing the title 'Quantified Self', a term that they had come up with to describe this phenomenon of detailed digitised self-tracking. Wolf went on to give a TED (Technology, Entertainment and Design) talk about the quantified self in 2010 and wrote an article on the topic for *The New York Times* that same year (Wolf, 2010).

Since the initial *Wired* article penned by Wolf, the Quantified Self as a subculture has exerted increasing influence over the definition and practices of self-tracking. The term 'quantified self' has now entered the cultural lexicon. My research suggests that its frequency of use has been increasing and

gathering momentum annually. In July 2015 I made a Google Trends graph comparing the terms 'self-tracking', 'lifelogging', and 'quantified self' to see relatively how often each has been used in Google searches: this was an indicator (if only a crude one) of online searchers' interest in each term. (Google Trends is an open tool that shows how often a particular search term has been entered into Google Search by comparison to other searches globally.) The graph showed that it was not until late 2007 that 'self-tracking' and 'lifelogging' began to be recognised. The term 'quantified self' only began to appear in the graph in May 2010 (not surprisingly, given that it was first coined in 2007) but rose quickly in popularity, beginning to overtake 'self-tracking' by January 2012. The volume of searches for 'self-tracking' and 'quantified self' began to converge in mid-2014, although results for 'quantified self' have remained higher for most months. 'Lifelogging' began to lose currency by early 2010 and has remained steady, but much lower in relative volume than the other terms ever since.

Interest in the quantified self among Google searchers was no doubt encouraged by news media interest, which has also grown steadily since 2009. The term has spread from being a proper noun that referred specifically to the official Quantified Self website and community to being now used as a common noun – a general term for self-tracking practices. Descriptions such as 'the quantified organisation', 'the quantified patient', 'the quantified doctor', 'the quantified body', 'quantified sex', 'the quantified home', 'the quantified mind', 'the quantified baby', and even 'the quantified pet' have appeared in popular cultural artefacts such as blog posts and news items, demonstrating the taking up of the term 'quantified self' and its application to more specific topics.

A study of reporting of the quantified self that I conducted using the Factiva global newspaper database to search for English-language articles that mentioned this term in the six years period between January 2009 and July 2015 found that it was increasingly prevalent in news articles over this period. In 2009 only two news articles appeared mentioning the quantified self: one, in the American *Life Science Weekly*, reported a study on the relevance of self-tracking to healthcare; and the other, in the Canadian *Globe and Mail*,

discussed the Quantified Self movement and the people involved in it. However, the number of articles rose to 21 in 2010 and 33 in 2011, and by 2012 148 articles had been published that used the term. The year 2013 witnessed greater interest: by the end of that year 466 news articles discussing the quantified self had been published. This figure rose even higher in 2014, when 564 articles appeared.

My review of the news media coverage of the quantified self found that the tenor and scope of reporting the phenomenon have also changed since the initial publication of news stories. Early news reports focused on the innovative aspects of quantifying the self and debated whether such close attention to the details of a person's life and bodily functions would extend beyond 'uber geeks' – those 'weirdly narcissistic' few who are interested in 'extreme naval gazing' to the general population, as *Forbes* magazine put it (25 April 2011). By 2012 news articles represented quantified-self practices as growing in popularity and becoming not only an important feature of health promotion but a part of everyday life, as a way of maximising productivity and happiness as well as health. As the British *Sunday Telegraph Magazine* (2 December 2012) contended: 'It began with a small group of digital obsessives recording their every heartbeat. Today the "quantified self" movement is a gadget-filled fitness craze.' By June 2013, *The Guardian* (UK) was asserting that 'the "Quantified Self" movement [is] all the rage for people tracking their physical activity, food intake, vital signs and even their personal genome through digital services'.

Data privacy and security issues concerning the personal information that is generated by self-tracking devices began to receive attention in the later years of reporting. A *Forbes* magazine report (31 July 2014), for example, referred to a new market research report that found that there were numerous data security risks associated with a large number of self-tracking apps and devices that were examined. This meant that the personal data uploaded to these technologies could easily be accessed by others and on-sold to third parties for commercial gain. Several articles raised the question of whether people were becoming too obsessed with digital self-tracking and focusing on their numbers to the exclusion of other aspects of their lives. *The Guardian* (7 March 2015)

published an account by a woman who believed that she had fallen into this trap to the point where she had asked herself: 'Do I even exist without my Fitbit? Without data, am I dead?' Reference was made, in a *Toronto Star* news story of 19 January 2015, to the 'big data junkies' who 'self-hack' incessantly. Despite these concerns, news articles have continued to report on the apparent popularity of wearable devices for self-tracking and on the opportunities for developers to profit from them. An Australian *Business Insider* report, for example, claimed that, '[in] just a few years, there could be more people using wearable tech devices than there are in the US and Canada' (15 July 2015).

