Blind maps and blue dots: the blurring of the producer–user divide in the production of visual information

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4 The Strava Global Heatmap

In this chapter I will investigate the Strava Global Heatmap, a map produced by a social network for athletes called Strava, which is based on data generated by the users of its fitness tracking app.[1] Although it looks like a regular map with lines in different colours on a base map indicating water and relief, I will argue that the Strava Global Heatmap is not as ordinary as it may seem at first glance. There is a disconnection between what you see and what is on the map. It raises questions about what it shows, how it is made and whether it can count as a map at all. By identifying, untangling and scrutinizing technological, economic, social and cultural aspects of the map, and using knowledge from different fields, I will try to gain insight into the complexities of the Strava Global Heatmap.

The Global Positioning System (GPS) is a technology that is essential for all three mapmaking practices investigated in this dissertation: Google Maps' Blue Dot, the Strava Global Heatmap and Thomas van Linge's map of Syria. The satellite-based navigation system, initially developed for military strategy purposes and later opened up for civilian use, is the key technology used to determine a user's position and plot it as a blue dot on the map app on her mobile device (Chapter 3). And it is GPS that is used to define the location information that is inserted as so-called geotags with digital photographs that form the raw material for amateur conflict mapmakers to produce their maps (Chapter 5). Unlike the chapters on the practices of Google Maps and Thomas van Linge, this chapter will also look into the infrastructure behind GPS and the hardware and service industry it prompted.

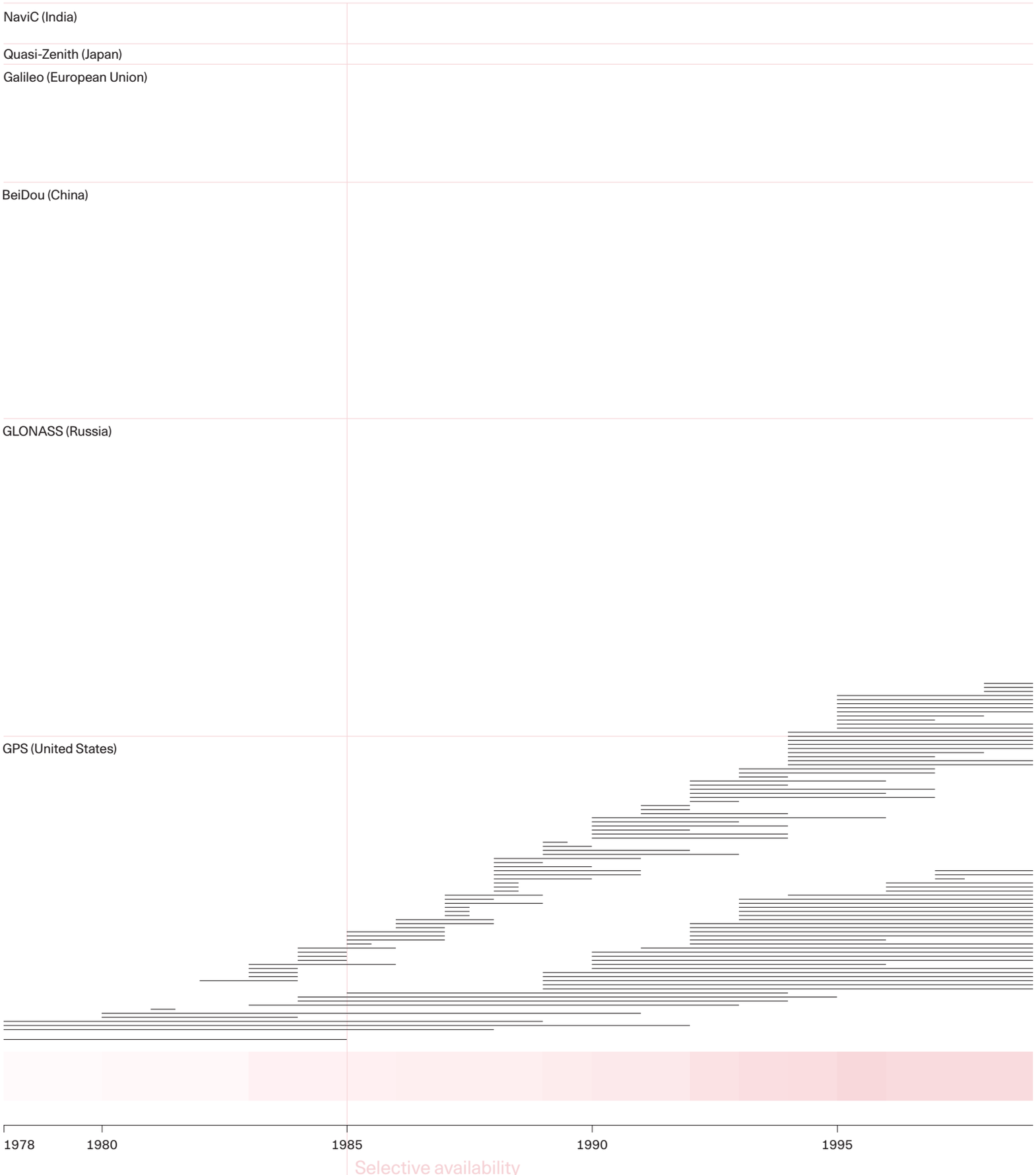
The Map

Published in November 2017, the Strava Global Heatmap shows in detail the aggregated, public activities of users of the Strava fitness tracking app of the last two years.[2] The Strava app enables users to record their physical exercise, but it is also a social media platform for sharing these activities. A heat map is a visualization of data where values are represented by a range of colours: the higher the value, the 'hotter' (brighter and/or warmer) the colours. A heat map is not necessarily a map, a geographic visualization, it can also be a diagram depicting non-geographic data. The 'heat' in the Strava Global Heatmap is the rendering of the activities of Strava users as lines on a world map. The more a certain route is run, cycled or swum, the brighter it will be displayed on the map. The Strava Global Heatmap became controversial when in January 2018 a military analyst discovered that the map shows the location of secret military bases.[3] Ironically, GPS—the technology that lies at the basis of fitness apps like Strava—was originally a closed-off military technology that was later made available for civilian use, partly to support the developing US commercial GPS equipment and service industry. After the discovery of the sensitive information about the locations of secret military bases, the discussions in the news media focussed on the privacy of users of social media and the power of technology companies like Strava, Facebook and Google to track our behaviour and use it to control our lives.

