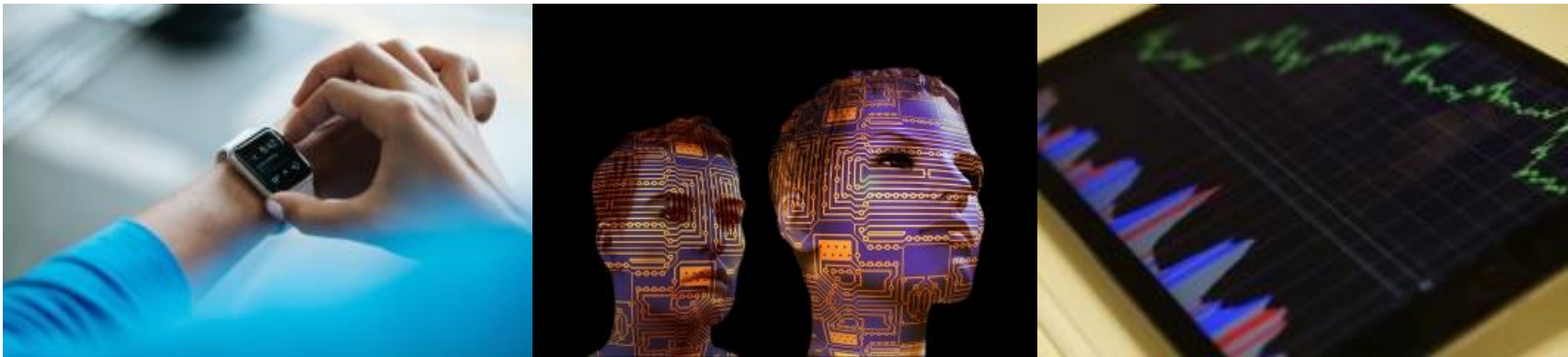# The Future of Quantified Self
Personal Sensors & Analytics

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Contents

Introduction

With the advent of smartphones and wearable electronics, personal health and fitness monitoring has been growing dramatically since the introduction of the FitBit in 2007. Previously, self-recording and monitoring of health, wellness, and other quantifiable personal data was largely manual. The first mechanical pedometers go back to the late 1700s. Personal journaling of items like weight, food intake, exercise, and other items goes back centuries further.

It is clear that people are interested in measuring themselves and using that information for self-knowledge and self-improvement. The rapid acceleration of personal electronics over the past decade has had a profound impact on the ability to automatically measure, record, and analyze personal wellness data. It has created a vibrant and sometimes volatile marketplace for quantified self products, software, and services.