Contemporary self-tracking technologies

Digitised self-tracking has attracted a high level of attention from developers and entrepreneurs seeking to capitalise on the practice. They are taking a keen interest in how best to produce technologies to market to self-trackers, and often attend quantified-self meetups and conferences (Boesel, 2013; Nafus and Sherman, 2014). The range and variety of self-tracking technologies that are now available, particularly new digital devices and software, are vast. The Quantified Self website lists over 500 self-tracking tools; in addition to geo-location, these include health-, fitness-, weight-, sleep-, diet- and mood- or emotion-tracking apps, services and devices that are able to record social interactions, emails, networks and social media status updates and comments (Quantified Self, 2015b). Other tools noted there allow users to track their meditation practices, television watching, computer use and driving habits, financial expenses, time use, beneficial habits and work productivity, and to monitor local environmental conditions, progress towards learning or the achievement of personal goals (see also the Personal Informatics website for another long list of tools: Personal Informatics, 2015).

The use of sensors is a pivotal feature of contemporary self-tracking technologies. Many different types of digital sensors are now used to monitor a diverse array of aspects of human and nonhuman activity. Biosensor devices collect

data from living organisms or systems. They contribute to self-tracking efforts to monitor bodily phenomena or elements of the physical environment. Biosensors include reactive agents that can respond to changes in bodily functions and indicators – such as blood glucose, hormone, enzyme or oxygen levels. Once used only by healthcare workers, environmental scientists or people with chronic illnesses who engage in self-management of their condition, biosensors are now available far more widely to the general public. Indeed smartphones now routinely include sensors such as global positioning systems (GPS), digital compasses, gyroscopes and accelerometers that can be employed for monitoring people's movements and geolocation. Some smartphones incorporate heart rate, body temperature, humidity, atmospheric pressure and air temperature sensors.

Tens of thousands of self-tracking apps are available for downloading to smartphones and iPod devices that can draw on the information collected by built-in sensors on the device or facilitate the input of other data by the user on his or her everyday activities and behaviours. Some technologies offer a genetic component to self-tracking, as individuals seek to identify their genomic profile, including their racial ancestry and risk of developing certain diseases and conditions. Various internet-based companies now offer services for members of the public to send in DNA (desoxyribonucleic acid) samples and have their genotypes identified (this is often referred to as direct-to-consumer personal genomics). Some such companies, for example 23andMe, are establishing large digital databases containing the genetic information of their customers.

Many devices equipped with sensors and other forms of digital tracking are now wearable. The wireless wearable heart-rate monitor was one of the first technologies to move out of the clinic and into the domain of fitness and exercise tracking (Pantzar and Ruckenstein, 2015). There is a now growing number of specifically designed wearable devices such as the Fitbit, Jawbone's Up and Nike Fuelband, which can be worn as bracelets or clipped onto belts. Various brands of adhesive patches are available for self-tracking, as are ingestible digital tablets that send wireless signals from inside the body to a patch worn on the arm. All of these are designed

to automatically collect data on bodily functions such as physical activity, pulse, breathing rate, heart rate, body temperature, calories burned, brain waves and sleep patterns. Some can be worn 24 hours a day, in order to provide constant readings of biometrics. Attachments to smartphones can be purchased that effectively turn them into medical devices – enabling pregnant women to monitor their foetus' heart rate, for example. Digital body weight scales, ECG (electrocardiogram) devices for measuring heart function, blood oxygen saturation monitors and blood-pressure monitors that link to smartphones are also on the market for the lay consumer.

Telehealth and telemedicine technologies have been in existence since the 1990s, involving computerised devices located within patients' homes to facilitate remote monitoring of their bodies. Digitised wireless patient self-care and self-monitoring devices are an important element of the latest array of self-tracking technologies. Such technologies as continuous glucose monitoring are now available for controlling diabetes via a device that is inserted within the patient's body, checks blood glucose in the surrounding tissues constantly and sends the information wirelessly to an external unit. Self-tracking devices are currently expanding into a greater number of medical and health applications. Arguments for persuading patients with chronic illnesses to engage in self-tracking through the latest wireless devices are becoming increasingly common in the medical literature. The British National Health Service (NHS) is working on rolling out such devices as part of preventive medicine and patient self-care. The Obama Administration's Affordable Care Act has similarly championed at-home medical self-monitoring devices as part of its initiative to reduce healthcare costs by decreasing the number of patient admissions to hospital. The American National Institutes of Health (NIH) is investigating ways of encouraging citizens to engage in voluntary digital self-tracking designed to generate big data sets for research as part of the Precision Medicine Initiative.

In health education and health promotion there is a long tradition of encouraging members of the public to take note of such aspects as their body weight or abdominal measurements, physical activity, diet and alcohol or cigarette

consumption as part of improving their health status (Lupton, 1995b). These attempts to change target groups' behaviours are now incorporating the use of digital devices. Health promoters and health educators are using an expanding array of self-tracking devices as part of their preventive health efforts; such devices include encouraging people to use health- and fitness-monitoring technologies and apps. Health-promotion organisations and agencies have developed apps and platforms of their own, custom-designed for such purposes, or else they advocate the use of health and fitness self-tracking apps and devices that are commercially available. These are represented as behavioural interventions designed to encourage adherence to health-promoting objectives (Lupton, 2012, 2015b).