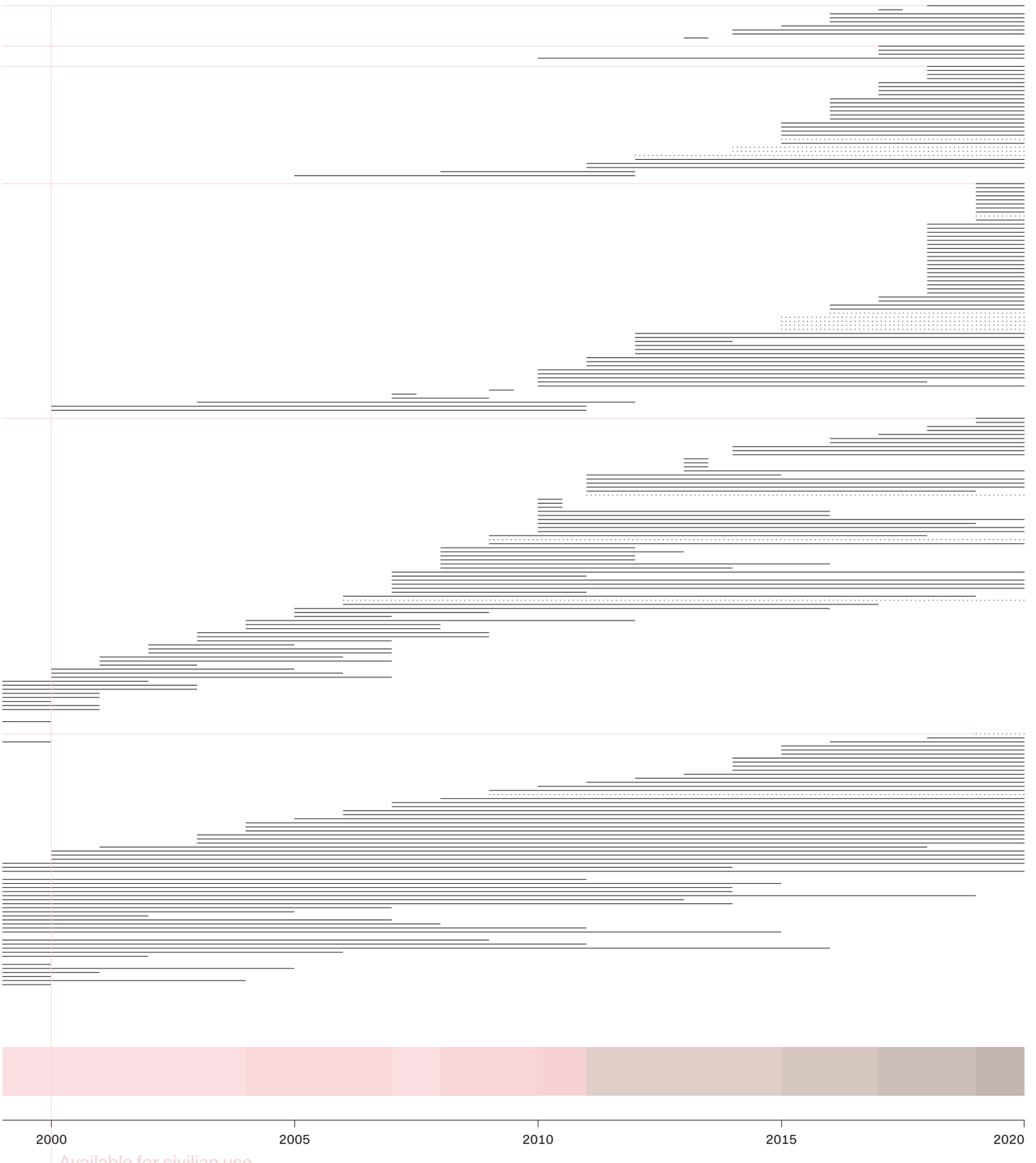
Privacy will not be the sole focus here. The main question is not so much what is revealed on the map, but what do I see when I look at the Strava Global Heatmap? What does the Global Heatmap reveal about Strava? The visual strategies of the

1 The fitness app and the heatmap are two separate entities that share certain aspects: the fitness app contains maps and the heatmap is a piece of software that the user can interact with. In this chapter I will use the term app for the Strava fitness app and map for the Strava Global Heatmap.
2 'Strava Global Heatmap'.
3 Hern, 'Fitness Tracking App Gives away Location of Secret US Army Bases'.

Satellite Navigation: Systems



This overview shows the number of active navigation satellites, both from the Global Positioning System (GPS) and from other systems. Each horizontal line represents the time a satellite is active. Satellite navigation systems consist of multiple satellites, the GLONASS network, for instance, consists of 24 satellites. Most smartphones support multiple navigation systems. The more satellites a smartphone can receive, the more accurately it can determine its position.



Operational
In reserve / Testing

Amount of operational satellites in orbit

10 20 30 40 50 60 70 80 90 100

map with its glowing lines are seductive, but I suspect there is more beneath the surface. I will look critically at a diverse range of issues, like the technological, sociological, economic, cultural and surveillance aspects behind the Strava map. Others have linked these fields to analyse current digital phenomena. My approach is to take a concrete example, the Heatmap, and link considerations from a variety of fields to its design—how it communicates and how it is produced—and the complex relationship between its producer and user.

A second topic of this chapter will be the impact of GPS on the field of cartography and how this can be explicitly observed in the Strava Global Heatmap. This second focus links this case study to the overall topic of this dissertation: the transformation of the field of graphic design as a result of technological developments of tools to create, record, edit, produce and distribute visual information, and their influence on the positions of producers and users.

The third focus is methodological, referring to the field of artistic research. Often projects in this particular field result in two parallel but separate kinds of output: academic and artistic. It is my aim to merge these two flows in formats or approaches that belong to both of these fields. For this chapter, the timeline serves as such a medium. The reason is that the Strava Global Heatmap can be much better understood by looking at temporal aspects like developments of technologies of ideas, or the linking of events, than by looking at a static object. This third topic has an ambition beyond the scope of the investigation: how to reshape my artistic practice into a research practice that uses graphic design as a means to conduct research and to disseminate the findings.

Satellites

GPS, originally Navigation System Using Timing and Ranging (Navstar), is a network of satellites and ground stations that provide users carrying a portable receiver with precise information on their location, anywhere, anytime and under any weather circumstances.[4] GPS satellites carry atomic clocks that are synchronized with one another and with ground stations. Thirty-two satellites orbit in six circular paths around the Earth at an altitude of 20,200 kilometres, transmitting data about their current time and position. A GPS receiver monitors multiple satellites and computes its precise position by measuring the time it takes to receive the different signals. At a minimum, four satellites must be in 'view' of the receiver to calculate its three-dimensional location (latitude, longitude and altitude).

The satellites, owned by the US government and launched and operated by the US Air Force, emit their signals to anyone with a GPS receiver, including those embedded in cameras, smartphones and smart wearables like fitness trackers. GPS was initially developed as a military technology, the first of its satellites was launched in 1978. For reasons of safety and economy the system, over the course of time, was opened up to civilian use.

In 1983, a Soviet plane shot down Korean Air Lines Flight 007 after it went astray into the USSR's prohibited airspace because of navigational errors, killing all 269 passengers. Following this incident, to promote increased safety for civil aviation, the Reagan administration announced that GPS would be made available as a 'dual-use technology' once it was completed.[5] This meant that GPS would

be available to everyone, but that the signal for civilian use was intentionally downgraded. Whereas the military signal would provide an accuracy of up to five metres, the civilian signal would give a position with an accuracy of up to 100 metres. It was, however, possible to improve the accuracy of this downgraded signal using a technique called 'differential correction', which involved gathering additional readings from base stations at known locations within roughly 500 kilometres (the area covered by four satellites). This enabled the reading of a position with an accuracy between two and five metres. Differential correction made the civilian signal close to or as good as the military signal and prompted the development of navigational hardware for hand-held and automotive use.

The decision to end the 'selective availability' of the signal was then made in 1996 by the Clinton administration, following a recommendation by the Secretary of Defence. From 1 May 2000 the same GPS signal became available to all. The reasons for this decision were twofold. The US military had developed technologies to deny GPS to potential adversaries in areas of operations while preserving the peaceful use of GPS services outside those areas. Also, the US government acknowledged that GPS had become an integral part of the global information infrastructure that had generated a US commercial GPS equipment and service industry that was a leading world player.[6]

GPS was first used on a large scale in the Gulf War (1990–1991)—also known as Operation Desert Shield for the build-up of troops and defence of Saudi Arabia, and Operation Desert Storm for the combat phase—in which a US-led coalition expelled Iraq's forces from Kuwait. With only sixteen of the planned twenty-four satellites in orbit, a number that would not be reached until April 1995, the system provided a coverage that lasted approximately nineteen hours per day.[7] GPS provided troops with accurate information about their location in the desert at day and during the night, which is seen to have contributed considerably to the swift 100-hour ground campaign. In contrast to the ubiquity of GPS technology today, the number of GPS receivers the US Army had at its disposal at the outset of Operation Desert Shield was limited. Of the 40,000 vehicles used in the battle, only 3,000 were outfitted with a GPS receiver. Most of these units were commercially produced models. Seven different types of GPS devices were used during the Gulf War. The two most frequently used models were the AN/PSN-10 Small Lightweight GPS Receiver (although at nearly four kilograms the term *lightweight* is relative), produced by Trimble Navigation, intended for use in vehicles and aircraft; and the smaller NAV 1000s, produced by Magellan from 1989, the first handheld consumer GPS device. The NAV 1000s sold at the time for $3,000 and measured 22.2 × 8.9 × 6.3 cm, weighed nearly 700 grams and were powered by six AA batteries, which allowed them to run for a few hours.