This study looks at these Quantified Self sensor and analytics technologies. It attempts to identify clear probable futures for these technologies and understand their larger impact on individuals, companies, and society at large.
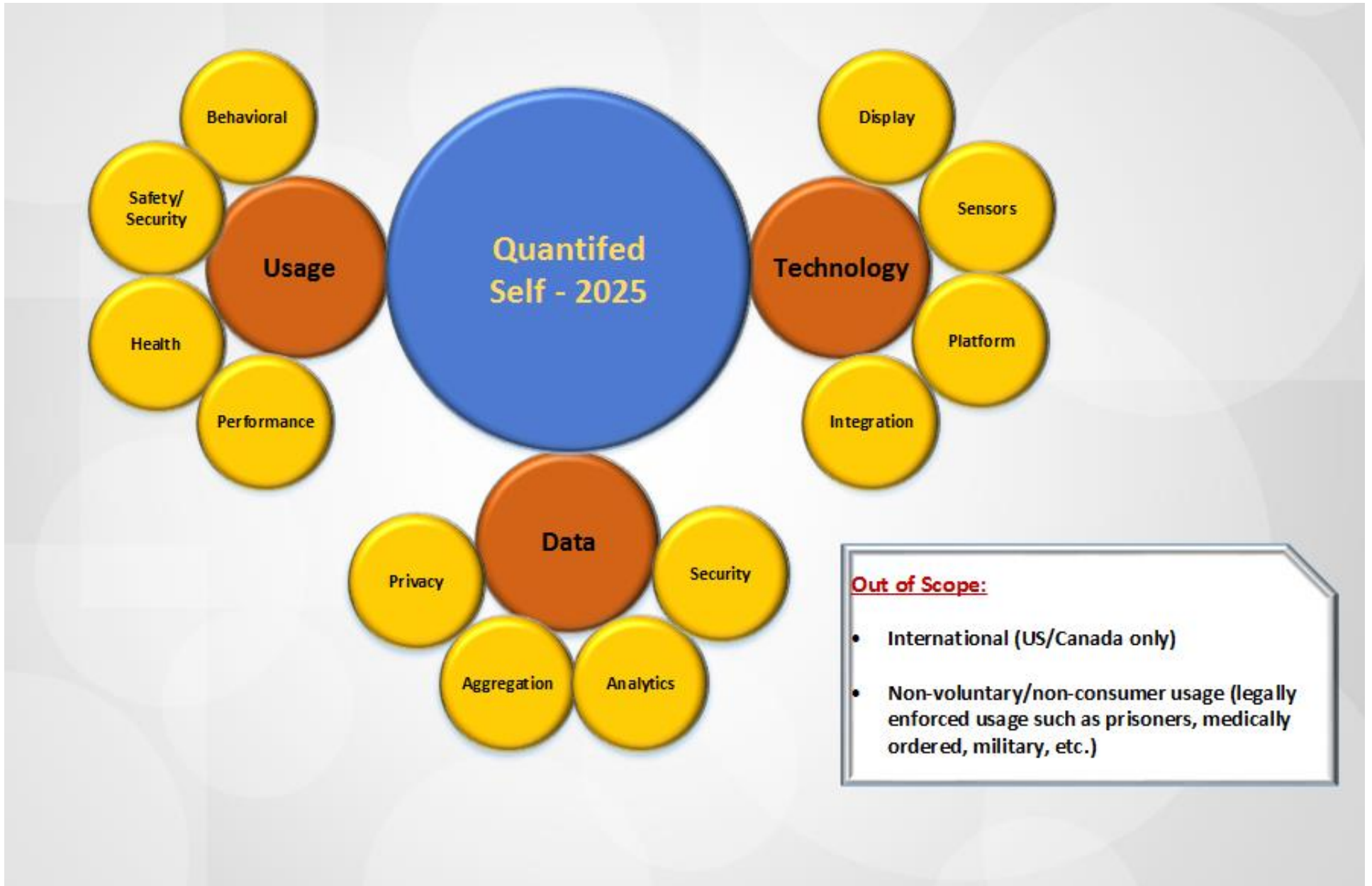
 It has been nine years since the FitBit was introduced. We now look forward nine years towards 2025 and the Future of Quantified Self – Sensors & Analytics.

Domain Description

Category	Description
Domain definition	**The Future of Quantified Self: Sensors & Analytics** Currently the consumer market is dominated by simple sensors like step trackers, heart-rate monitors, and location sensors (GPS). They are either integrated with smartphone apps or are stand-alone units used primarily for goals-based performance tracking and enhancement. The current market for wearable technology is about $30bn in 2016 and is expected to reach over $150bn by 2025. Much of that market will center around quantified self products. The goal of this forecast is to explore foreseeable changes to personal sensors, analytics software, and services within the commercial marketplace. The forecast will try to identify the future landscape of this field and along with any outside trends which may substantially influence the likelihood of certain futures within that marketplace and opportunities within those futures.
Client	**Alphabet, Inc. - https://abc.xyz/** Alphabet is an multinational conglomerate founded by Google co-founders Sergey Brin and Larry Page in 2015. It is now the parent company of Google and several other subsidiary companies originally owned by Google. They cover a broad base of areas including technology, life sciences, investment, and research.
Geographic scope	**United States & Canada**
Time horizon	**9 years – 2025 C.E.** A 9 year time horizon picked because: a) Industry leader Fitbit was founded 9 years ago. This provides a good measuring point for rate of change in the field. b) 2025 is a more viscerally satisfying date than 2026.