The internet empires are now entering the wearable self-tracking technology arena. Amazon has opened a specialist wearable technology store on its website. In 2014 Apple, Samsung and Google all announced new wearable devices that have self-tracking functions. Apple released its smartwatch, the Apple Watch, in April 2015. Among its other functions, the Apple Watch acts as a wearable health- and fitness-tracking device. Apart from allowing customers to use third-party apps, it incorporates two new apps, simply called 'Fitness' and 'Workout', which operate with its embedded sensors to track users' physical activities and heart rate. According to Tim Cook, Apple's CEO (chief executive officer), the Watch is viewed by Apple as 'the most personal device we've ever created' – both because it is worn on the body, potentially 24 hours a day, and because it can act as a 'personal trainer' (Colt, 2014). Apple has also moved into the realm of facilitating the collection and use of personal data for medical research. It has partnered with several medical research institutions to enrol people into health research projects that use apps on Apple mobile devices that collect users' health, medical and fitness information as part of its ResearchKit software platform. Samsung has developed the Galaxy smartphone and Galaxy Gear smartwatch, both of which are endowed with biometric monitoring capabilities. In 2014 Google announced its Google Fit platform, which is directed at allowing health- and fitness-tracking apps from different developers to access data across platforms.

The range of wearable fashion objects that track the wearer's bodily functions through sensor-embedded smart fabrics is expanding into the production of clothing, hats, helmets and shoes. Gloves, arm bands and devices meant to be placed on sporting equipment are on sale that can monitor sporting activities such as golfing, tennis or baseball swings, while sensor-embedded basketballs and footballs track sporting prowess. Face-worn devices and cameras that can be mounted on sporting equipment are also available that can be used to record and capture images and geolocation data or be integrated with sport- and fitness-tracking apps and platforms. Some fashion designers are working on high-fashion clothing and jewellery that are able both to collect information on the wearer and to look appealing. One example is the collaboration of the jewellery company Swarovski with Misfit in developing crystal-encrusted fitness and sleep trackers. High-end fashion-design house Ralph Lauren has developed a 'Polo Tech Shirt' embedded with body metric sensors, while several companies have developed stylish headphones or earbuds that pipe music into users' ears while simultaneously measuring their heart rate.

In a far less glamorous context, self-tracking is used in programs that involve monitoring location and drug use for probation and parole surveillance, alcohol and drug addiction programs, and family law and child custody monitoring. Digital cellular monitoring devices allow the radio frequency monitoring of offenders who are serving at-home sentences. In some criminal justice systems global positioning technologies are also used to track parolees' movements. Several self-tracking devices for monitoring alcohol use have been developed for use in programs for alcohol addiction and policing. The secure continuous remote alcohol-monitoring device is used to provide alcohol testing (via the wearer's sweat) through the wearing of a bracelet or anklet. Some such monitoring devices combine a number of biometric tracking and surveillance technologies. For example the Soberlink company has developed digital mobile alcohol breath-testing devices that combine alcohol monitoring with facial recognition technologies for authenticating identity. The company sends text messages to clients to remind them to test their breath and send their data to designated contacts.

Other technologies available on the market are designed to assist people in tracking their sexual and reproductive functions and activities. Many apps are available for women to monitor their ovulation and menstrual cycles and to assist with achieving (or avoiding) conception. Some of these involve the input of highly detailed bodily data. For example the Glow app provides daily predictors of chance of conception and identifies fertile times on the basis of data that users input on their menstrual cycle, indicators of ovulation, intercourse, basal body temperature, cervical mucus, body mass index, cramps, use of contraception, exercise, spotting, period flow and period symptoms. The app syncs with data entered from the physical activity tracker My Fitness Pal. Glow also provides a mirror app for a woman's partner, so that the couple can track the woman's fertility as well.

Also in the realm of sexual and reproductive health and activity self-tracking, devices with motion sensors that are inserted into the vagina are sold for the purposes of helping women track their progress in strengthening their pelvic floor muscles. Developers have created monitoring devices that fit onto penises as well and are designed to measure a man's sexual activity. There are also several smartphone apps that can be used to monitor sexual activities: these apps use the sensors in the phone to monitor sound and thrusting movements when the phone is placed on the bed during sexual encounters. Some apps even calculate the calories burnt during sex and provide league tables through which men can assess their sexual prowess against other users of the app (see my more detailed analysis of these apps in Lupton, 2015c).

Various apps and devices are available for pregnant women that direct and encourage them to observe and collect detailed data about their bodies and their unborn offspring. There are numerous apps that encourage pregnant women to track such features as their diet, vitamin intake, liquid consumption, physical activity, body weight and body temperature. Several such apps contain pregnancy countdowns, so that women can see at a glance how many weeks and days along they are in the gestation timeline. Some encourage users to record their moods, feelings, cravings, appetite level and nausea as pregnancy progresses, as well as facilitating the recording of medical and test information. There are apps on the market,

such as Watch Me Change, that enable women to photograph their pregnant bellies week by week and generate a time-lapse video of changes over time as their bumps grow.

Apart from technologies focusing on bodily functions and activities, a multitude of devices and apps have been formulated that allow people to monitor and record other aspects of their lives, such as their finances, their social interactions, the use of energy in their homes, the music they listen to, the book they read, the television or films they watch and the places they visit. One of the latest self-tracking technologies is Sony's SmartBand SWR10, a digital wristband that is designed to be worn day and night. It connects wirelessly to a smartphone and also to Sony's Lifelog app, which enables the user to access other apps and platforms such as Facebook and his or her phone in order to log such aspects as places visited, music listened to, people interacted with and games played, as well as body metrics such as sleep and exercise activities.