Following GPS, other global navigation satellite systems were built. The first satellite of Russia's Global Navigation Satellite System (GLONASS) was launched in 1982. GLONASS consists of 24 satellites and is operational since 1995. Named after Italian astronomer Galileo Galilei, Galileo is the satellite network of the European Union that will consist of 30 satellites once it is fully operational in the late 2020s. The first Galileo satellite was launched in 2011. The BeiDou Navigation Satellite System is the Chinese satellite network, which will achieve full global coverage by 2020. The first BeiDou satellite was launched in 2000. Besides these global networks, some local networks are active, like NavIC (India) and QZSS (Japan),

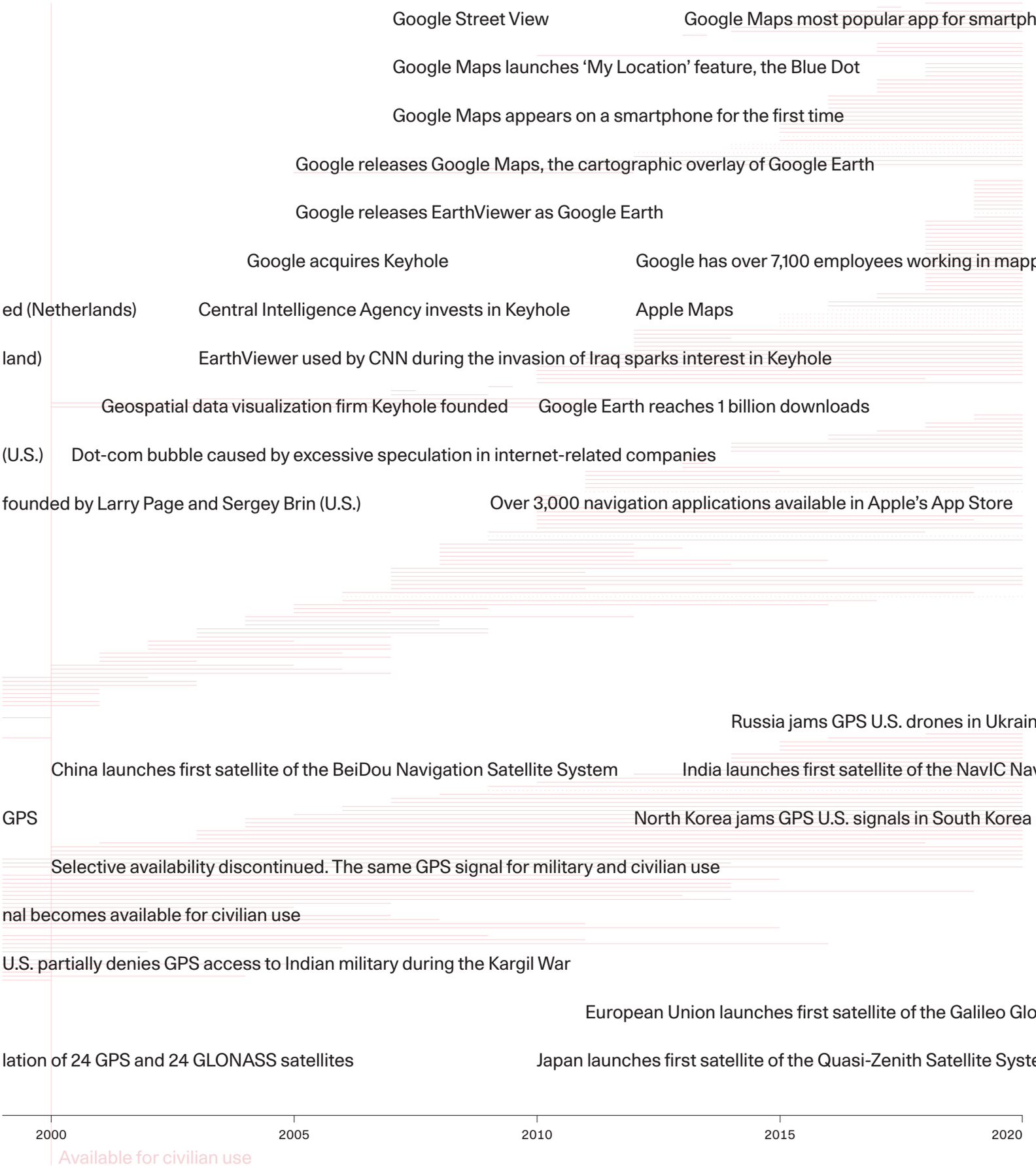
4 Kurgan, *Close Up at a Distance. Mapping, Technology, and Politics*, 39.

5 United States Department of Commerce, National Oceanic and Atmospheric Administration, 'GPS & Selective Availability Q&A'.

6 United States Office of Science and Technology Policy, National Security Council, 'Press Release U.S. Global Positioning System Policy'.

7 Dissinger, 'GPS Goes to War. The Global Positioning System in Operation Desert Storm'.

This timeline compares the development of the number of navigation satellites (4.1) with developments in technological, political and economic power.


Google Street View
Google Maps most popular app for smartphon
Google Maps launches ‘My Location’ feature, the Blue Dot
Google Maps appears on a smartphone for the first time
Google releases Google Maps, the cartographic overlay of Google Earth
Google releases EarthViewer as Google Earth
Google acquires Keyhole
Google has over 7,100 employees working in mappin
ed (Netherlands)
Central Intelligence Agency invests in Keyhole
Apple Maps
land)
EarthViewer used by CNN during the invasion of Iraq sparks interest in Keyhole
Geospatial data visualization firm Keyhole founded
Google Earth reaches 1 billion downloads
(U.S.)
Dot-com bubble caused by excessive speculation in internet-related companies
founded by Larry Page and Sergey Brin (U.S.)
Over 3,000 navigation applications available in Apple’s App Store
Russia jams GPS U.S. drones in Ukraine
China launches first satellite of the BeiDou Navigation Satellite System
India launches first satellite of the NavIC Navig
GPS
North Korea jams GPS U.S. signals in South Korea
Selective availability discontinued. The same GPS signal for military and civilian use
nal becomes available for civilian use
U.S. partially denies GPS access to Indian military during the Kargil War
European Union launches first satellite of the Galileo Globa
lation of 24 GPS and 24 GLONASS satellites
Japan launches first satellite of the Quasi-Zenith Satellite System
2000
2005
2010
2015
2020
Available for civilian use

that do not provide global coverage. All of these networks send out signals that can be received by newer devices. Sometimes up to twenty signals can be received, dramatically optimizing the accuracy of the determination of a user's location.[8]

Over time, GPS receivers became smaller, lighter, cheaper and more widely available. GPS tracking also became a feature on other devices such as digital cameras, adding location coordinates to digital photographs, to mobile phones, to smart phones, where GPS tracking is a standard feature, and to wearable technology like fitness trackers and smartwatches. The devices in the latter category are in close contact with the user and are equipped with additional technologies to collect data about the number of steps walked, calories burned, blood pressure and heart rate. In the fitness trackers the signals from remote satellites are combined with the user's internal signal of the heartbeat. GPS in these devices is not only used as a technology to know one's location, but also to track one's time.