The Reporter app can be programmed by the user to send regular questions throughout the day, in an attempt to 'illuminate aspects of your life that might otherwise be unmeasurable', such as 'Where are you?', 'Who are you with?', 'What are you doing?' and 'How do you feel?'. Users can formulate their own questions on the basis of what information they would like to collect. Apps like Swarm from Foursquare encourage people to 'check in' and update their physical location, eventually providing recommendations on places they might like to visit next. People can also use wearable or mobile devices with biosensors, in order to measure environmental conditions inside or outside such as pollution, radiation, humidity and air oxygen levels (these are often referred to as 'environmental tracking devices' or 'enviro-trackers').

Many social media sites themselves provide the quantification of users' attributes. On Twitter people's number of followers can be viewed by all users, and users themselves can check how many times their tweets are 'favourited' or retweeted by others. Facebook also displays such metrics as how many friends people have and how many comments they receive on their status updates. For some users, the 'like' button on Facebook is a powerful indicator of

their popularity and social standing. Indeed some scholars have referred to the 'like economy' of Facebook (Gerlitz and Helmond, 2013). A number of apps and platforms merge social media functions with self-tracking, in an attempt to provide social support for people who are trying to achieve behaviour change or other goals. Dedicated web platforms and services for aggregating data and comparing them with others people's data are also available.

One example is the PumpUp app, which is directed at social fitness status updates. It encourages users to upload images of themselves after a workout or to demonstrate their progress towards weight loss or fitness goals, or the healthy meals they are eating – as well as enabling them to generate customised workout plans and coaching and to monitor exercise activities and progress towards their goals. The idea is both to monitor one's activities and to share them as part of encouraging positive feedback from other users, who should then act as motivating forces. Several self-help apps use the social support that may be generated by other users as part of their selling points. Apps have been developed, for example, that encourage people to construct a 'gratitude journal' in which they regularly record aspects of their lives that they appreciate (including taking photos); this journal has the function of enabling them to share the list online with others. Use of the Lift app involves creating and establishing habits and tracking progress, and it also has a social network function that allows users to provide support to others who use the app.

Gamification, or the rendering of aspects of using digital technologies and self-tracking as games, is an important dimension of new approaches to self-tracking as part of motivation strategies. Obvious examples are gaming technologies such as the Nintendo Wii Fit and the Xbox Kinect consoles (sometimes referred to as 'exergaming'). Both consoles incorporate sensors that are able to configure body metrics as part of the games they offer. Another example of gamification software is Chore Wars, which rewards users for undertaking domestic jobs by enrolling them so that they earn points. The platform gives users a fictional character and allows people in a household to track their own participation in domestic tasks and compare their data with other people sharing their

house. Self-tracking apps and software adopting gamification strategies may employ such elements as built-in reward or docking systems, so that badges, points or real money can be collected or paid if various commitments – to regular exercise or weight-loss goals, for example – are either met or unmet; or they may employ websites where one's metrics can be compared competitively against those uploaded by other users. Thus, for example, the Strava running and cycling app and platform use the self-tracked data from a number of compatible GPS (global positioning system) devices. Once a run or bicycle ride has been completed, users can upload the details of their route so as to quantify and analyse their performance. An important feature of the software is the opportunity it provides for users to compare their performances with one another, in what the Strava website describes as 'social fitness – connecting and competing with each other via mobile and online apps' (Strava, 2015).

It is not only adults who use self-tracking technologies. Children are targeted for self-tracking by a plethora of software and devices in schools. Learning analytics software, for example, can supply students as well as their teachers and parents with regular reports on their learning progress. Similarly, the use of self-tracking technologies in physical education lessons may involve students accessing fitness and skill-training information that has been collected on them. Some physical education teachers require their students to wear heart-rate monitors or to use health- and fitness-related apps or coaching software that record performances for analysis. For example, the Polar GoFit app with a set of heart-rate sensors is expressly designed for physical education teachers as a monitoring tool for students' physical activities during lessons. Teachers can distribute the heart-rate sensors to students, set a target zone for heart-rate levels and then monitor these levels online while the lesson takes place – either for individuals or for the class as a group.

Platforms such as Class Dojo have also become popular in schools, particularly in the United States, where they are used by teachers as a form of behaviour monitoring and classroom control. Teachers use Class Dojo by recording aspects of their students' behaviours in class each day (how cooperative they are, how hard they work on tasks, their teamwork and so

on) and send parents messages summarising these data. Students can earn points for good behaviour and lose them for non-sanctioned behaviour. They may also be encouraged to use the Class Dojo app to review their own performance. Outside the classroom there are wearable devices on the market that have been designed explicitly for children, such as the Leapfrog Leapband, which allow them to record their physical activity and earn points towards caring for a digital pet. Exergaming technologies are also promoted as ways of encouraging children to be more physically active at home and school.

The workplace has become a key site of self-tracking. Productivity-monitoring devices and software are becoming a feature of many workplaces, as employers seek to identify the habits of staff members in the interest of collecting data that will assist in maximising worker efficiency or in reducing costs. Apps designed for this purpose include RescueTime, which runs in the background of computer devices and tracks the time that users spend on applications and websites, 'giving you an accurate picture of your day' by providing detailed reports and data. Its logo is 'Measure Your Digital Life' (RescueTime, 2014). Another tool is WorkTime, a Windows app that sits in the corner of the screen and allows users to measure the time they spend on tasks. BetterWorks is one example of a social work productivity app that allows both employees and employers to track workers' progress towards achieving agreed goals and is designed to encourage employees to maintain progress, as they observe one another's information.

Many employers are also turning to the use of digital self-tracking technologies ('digital wellness tools') as part of workplace health-promotion programs or 'wellness programs'. The Virgin Pulse platform, for example, offers both productivity- and health- and fitness-tracking programs for employers (or, as the website puts it: 'Technology to replenish the modern worker'). Virgin Pulse offers a range of self-tracking services for employers to use with their workers, including wearable fitness, diet, weight, sleep and work commitment trackers. Employees receive updates on their own data and the employers view the aggregated data. Rewards and incentives for reaching goals are part of the program.

These are all designed to achieve the bottom line: 'better quality of life for your employees, and higher productivity and performance for your business' (Virgin Pulse, 2015).

There is a multitude of ways in which self-tracking technologies are used for commercial and marketing purposes. Market research companies use self-tracking apps issued to their research subjects to gauge their habits and responses, including their use of brands. The ability to send research subjects messages or prompts or to track their responses via mobile or wearable devices in real time, throughout the day, is viewed as a major development in marketing research. Mobile devices are regarded as affording the opportunity for market researchers to make 'passive data collection' – that is, data that are automatically generated by the device (such as geolocation details of users, how long they engage in activities and with whom they interact) – and 'participative data collection' – by asking users to respond to questions or prompts through their mobile devices (this is also referred to as 'push' requests). Both kinds of data can be combined; for example, the location of users can be identified, and then 'push' requests can be issued to them on the basis of where they are and what they are doing at the time (Poynter, 2014).

Emotion tracking has become an area of interest for marketing research. For example, Studio XO has developed XOX, an 'emotional technology' program that enables brands and artists to collect data on the emotional states of individuals in order to measure 'crowd excitement' and to tailor their products, experiences and services accordingly. The system involves a wristband embedded with sensors that collects 'intimate data' on 'levels of excitement' (XOX Emotional Technology Platform, 2014). This device is advertised as being a way not only for commercial entities and artists to harvest the emotional response of target audiences at an aggregated level, but also for people wearing it to be able to identify their own emotions. The concept is based on the idea that, as audiences or target groups are experiencing an event or using a brand, they will also be able to view the collective emotional responses of others in visual form, thus heightening their own experience. Artists and developers of brands will be able to measure group emotional engagement by using the same data.

Self-tracking devices are also becoming incorporated into projects that seek to enhance users' mood, happiness and social relationships. Some designers are working with experimental technologies and investigating their potential. For example, a team at Newcastle University has developed the prototype of an acoustic monitor that is worn on the arm and measures the quality and quantity of social interactions as part of determining the wearer's psychosocial wellbeing. The actual words used are not recorded. Rather the device collects such data as frequency and length of interaction and voice acoustic properties such as pitch and amplitude – indicators of emotional state according to the researchers. The device will be piloted by clinicians working with people with depression (Open Lab, 2011).

Designers who work for the nytlabs – that is, the New York Times R&D (research and development) Lab – are experimenting with prototypes of wearable devices that they dub 'social wearables/augmentation' (Feehan, 2014). One example is Blush, an object worn like a brooch. Blush listens to conversations with and around the wearer and lights up when the conversation refers to topics that the user has listed in the associated app. The researchers of Intel Labs are investigating ways of sharing with others personal data derived from self-tracking so as to contribute to social relationships and empathy. Drawing on such bodily indices as galvanic skin response (electrical changes in the skin) and heart rate in wearers of digital devices, these researchers are attempting to develop algorithms that can interpret physiological responses as moods. They are also developing technologies that allow users to transmit their experiences and physical sensations directly to others by using such indicators as the colour of their own clothing (which transmit their physiological reactions or responses), so that other people can more easily understand how these users are feeling (Intel IT Center, 2014).

While the array of wearable self-tracking devices has proliferated, many objects or environments have embedded sensors that are not inserted in, worn on or carried by the human body but only touched by it, being located in the physical surroundings in which a person moves, sits or lies: furniture, floors, cars, bicycles, toys, fridges, shopping centres,

roads, airports, schools and so on. Urban environments – the so-called 'smart cities' – are becoming equipped with sensors, cameras and other digital data-gathering technologies. These generate information that is displayed with the help of real-time interactive visualisations and digital dashboards; and these in turn assist citizens, policymakers and managers to easily access and read this information. A number of these 'smart' objects (also called 'anti-wearables') provide capacities for self-monitoring. Some 'smart cars', for example, now have sensors that monitor driving habits and heart rate to identify drowsiness, alerting drivers if they are at risk of falling asleep at the wheel. Smart cars have also become incorporated into car insurance packages. Telematic devices are installed in the car engines of drivers to track the distance they drive, their destination point and their driving style (braking habits, speed, rapid acceleration, hard cornering and so on). These data are sent wirelessly to the insurance company and are used to calculate personalised premiums.