GPS, together with the Internet, mobile mapping applications, geotagging and 'open source' collaborative tools, is one of the technologies that 'undisciplined' cartography.[9] The navigation system enabled non-specialists to collect spatial data and map them out. And while the technology offered individuals possibilities to compile their 'personal plots', as the GPS tracks are called by Lisa Parks, Professor of Comparative Media Studies and Science, Technology, & Society at the Massachusetts Institute of Technology, the Global Positioning System also provided opportunities for the state and commercial enterprises in their quest for 'total knowledge'.[10] The simultaneous difference between the 'intimate particularity'[11] of the individual GPS track and the 'total vision'[12] of an enterprise is one of the many dichotomies I encountered in the Strava case study.

Search Engines

The beginning of the twenty-first century saw an important step in the evolution of the World Wide Web, with users moving away from being only the consumers of content. The Web 2.0 emphasized user-generated content, ease of use, and the connection between the Internet and other products, systems and devices. Social media platforms like Facebook, YouTube, WhatsApp, Instagram and Twitter and web search engines like Google, Bing, Baidu and Yahoo! made it possible for users to express themselves, learn, connect and search at will.

Observing the implications of this next step in information technology, American social scientist and professor emirata at Harvard Business school Shoshana Zuboff sees a new economic and social logic that she calls 'surveillance capitalism', in which the user's behavioural data are the source of new economic value.[13] Surveillance capitalism is the feedback loop between surveillance, the accumulation of information, and capitalism, the accumulation of wealth. It is a business model for companies to track, store and analyse everything of their users and monetize this by selling it to their customers.

Surveillance capitalism was invented by Google. After the dot-com collapse in 2001, Google was under pressure from its investors to make profit. It tried to increase the revenue of advertisements by using the behavioural data that were stored but so far never used. Up until then the search terms that trigger the display of advertisements were selected by advertisers themselves. Using the substantial

analytical capabilities Google had developed for its search engines on the vast amounts of behavioural data it had collected turned out to be a historic turning point for the company. Google had a substantial success in pairing advertisements to pages and making profit from the zero-cost asset behavioural data. In this new model, users were no longer an end-in-themselves, they became a means to make financial gains.

This business model made Google one of the wealthiest and most powerful tech companies in the world. The wealth it obtained allowed it to buy and develop further products, services and tools, like YouTube and Android, currently the operating systems used on 82 per cent of all smartphones. Social media company Facebook, with over 2.4 billion monthly active users worldwide,[14] also adopted surveillance capitalism and with the profits it made acquired other companies like Instagram and WhatsApp, increasing its power.

In the 1980s, the aforementioned Zuboff formulated three laws of surveillance.[15] First, everything that can be automated will be automated. Second, everything that can be informated will be informated.[16] And third, every digital application that can be used for surveillance and control will be used for surveillance and control, irrespective of its original intention. It is especially this third law that comes into play in surveillance capitalism.

Turkish/French developer and cyborg rights activist Aral Balkan has called surveillance capitalism 'people farming', a business model that is transforming the public sphere: 'Google and Facebook want us to believe they are parks but they are shopping malls.'[17] Social media and the Internet are private space masquerading as public space. According to Balkan, the lack of public space in the digital realm is detrimental to democracy and lies at the heart of symptoms like fake news and hate and bullying on social platforms. Balkan calls the exponential power distance between users and the technology companies 'Slavery 2.0' and claims that the technology companies care more about the profile—the digital you, than the user—the you.

David Lyon, social scientist and director of the Surveillance Studies Centre of Queen's University Kingston, Canada, sees in today's world of software and networks a reduction of the body to data and the creation of data-doubles on which life-chances[18] and choices hang more significantly than on real lives and their stories.[19] Lyon refers to Zygmunt Bauman's work on the 'liquidity of modernity', introducing the term 'liquid surveillance' to describe the ubiquitous technologies and new surveillance practices that constantly check, monitor, test, assess, value and judge us. The concept I take from Lyon's theories is the dissection of data and body in the surveillance practices of social media companies: disembodied data. Whereas in the case of Strava it is the body that generates the data: no body, no data.

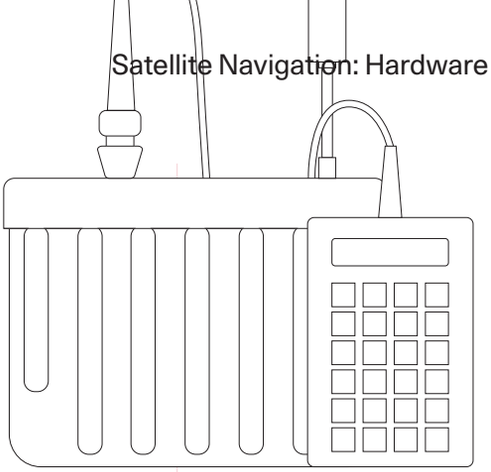
Self-Tracking

Self-tracking is the recording and monitoring of specific features of one's own life. It is also called life-logging, personal analytics, personal informatics and the quantified self.[20] These practices go back to the keeping of a diary, but have changed with the dispersion of mobile digital devices. Activity tracking or fitness

8 'What is GPS'.
9 Crampton and Krygier, 'An Introduction to Critical Cartography', 12.
10 Parks, 'Plotting the Personal: Global Positioning Satellites and Interactive Media'.
11 Ibid., 218.
12 Ibid., 220.
13 Zuboff, 'Google as a Fortune Teller. The Secrets of Surveillance Capitalism'.
14 Clement, 'Number of Monthly Active Facebook Users Worldwide as of 2nd Quarter 2019,.
15 Zuboff, 'The Surveillance Paradigm. Be the Friction—Our Response to the New Lords of the Ring'.
16 Informating is the process of translating descriptions and measurements of activities, events and objects into information. It is a term coined in Zuboff, *In the Age of the Smart Machine. The Future of Work and Power*.
17 'Digital Dystopia: Tech Slavery and the Death of Privacy'.
18 Life-chances, from the German *Lebenschancen*, is a concept of German sociologist Max Weber on the opportunities individuals have to improve their lives.
19 Lyon, 'Liquid Surveillance. The Contribution of Zygmunt Bauman to Surveillance Studies', 325.
20 Lupton, 'Self-Tracking Modes: Reflexive Self-Monitoring and Data Practices'.

Satellite Navigation: Hardware

Military GPS Receivers



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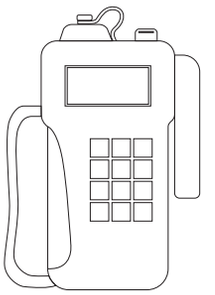
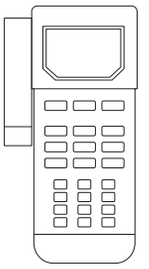


2

Commercial GPS Receivers

Hand-held



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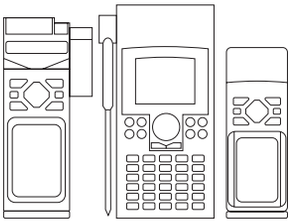

5 6 7

Automotive

Smartphones with GPS receiver

Smart wearables with GPS receiver

1978 1980 1985 1990 1995

Selective availability

This timeline compares devices that can receive satellite navigation signals, from satellite navigation devices (also called GPS receivers), to car navigation systems, to smartphones, to smart watches.

1 AN/PSN-8 Manpack GPS receiver
2 AN/PSN-11 Precision Lightweight GPS Receiver (PLGR)
3 DAGR—Defense Advanced GPS Receiver
4 Magellan NAV 1000
5 Garmin GPS 45XL
6 Magellan GSC 100
7 Garmin 12XL
8 Magellan GPS 315
9 Magellan SporTrak Map GPS
10 Magellan Meridian Gold
11 Magellan exPlorist 100
12 Garmin eTrex
13 Magellan Triton 2000
14 Magellan exPlorist 710 hiking
15 Garmin GPSmap 66s
16 Garmin edge explore
17 Garmin StreetPilot
18 Garmin StreetPilot 2660
19 Garmin c340
20 TomTom IQ routes
21 Garmin nüvi 3597 LMTHD
22 Magellan TRX7
23 Benefon Esc!
24 Blackberry 7750
25 iPhone 3G
26 HTC G1
27 ZTE 945
28 Samsung Galaxy S
29 iPhone 4s
30 iPhone 5s
31 iPhone 6s
32 SONY Xperia Z5
33 iPhone x
34 iPhone xs max
35 Samsung Galaxy S10
36 Nike+ Sport GPS
37 FitBit Flex
38 SONY Smartwatch 3
39 Fitbit Surge
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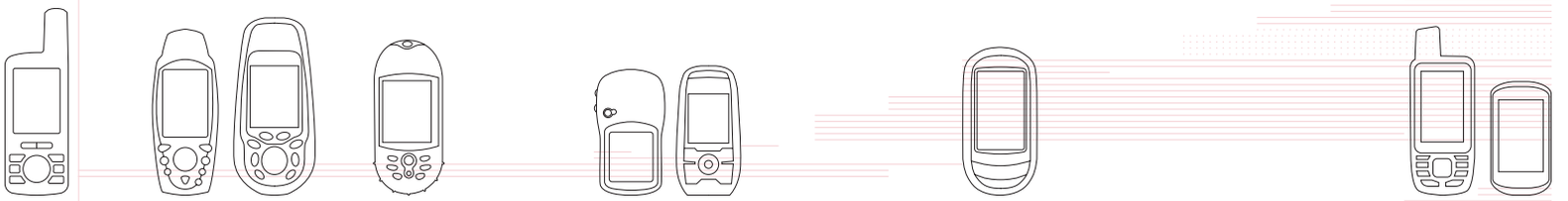
41 HuaweiBand 2 pro
42 Fitbit Ionic
43 Apple Watch Series 4
44 Garmin 945

3



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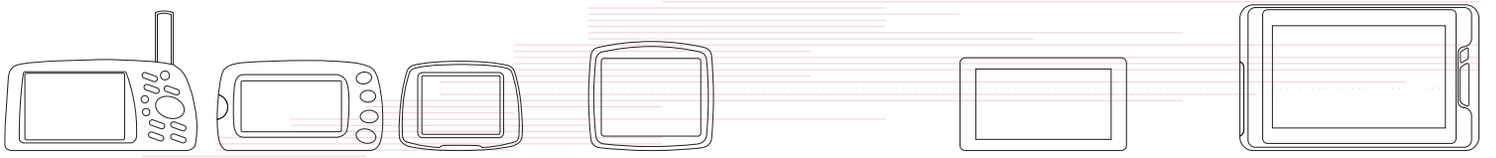

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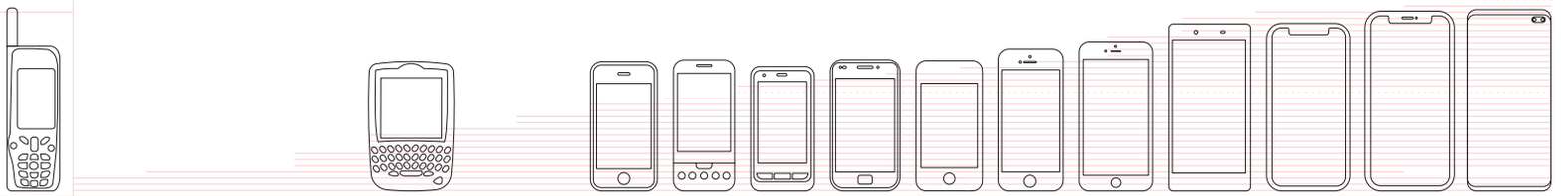

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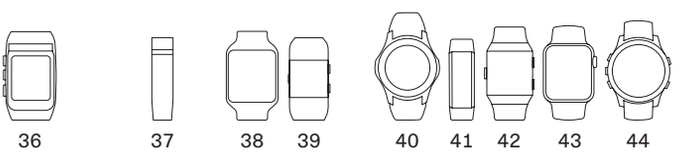


36 37 38 39 40 41 42 43 44

2000 2005 2010 2015 2020

Available for civilian use

tracking is a specific kind of self-tracking. Using the GPS and other functionalities of mobile and smart devices, the position and time of sport activities is recorded as well as the condition of the body in terms of heart rate and blood pressure. Apps keep track of the recorded data and combine these to give users insight and comparison.

Strava is a social network for athletes, more specifically runners, cyclists and triathletes.[21] The Strava website and mobile app let users track their activities and share and compare their performances with those of other users, called 'athletes', in the app. Founded in San Francisco in 2009, the company has a global reach and publishes its app in eleven languages. It is used by both professional and amateur athletes. The app is free but for €59.99 a year Strava also offers a premium membership that gives users additional features.

As a private company, Strava does not publish information about its number of premium users. For this research I created a Strava account. The personal homepage to that account, https://www.strava.com/athletes/29553709, lists me as the 29,553,709th user. It is not clear how many of my predecessors are active users. Strava is not yet profitable and has raised venture capital to compensate its expenses.[22] Strava is one of the last independent fitness trackers. Other trackers were developed or bought up by either technology firms, like Apple (Apple Health), Fitbit (Fitstar), Google (Google Fit), Microsoft (MSN Health & Fitness), Nokia (Nokia Sports Tracker), Samsung (Samsung Health), or sportswear companies like Adidas (Runtastic), Asics (RunKeeper), Nike (Nike Training Club) and Under Armour (Endomondo, MyFitnessPal, MapMyFitness). Following the acquisition of three fitness tracking apps, the American sportswear brand Under Armour issued a press release that states that the apps will help the companies' understanding of the evolving needs of athletes, that is, how they interact, consume and strive to live healthier lifestyles.[23] Kevin Plank, chief executive of Under Armour, said in a 2015 *Financial Times* interview: 'We now have the world's largest digital health and fitness community. We believe ultimately this will help us sell more shirts and shoes, reach more athletes and make them better.'[24]

In 2013, Strava published its first Global Heatmap showing the aggregated and anonymized activities of its users. The map generated the interest of city planners and departments of transportation, for whom it provided a unique opportunity to see the movements of cyclists through their cities.[25] Measuring movement is a method these planners and departments use regularly. Traditionally the measuring is done by people notating by hand. The dataset of Strava offered a unique opportunity to access many movements, at different times of the day, including routes and speed. In 2014, a new enterprise grew from this interest of cities: Strava Metro uses the data of Strava users to work with cities to improve infrastructure for cyclists and pedestrians.[26] On its website it states that over one hundred transportation planning departments use Strava Metro data. This is a paid service that charges € 0.80 a year for every Strava member being tracked.[27] Keeping the commercial enterprise of Strava Metro in mind, the Strava Global Heatmap is much more than a map that shows the data of its users. And while the introduction pop-up window of the Global Heatmap states that it was made for users to 'discover new places to be active',[28] I cannot but help to see the map first and foremost as a showcase of the technical and commercial possibilities and the data the company has to sell.

Strava not only passively tracked data for Strava Metro, it also actively encouraged users to collect more data. On 10 May 2016, Strava invited cyclists to join the Global Bike to Work Day Challenge. *#CommutesCount*, a short animation that accompanied the campaign, contains the message: 'Commuting with Strava makes cities better.'[29] If the message had been completely transparent, it would have ended with 'and Strava too', given the fact that Strava Metro is commercially exploiting the data it collects. The Strava app gives users the opportunity to not share their data. The app's default setting, however, is to accept the sharing of user data with Strava. Users have to go into the app's settings to disable tracking, but most people do not.