The 'smart home' has become a feature of some people's domestic lives. Mattresses can monitor sleep patterns and body temperature, chairs and floors can sense physical movements. Smart meters can be installed to measure energy use in the home. Technologies such as the Nest platform are able to monitor inhabitants' energy use and their movements in and around this space, such as when they leave and arrive at their home. The Nest Thermostat itself learns these habits and programs accordingly. Nest has now developed partnerships with self-tracking technologies such as Jawbone, so that digital data on people's sleeping habits can be incorporated into the platform's software, allowing for the thermostat operation to be automatically linked to times of going to bed and waking up. It also offers a digital live-streaming camera, DropCam, which users can install in their homes to conduct surveillance of people and pets, checking in at any time to observe proceedings through their smart device. In essence, this results in a home that is both tracking and responding to its inhabitants.

The interconnected smart home offered by Nest is an example of the developing Internet of Things. As the Internet of Things expands further and sensor-embedded objects and environments become ever more distributed, digital objects

will have even greater capacity to connect to and communicate with one another independently of human intervention, constantly creating masses of digital data on a greater number of elements of human life. Indeed some commentators contend that, instead of the Internet of Things, we should be referring to the 'Internet of Life' (Elwell, 2014).

While I have dwelt on the digital technologies for self-tracking in this chapter thus far, it is important to emphasise that nondigital methods are still used by many people (and perhaps by the majority of those who self-track) for monitoring and recording aspects of their lives. As a Pew Research Center report on self-tracking for health reasons found, while 70 per cent of the Americans whom the Center surveyed in 2012 reported that they monitored health indicators for themselves or for a loved one, most did not use digital devices to do so (Fox and Duggan, 2013). Of those who engaged in self-tracking, almost half said that they simply noted details 'in their heads', relying on their memories, while a third said that they used pen and paper. Only one fifth of self-trackers said that they used digital technologies for self-tracking health indicators.

Furthermore, self-tracking is not simply about quantified (or quantifiable) information. Material objects may be used as a form of monitoring change in one's body, state of mind or social relationships. As Susannah Fox from Pew Research put it, an old pair of jeans can provide a device by which body weight or size can be monitored: too tight, and you know you have gained weight (Montini, 2013). Not only photographs but pencil marks on door jambs have traditionally measured children's growth. Similarly a collection of baby and children's clothes may signify to a parent the growth of their children, while a set of drawings, writings by one's children, and school reports collected over time demonstrate those children's cognitive development, learning and other achievements.

Many self-trackers record nonquantifiable data as part of their practice; such data include journal accounts of their daily activities, emotional states, and relationships and collections of audio data or visual images. Several apps are available that encourage people to log their moods and emotions, their dreams, and their social relationships, focusing on

qualitative features. The Shadow app, for example, allows people to describe their dreams on first waking by voice or text, while the InFlow app is designed for users to log information about their emotions and energy levels by using text descriptions and pictures rather than numbers; the aim is to discover whether there are any correlations between emotions and energy levels. The Autographer, Narrative and Ethnographer devices are tiny digital cameras that can be clipped onto the user's clothing or hung around his or her neck; they take photos continually from the wearer's perspective. In using these devices, one's focus is on collecting images that are valued for what they reveal about one's daily activities and interactions, as indicated by their visual properties rather than their metrics.

Research on self-tracking practices

Few academic research studies have yet been published on how many people are engaging in self-tracking and why they are. There has been a spate of interest in studying the phenomenon of lifelogging in human–computer interaction research. These studies were mostly directed at investigating prototypes for devices or software designed to assist in lifelogging or aimed to explain how data such as images, audio or location, collected as part of lifelogging, can assist memory. Little of this research attempted to investigate how people were using lifelogging technologies 'in the wild' and what their motivations and experiences were. Building on this work, there is now a growing collection of papers that have been published by researchers in human–computer interaction studies on self-tracking. Again, these generally take a design-oriented perspective or employ cognitive or behavioural psychological models to investigate how people interact with devices.

Most of the current research on self-tracking has been conducted by market research companies and focuses almost exclusively on people who live in the United States and who self-track for health or fitness purposes. One example is a report concerning the results of an internet survey of Americans conducted by the company TechnologyResearch

in September 2014 (Graham, 2014). The company found that a quarter of the respondents said that they used either a fitness-tracking device or a smartphone app to track their health, weight or exercise. Among those who did not do so, lack of interest and concern over cost were the primary reasons that were given, although almost half of non-users said that they would use a fitness-tracking device if it were recommended or prescribed by their doctor and 57 per cent said that the possibility of lower health-insurance premiums would make them more inclined to consider wearing such a device.

A report by Nielsen found that one in six of the American adults whom this company surveyed in early 2014 used wearable devices in their daily lives. Digital fitness-tracking bands were the most popular of self-tracking devices among those who owned wearable technologies: 61 per cent owned such devices, by comparison with 45 per cent who owned smartwatches and 17 per cent who owned other mobile health devices, such as pedometers (Nielsen, 2014b). Nielsen found that young adults were more likely than older adults to own wearable devices, but men and women used them in equal numbers (Nielsen, 2014b). Men and women were nearly equally likely to wear fitness bands (women slightly more likely than men), but women were more likely to use other specialised mobile health devices (Nielsen, 2014a). Owners of wearable devices were more likely to have a high household income, particularly fitness-band owners (Nielsen, 2014b).