Not all self-tracking practices are taken up voluntarily. Deborah Lupton, professor of sociology at the University of New South Wales, Sydney, identifies five different modes: private, pushed, communal, imposed and exploited self-tracking.[30] In the case of the Strava app, a variety of these types can be observed. Many individual Strava users will use the self-surveillance app to collect information about themselves, raise self-awareness and optimize their lives.

Since Strava is also a social medium, the focus of the tracking goes beyond the individual user. Users are part of a community of trackers. The platform enables the comparing and sharing of data with other members. Another form of communality is the message Strava puts forward in its Commutes Count campaign. In an animation for the 2017 campaign, users are persuaded to take responsibility for their city and take part in an event: 'Every time you commute on Strava you create anonymous data. The data show urban planners how to improve your city. Commuting by bike is good for you anyway. Now it's good for your city too. Record your ride on May 11 for Global Bike to Work Day.'[31]

The Strava Global Heatmap revealed the locations of secret military bases as the personnel on those bases were recording their activities. Ironically, some military personnel were given the devices to track their activities by the army. In 2013 the US Army provided some of its personnel with fitness trackers to promote a healthier lifestyle.[32] A considerable number of the military personnel can be considered obese.[33] Lupton calls this mode of self-tracking, where the initial incentive doesn't come from the user, pushed self-tracking.[34] Or even imposed self-tracking if the benefit is only to the advantage of others than the user.[35]

Exploited self-tracking are those practices where personal data of users are repurposed for the (commercial) benefit of others. This is the case when Strava Metro sells the behavioural data of users to cities. One could argue that in the anonymized aggregated data it is not possible to find the data patterns of individual users. However, hacking practices and instances where datasets have been combined to uncover secrets show that the boundary between personal small data and anonymous big data is blurry at best, and non-existing at worst.

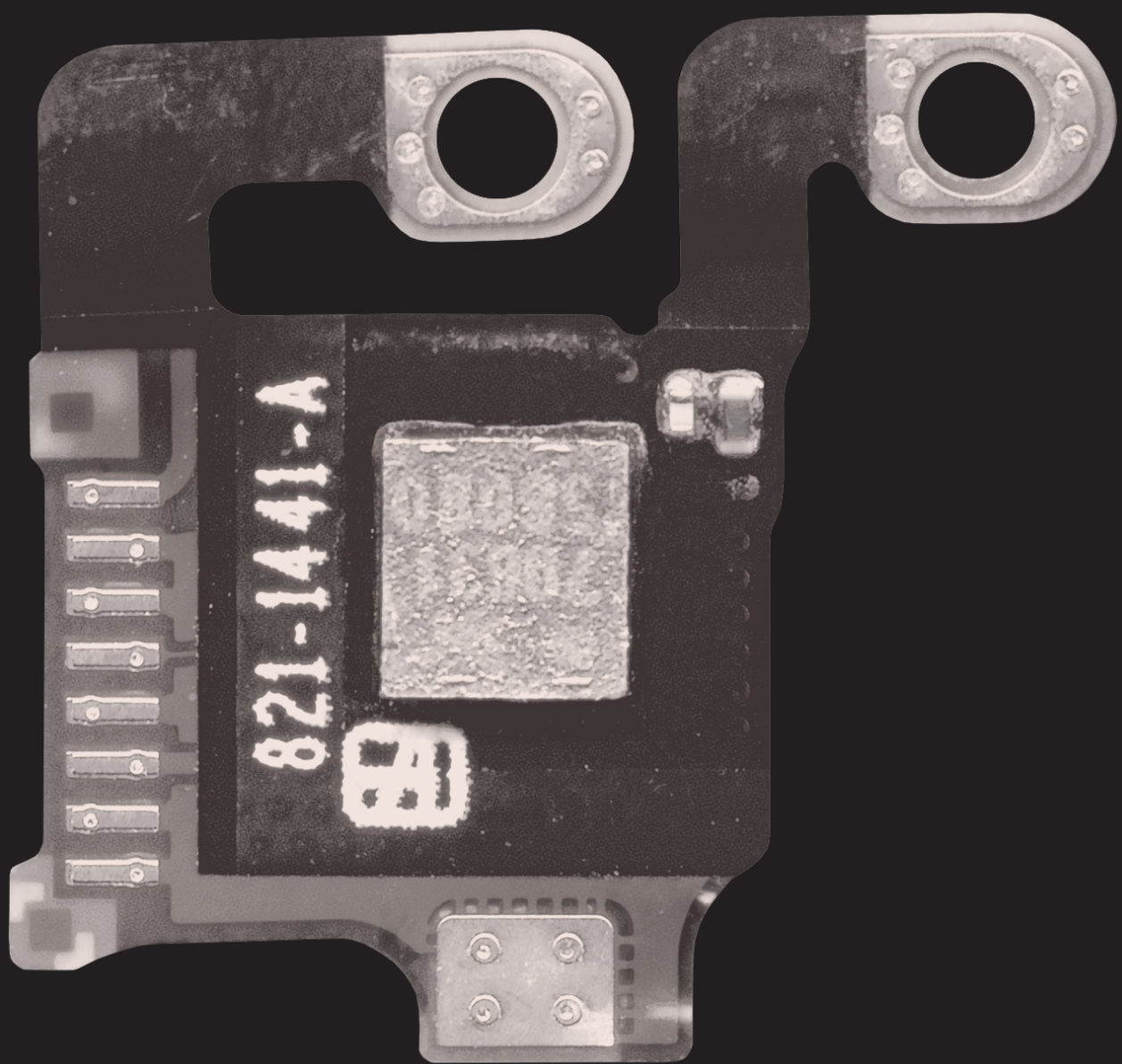
Deceiving Familiarity

On 1 November 2017, Strava published an updated version of its Global Heatmap. The map was generated using data of the past two years. In total ten terabytes of raw input, data of 1 billion activities were used to create the map.[36] The map consists of two layers: a background layer containing relief and road information

21 Strava, 'About Us'.
22 Lassiter III, Sahlman, and Misra. 'Strava'.
23 'Under Armour Reports Full Year Net Revenues Growth Of 32%; Announces Creation Of World's Largest Digital Health And Fitness Community'.
24 Bradshaw, 'Under Armour Snaps up Fitness Apps'.
25 Shaw, 'The Story behind Strava Metro'.
26 'Strava Metro'.
27 Olson, 'Why Google's Waze Is Trading User Data with Local Governments'.
28 'Strava Global Heatmap'.
29 '#CommutesCount'.
30 Lupton, 'Self-Tracking Modes: Reflexive Self-Monitoring and Data Practices', 5.
31 'Commutes Count'.
32 Lilley, '20,000 Soldiers Tapped for Army Fitness Program's 2nd Trial'.
33 Tilghman, 'The U.S. Military Has a Huge Problem with Obesity and it's Only Getting Worse'.
34 Lupton, 'Self-Tracking Modes: Reflexive Self-Monitoring and Data Practices', 7.
35 Ibid., 9.
36 Robb, 'The Global Heatmap, Now 6× Hotter'.

Many fitness trackers function in combination with a smartphone. The fitness tracker detects the number of steps taken, distance travelled on foot, number of floors climbed, calories burned, sleep patterns and heart rate. Through a Bluetooth signal, the tracker uses the satellite navigation capabilities of the smartphone. The tracker also uses the phone's connection to the Internet to store and share recorded performances online. In this series of scans, the antennas of a smartphone and fitness tracker are shown. The fitness tracker is the FitBit Flex, the tracker that the US Army gave to parts of its personnel to combat obesity among its troops.

iPhone 5 GPS antenna



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from open-source mapping platform Open Street Map and a foreground layer containing the aggregated and anonymized Strava user activities of the past two years. The map is an interactive website that lets users zoom in and out, adjust the transparency and the colour of the foreground layer, switch the background layer map for a map or filter the activities that are visible. My reading of the map is based on the default settings of the map, which are also the settings used by Strava in the communication about the map.

I will not dwell on the controversy following military analyst Nathan Ruser's discovery of secret military bases on the Global Heatmap on 27 January 2018.[37] Nor will I discuss the backlash of international news media, the response of the military or the statement and actions undertaken by Strava. Neither will I discuss what the data in the map show or does not show as the majority of Strava users are men, while it also has been argued that the Heatmap only contains activities by affluent runners.[38] For me, the controversy surrounding the discovery of secret military bases is an incident that distracts from the issue at hand: What does the map reveal about Strava and its agenda? And, what to me is a more fundamental issue, can Strava's underlying intentions be observed on the map, and if so, how?

A heat map is a visualization where values are represented by a range of colours. The term was coined and trademarked in 1991 by the then twenty-year-old American student in economics and business science Cormac Kinney for a 2D visualization of financial market information.[39] This specific type of visualization has an even longer history, dating back to matrix displays, before and after the computer era.[40] The visual format was developed by a number of statisticians, among whom the French cartographer Jacques Bertin. I suspect that when Kinney invented the name he was reminded of thermography, the photographic recording of warmth, as the colours of these photographs, ranging from blue for cold via green, yellow and orange to red for warm, correspond with the colour palette used in many data visualizations of the type we now call heat maps. The reason for this particular colour palette is that it has the largest range of colours, much larger than, for instance, from white via grey to black, and is therefore capable of showing the widest range of values.

In order to make a map of the public activities of Strava users, the data need to be filtered. First a speed threshold was applied to filter out high speeds that probably are the result of a user travelling in a car or plane.[41] Also, non-moving activities like exercises in a gym are filtered out. Still, the remaining amount of data is so large that it is not possible to generate it all at once. Therefore the map is divided into many smaller square segments—called map tiles—that are rendered separately. This process is repeated for each of the map's twenty zoom levels. At the highest zoom level, the map consists of 30 million tiles.

To ensure that the individual map tiles connect when reassembled as a map, a normalization process is applied in the translation process of data, numbers, to map imagery, pixels. Normalization ensures a uniform distribution of the different visual steps, from dark for low data values to light for high data values. Without the normalization only the single most popular areas on Strava will be rendered. The normalization technique is common in image processing, of photographic images, for instance, where it is called histogram equalization. The effect of the technique is an evenly balanced range of tones and colours that results in a strongly heightened contrast in images that are either very dark, or very light. For

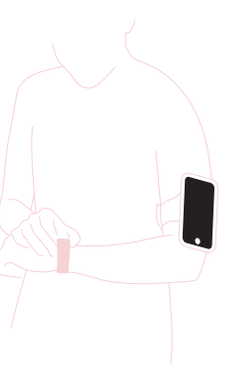
the individually rendered tiles to connect well, a normalization setting is chosen that filters out activities with little heat. Although the reasoning behind the application of a normalization filter is understandable—without it the map would be very empty in most parts or have areas that do not connect smoothly to neighbouring zones—the fact remains that data are manipulated and while the map is quantitatively accurate on a map-tile level, it is not on the level of the map as a whole. Strava admits as much in a blog post and gives two arguments for applying the normalization filter: it ensures a uniform distribution of the colour values over the map and Strava 'also subjectively finds that it looks really nice'.[42]

Another manipulation of data is the introduction of a random offset of a two-metre-wide distribution to all points.[43] Instead of several lines on top of each other for activities on a footpath, for instance, all the points that constitute the lines of the walks are dispersed randomly within two metres of that point. This will make the footpath appear wider and more blurry, it will also result in footpaths that have more activities showing up more clearly on the map as more activities are used to render the line on the map. Another reason for the random offset is that many mobile devices, most notably the iPhone, will occasionally slightly change the GPS signal in urban areas and connect it to road geometry in the device's database rather than the recorded position of the user. As a result, the aggregated activities in those instances are perceived as a thin line along the street. In the Global Heatmap the effect of this error is diminished by adding the random offset.

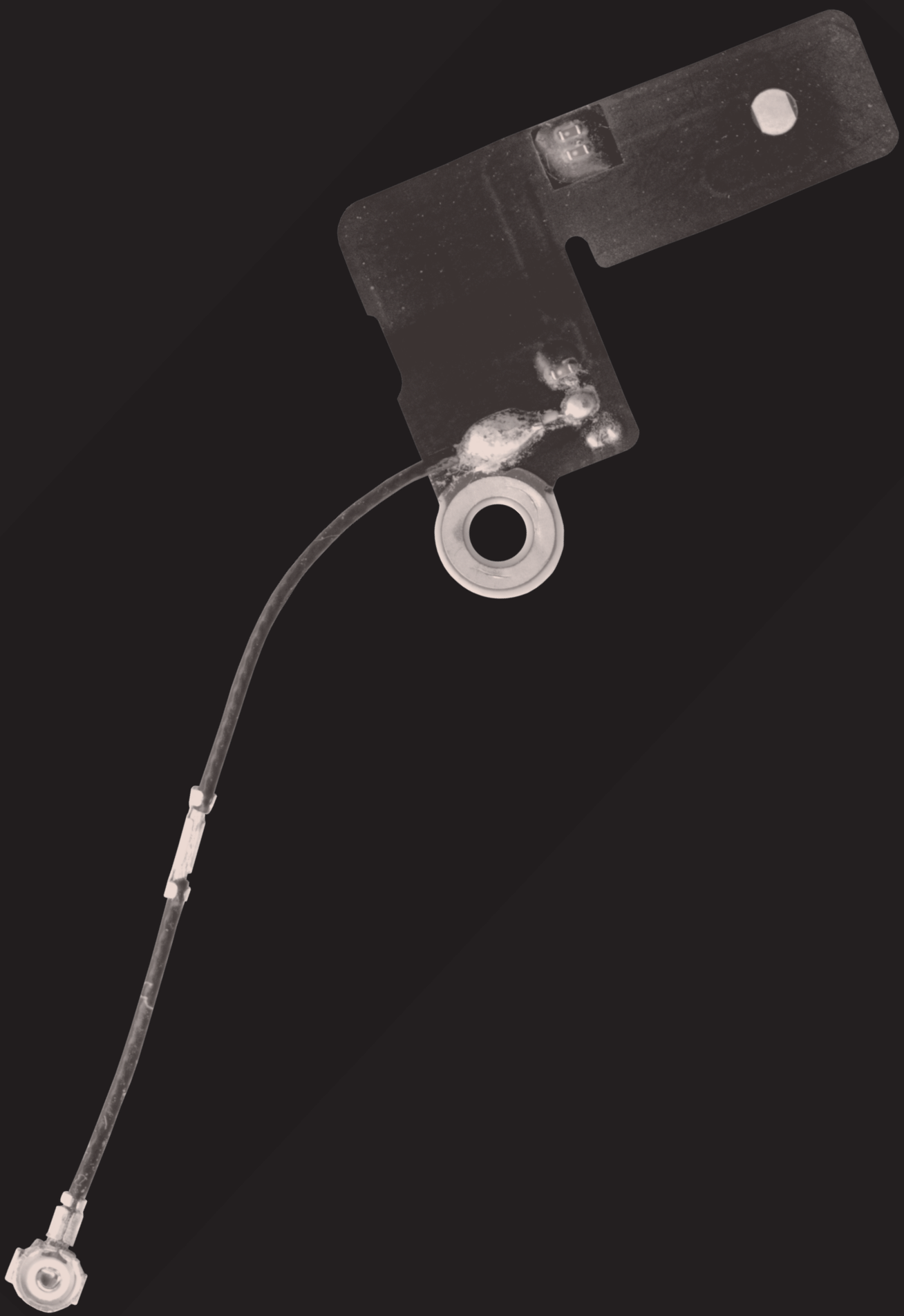
Historian of data visualizations Michael Friendly has argued that there is a trickledown effect in the understanding of visualization formats.[44] New types of visualizations are developed by specialists. Over time these improvements of maps and diagrams are implemented in publications, after which it takes some more time for the general audience to grasp them fully. This process takes a considerable amount of time and only today is a general audience familiar with formats developed in the second half of the nineteenth century. According to Friendly, this period is the first golden age of data visualization, an era with many 'milestones' in the advancement of data visualization.[45] This golden age was followed by the modern dark ages of data visualization, a period of few new discoveries. Right now, under the influence of digital technologies, we are living in a second golden age according to Friendly, but it will take some time before the improvements and new kinds of visualizations developed today are widely used and even longer for them to be understood by all.