Yet another market research survey conducted in September 2013 found that one in ten American adults owned a digital device for monitoring physical activity, such as a Fitbit or Jawbone wearable (Ledger and McCaffrey, 2014). The survey also found that younger people mainly used these devices to improve their fitness, while older people used them for the sake of improving their health and extending their lifespan. However, in what the researchers call 'the dirty secret of wearables' (Ledger and McCaffrey, 2014: 4), it is noted that many users of physical activity wearables relinquish their use quite soon. Half of the fitness-tracker owners who were surveyed had given up using them, and a third had done so within six months of acquiring their device.

American middle-class white men with high levels of digital technological know-how are perhaps the more public face of self-tracking, particularly in their participation in and membership of the Quantified Self movement. In a study in which human–computer interaction researchers analysed 52 videos of members' talks about personal experiences of self-tracking that were posted on the Quantified Self website (Choe, Lee, Lee, Pratt, and Kientz, 2014), it was found that this demographic dominated. The presenters in most such videos were American, and particularly from the San Francisco/Mountain View/Silicon Valley area, where the Quantified Self movement was established. The vast majority of speakers were men (79 per cent), and a high proportion worked in the digital technology industry. The largest group of self-trackers in this study were monitoring health-related factors such as physical activity, food consumption, weight, and mood. Another group (comprised of software engineers and students) was interested in tracking work productivity and cognitive performance. A third group was identified, comprised of people who wanted to have new life experiences through self-tracking, which they considered to be a form of experimenting. Indeed the term 'self-experimentation' was used frequently by the speakers as relating to finding meaningful knowledge about themselves, which they could use for self-optimisation.

The self-trackers who reviewed their experiences in the videos under analysis reported many benefits of self-tracking. They noted that their health had improved or that they had successfully identified what triggered their symptoms. They also often reported becoming more aware of themselves, their social relationships and the surrounding environment. However, Choe and colleagues (2014) observed that several common pitfalls were identified in the videos: trying to track too many things; not tracking the triggers of illness symptoms; and the lack of scientific rigour in tracking approaches. Tracking too many aspects either led to people becoming weary of the process or being faced with too many data to deal with. Some participants asserted that automating one's data collection resulted in less 'tracking fatigue', as the researchers put it.

Another human–computer interaction study of American self-trackers (Li et al., 2010; Li et al., 2011) found that the

reasons the participants gave for engaging in these practices were: curiosity about what their data would reveal; an interest in quantitative data and numbers in general, as part of being a 'geek'; an interest in experimenting with new tools for self-tracking; acting on a suggestion from another person; and various triggering factors – such as suffering from sleep problems, wanting to lose weight or developing an illness. This study also identified some barriers to, or difficulties in, engaging in self-tracking. These included switching between tracking strategies and therefore losing data, lacking time or motivation, forgetting to collect information, having difficulties with the methods used or with interpreting the data, or finding enough interesting information to record about oneself. Participants in the study also observed that incorporating data from different sources could be difficult, and that understanding the implications of their personal information could pose challenges.

Similar findings were evident in another content analysis of posts on the Quantified Self website: a project that sought to identify which tools members used for self-tracking and how they discussed their value and ease of use (Oh and Lee, 2015). This study found that many complaints had been raised on the website about data transfer from one device to another and problems had been discussed concerning some platforms or devices becoming discontinued, which resulted in loss of people's data. Data accuracy and the design of wearables and software were also problematic for some members. The simplicity of collecting and inputting information into self-tracking tools was a further point of discussion in members' comments. The researchers noted that members' posts were positive about their authors' sharing their own self-tracked data with other people engaged in similar pursuits, particularly in the interest of finding support and improving their motivation to achieve their objectives.

While privileged white men from Silicon Valley may dominate video talks on the Quantified Self website, there is evidence to suggest that other social groups engage in self-tracking activities. The Pew Research Center survey mentioned earlier demonstrated that women and men were equally likely to engage in self-tracking and that African Americans were more likely than non-Hispanic whites or Latinos to do so (Fox and

Duggan, 2013). In another study, based in the United Kingdom, focus group interviews with university students and junior staff members found that several of the female participants used calorie-counting apps, while some of the male participants reported using fitness-tracking apps (Dennison, Morrison, Conway, and Yardley, 2013). The participants who used such apps noted that the latter were convenient tools for them to track their own progress, to work towards goals and targets that they had set themselves and to find the motivation to achieve weight loss or better physical fitness.

People may use self-monitoring technologies to track not only their own bodies, habits and activities for personal reasons, but also those of significant others. This is particularly the case of caregivers, who may have responsibility for protecting or caring for infants or children, elderly relatives, or family members with chronic medical conditions. Fox and Duggan (2013) found that 12 percent of the Americans surveyed in the Pew Center report engaged in the monitoring of health and medical-related indicators for a loved one. Of all participants, 36 percent were caregivers; and 31 percent of these caregivers said that they tracked health indicators or symptoms in those for whom they provided care. Caregivers were also more likely to track their own health: 64 percent tracked their body weight, exercise or diet, and 39 percent tracked other health indicators or symptoms.