In the Global Heatmap, processes and effects are used that refer to the photographic process. Even the name heat map might refer to photography, as I speculate that it is derived from thermography. The sharply defined background with blurry lines on top suggests a depth of field more closely linked to photography than cartography. The overall image of white blurry lines on a black background is reminiscent of long exposure photography. The process of image normalization used in the processing of the data is one often used in photographic image editing software. The effect of the image normalization, a stronger contrast, is often used in photography as well as in other graphic reproduction processes. The combined effect of these techniques and effects is an ambiguous image of a photographic map or a cartographic photograph. It is a visualization that we do not know how to read but whose visual language looks familiar.

37 Ruser, 'Strava released their global heatmap'.
38 Malouff, 'Heat maps show where people bike... or at least, where affluent people exercise by bike'.
39 US Patent 'Heatmaps'.
40 Wilkinson and Friendly, 'The History of the Cluster Heat Map', 183.
41 Robb, 'The Global Heatmap, Now 6× Hotter'.
42 Ibid.
43 Ibid.
44 Friendly, 'A Brief History of Data Visualization'.
45 Ibid., 2.



iPhone 5 Wifi and Bluetooth antenna



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Conclusion

In the Strava Global Heatmap there is a disconnection between what you see and what is on the map. The complexity and multi-layeredness of the Heatmap become apparent by listing the many discrepancies found in analysing its full process. There is the difference between the particularity of the user's individual GPS track and the total knowledge pursued by governments and enterprises using the tracks. There is also the opposition between signals of a remote global satellite network and that of an intimate heartbeat that are monitored and combined by fitness trackers and fitness apps. And there is the opposition between non-visual data and the cartographic visualization that is made from it. As well as the difference of the pretext given and what I suspect to be the true motivation for producing the Strava Global Heatmap: not to show users where they can go, but to show customers where Strava's users are going.

The discrepancy that intrigues me the most in the cartographic rendering by Strava is the difference between the disembodied point of view that the map takes and the content of showing the tracks of bodies moving. American feminist scholar Donna Haraway argues that all vision is embodied.[46] In the 1988 article 'Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective', Haraway is critical of the disembodied objective view in science that is also taken in many maps. At the same time, Haraway does not favour the opposite position according to which neutrality does not exist and all is a matter of opinion. Instead, she proposes an approach that is based on 'situated knowledges', and urges us to think outside the duality of objectivity and subjectivity. She argues 'for a doctrine and practice of objectivity that privileges contestation, deconstruction, passionate construction, webbed connections, and hope for transformation of systems of knowledge and ways of seeing'.[47] Haraway contends that by recognizing the impossibility of neutrality and by questioning one's own position, a greater claim to objectivity can be made.

I want to argue that, from a post-representational perspective, the term situated knowledges can be used to evaluate the production and use of maps. As Haraway has shown, knowledge is not neutral, it is always situated: the mapmaker always has a subjective position, even when there is no agenda or design strategy, and even if an attempt is made to ignore or disguise it. This is not only true for the producer of the map, but equally true for the user of the map. Like the producer, the user of a map is situated. Users bring experiences and value systems, they access information at a particular time and place, and they too have their particular motives for using a map. The question then remains: If both the production and the use of maps is situated, how then can an exchange of knowledge occur?

The strategies of contestation and deconstruction argued for by Haraway are absent in the Strava Global Heatmap. On the contrary, the map uses a deceivingly familiar formal language. It looks like a map, like a familiar image, but it is a visualization type we are not yet familiar with, the content of which is manipulated, using a visual language with similarities to photographic images that makes it appear well-known. If defamiliarization is the technique of disrupting the user's expectations to stimulate fresh perceptions, than the visual strategies at work in the Global Heatmap do the exact opposite. They render the map in a soothing, familiar form.

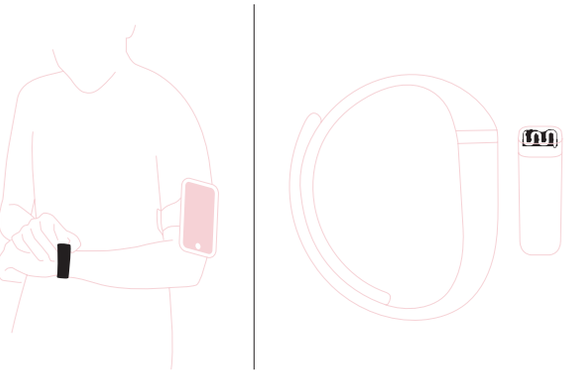
On closer inspection, the deceiving familiar strategies are at work on several levels in the case study of the Strava Global Heatmap. For example, the platforms offered by social media are presented as public space, but are in fact private space. They are not town squares but shopping malls that are designed to keep users there, maximizing the number of moments to monetize on their presence. In the case of GPS, a defence technology was opened up to empower civilians, but at the same time the move was a shift in power from military to economic dominance. And there are the GPS tracks that are personal expressions of users, selfies of their movements, scratch marks on the maps, that as part of the pursuit for total vision might reveal the patterns of our lives, the places we work, the secrets we keep.

From a post-representational cartography perspective, the deceiving familiarity of the Strava Global Heatmap raises an intriguing question: If a map is seen as a process, as an unfinished product that needs a user to complete it, can an object that is falsely understood by a user to be one kind of map, but is in fact a cartographic representation of something else, still be called a map? To me this is not a binary issue; the question is more interesting than the answer. The same can be said about the other discrepancies I encounter in this research. These are not either-or issues, but matters that are both-and.

I was not expecting it when starting this research into the Global Heatmap, but I found the Strava case study to be an endorsement of the ambiguous strategies I employ in my map design practice, which I presented in the previous chapter. The presentation of complex information asks for a design approach that both presents the content and questions itself, questions the methods and format employed to show it. When there is no clarity, show the opacity. The many layers and intricacies of the Strava case highlight this need. In Donna Haraway's 'Situated Knowledges' I found a theoretical foundation for an approach that takes the design of information even one step further: in designing information not only content and form need to be questioned, but the positions of designer and user as well.

At the Visualizing Knowledge 2019 conference at Aalto University Helsinki,[48] Finnish visual artist Antti Tenetz presented his Jalesta/Tracing project in which the movements of wolves and trout in Lapland are visualized.[49] The data derived from GPS collars is presented in multi-layered installations consisting of video, photographs and data visualizations. What struck me in his presentation, moved me even, was when he talked about the ethical dilemmas of visualizing the tracks of wolves. Making visible the movements that the animals try to hide, making public where they live for scientific or artistic purposes, also makes the information accessible to hunters. And while I do not want to draw a parallel between Tenetz's project and the Strava Global Heatmap—the Strava users voluntarily share their data and have the right to opt out of any exploitation of their information—Tenetz raises a valuable point. When questioning the contents, methods and formats of visualizations, we should first and foremost ask whether it should be shown at all.

46 Haraway, 'Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective', 581.
47 Ibid., 584–585.
48 'Visualizing Knowledge 2019'.
49 Tenetz, 'Tracing—Jalestaa'.



Fitbit Flex Bluetooth antenna

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