To date there is little published research carried out by sociologists or anthropologists who have attempted to investigate self-tracking cultures and practices empirically and from a more in-depth perspective. One example is Minna Ruckenstein's (2014) interviews with Finnish people who volunteered to wear self-tracking devices continually for a one-week period, for monitoring their heart rates and their physical activity levels. Many of her study participants found the devices reassuring and regarded them as benevolent supporters of their efforts to increase their physical activity and fitness. These participants had not used an activity- or heart rate-monitoring device before; they were healthy and not dealing with chronic illness. Ruckenstein found that people who were already regular exercisers or had an interest in monitoring technologies were particularly drawn to participating in the research, as they already had a predisposition

to monitoring, measuring and comparing and wanted to be challenged by their biometric data. Participants in her study were reluctant to relinquish the device when the project had come to an end. They adopted the ethos of personal responsibility for health and wellbeing and found that these devices helped them to conform to this ideal and to manage and achieve their goals: they acted as a catalyst for change. These people expected the data produced by the devices to have an effect on them, and several commented that this indeed was the effect of wearing them. Because they knew that the devices were monitoring their physical activity, they were more likely to be active. The findings also revealed that, at least in the initial stages of wearing a device, people reported feeling more aware of their bodies than usual, although some found wearing such devices annoying. Not all of the participants found the data generated from the devices useful or interesting, but some enjoyed seeing and reflecting upon their data.

Intel Research anthropologists Dawn Nafus and Jamie Sherman (2014) engaged in ethnographic fieldwork with members of the Quantified Self movement, seeking to document the beliefs and practices that underpinned this organisation. Nafus and Sherman discovered that discourses of mindfulness and awareness of one's body and one's life were dominant at the Quantified Self Global Conference they attended. Self-tracking was represented at this forum as different from other technological practices in its intense focus on the self or the body. Nafus and Sherman discovered that the self-trackers at the conference learnt to feel their bodies or gain insights into their selves through the data that they were gathering. They often challenged accepted norms and categories about health and behaviour and what is considered relevant information through their personalised and individualised data practices.

Nafus and Sherman further observed that Quantified Self movement members tend to combine technical, community, commercial and personal objectives and often have some kind of technological, academic or medical background. However, the emphasis on personal experience in one's qualification as a Quantified Self movement member means that participants in group meetings or conferences are encouraged to relate their own reflections of using self-tracking tools rather than

simply pitching ideas about devices or software that they may have developed. Against arguments that people who relinquish the use of self-tracking devices or practices are disaffected with them or do not find them useful, Nafus and Sherman adduce evidence from their fieldwork and interviews that suggests that people may do so because a new pattern of behaviour has become habituated, so that self-tracking is no longer required. In other words, by using the devices, people have achieved the self-knowledge and behaviour change they sought and no longer need them (see also Lee and Kristensen, 2015). Alternatively, self-trackers might try a different way of monitoring their behaviours or bodily functions, one that should be more relevant to their purposes.

In another study, Nafus (2014) investigated how people in London (United Kingdom) and on the West Coast (United States) used a digital home energy-monitoring system. Her focus was on how the participants in her research conceptualised and interpreted the data that these systems generated. Nafus' interviews revealed the complexities involved in making sense of the kind of information that is created by sensor-based technologies. Participants in her study commented on the need to contextualise the data that their monitoring system produced and on the work that was required from them in order for inferences to be drawn from what the sensors were telling them about their home energy use. As the interviews showed, the more the people learnt about their home energy use, the more questions were raised for them about what else they should be monitoring or about how they could compare their data with other people's data in a useful manner. They were confronted with the issue of how difficult it is to adequately monitor one's home energy use efficiency – for example how many sensors might be required, how the information generated by each sensor could be interpreted, and how these sensors might be understood in relation to each other. For many participants, the data were therefore 'dead' or 'stuck', as they were not useful or enlightening for their own purposes.

While for some people using self-tracking technologies may represent taking control of one's health, wellbeing and productivity, for others it may signify weakness, ill health or

lack of self-discipline. The young English users of self-tracking health and fitness apps in the research by Dennison and colleagues (2013) mentioned that they did not want other people to know about their use, because it represented them as weak or vulnerable – in need of the assistance of such apps to achieve behaviour change. They were therefore not enthusiastic about sharing their self-monitored information with friends or family members on social media sites, as using such apps was positioned as embarrassing and socially undesirable – unless contacts on such sites were working towards similar goals and thus supporting one another. Some participants also commented on the possible negative emotional effects of not making progress and having the app constantly remind the user of this (or 'telling them off'). They asserted that such apps could be helpful when a user had a preexisting motivation, but in the absence of such motivation the apps would be irritating.

I began this chapter by outlining the evolution of contemporary self-tracking practices and by providing details of the huge range of devices and technologies that are now available to engage in these practices. The research reviewed above offers several insights into what types of people engage in voluntary self-tracking and what they gain from it. Chapter 2 will introduce some compelling theoretical perspectives that can be employed to understand self-tracking practices still further and to place them within broader social, cultural and political frameworks of meaning.