Key Issues or Questions	**Data ownership** – Who owns or controls your data? **Security & Privacy** – How secure is your data? How invasive will sensors become? **Market** - Is there a larger market beyond fitness/health? **Capabilities** - What new capabilities needed to appeal to wider/deeper markets? (non-traditional users, non-performance oriented, tech-adverse, passive users, etc.) **How can User Experience change with devices/services capabilities?** (Passive vs Active, simplicity vs "bottomless analytics", gamification, adaptive coaching, Augmented/Virtual Reality, etc.) **Legal implications** (self-incrimination, 3rd party monitoring, etc.) **Insurance & Liability** – Will not tracking impact your coverage? Your job? **Development strategy questions**: How fast will new sensors move into smart phones? Will separate sensor/tracker devices still be needed? What will never move into a smart phone? Will smart phones fragment into a networked collection of devices or will new features continue to concentrate into them? **Specialty Usage by age/demographic breakdown**: Different sensors? Different analytics? Different coaching styles? Different social media sharing/privacy defaults? **Killer App** – what compelling new capabilities will be possible that aren't available now?

Domain Map

Current Assessment

Category	Inputs
Current conditions	**Fitness Bands** - Currently fitness bands dominate the US wearable trackers market. Fitbit took an early lead and still holds over 60% of the market. Over 12% of Americans own a fitness tracker or smartwatch with fitness tracking capabilities. http://www.kantarworldpanel.com/global/News/Kantar-Launches-Quarterly-Report-for-Wearable-Technology **Apple & Google Data Hubs** - Apple and Google are increasingly acting as hubs for fitness data via their iOS and Android smartphone platforms. Both give developers a supporting API framework of services and data types for fitness/wellness tracking. Both Google Fit and Apple HealthKit support the development of apps which can track, store, and analyze fitness and wellness data from wearables and from sensors on smartphones. Both platforms extend to smartwatches via Google Wear and Apple Watch. http://www.wareable.com/sport/google-fit-vs-apple-health **Smartphone Fitness Apps** - Integrated smartphone fitness apps are increasingly being used to track everything from steps, food/caloric intake, exercise form, sleep, weight, and more. Tracking is accomplished through a mix of manual input and collection of sensor data from the smartphone, fitness bands, or smartwatch. Many include training and coaching guides. Most are cross-platform apps that work on both iOS and Android phones. In general, users of fitness apps are more active than non-users. http://www.active.com/fitness/articles/16-best-health-and-fitness-apps-of-2016 **Growing Market** - The market for wearables is expected to grow to over 101 million shipped in 2016. This is an increase of over 29% from 2015. Sales of fitness bands and smartwatches is expected to increase to over 213 million units shipped per year by 2020. Fitness bands currently represent approximately 50% of wearable sales with smartwatches comprising about 40%. By 2020, smartwatches are expected to be over 51% of the wearables market with fitness bands dropping to 28%. The addition of cell-connection technology to wearables is expected to drive growth of capabilities by untethering the devices from smartphones. http://www.idc.com/getdoc.jsp?containerId=prUS41530816 **Integrated Health Data** - There is growing interest with sharing personal fitness and wellness tracking data with healthcare professionals. Health & Wellness professionals want to integrate that data with electronic health records (EHRs) in order to further research and provide more personalized assessments of patient health and wellness. http://www.mobihealthnews.com/news/ehrs-and-wearables-their-time-has-come

Stakeholders	**Users**: end-point users of QS technology & services **Technology Companies:** (Fitbit, Apple, Google, Samsung, SleepNumber, etc.): Important because they currently produce the Personal sensors and apps used for commercial fitness/wellness sensing. **Medical Equipment Manufacturers:** Important because they manufacture current medical sensors and equipment for doctors and patients. **Medical/Wellness Professionals:** Likely future consumers of QS data from their patients **Insurance Companies:** Interested in improving the health/wellness of their customers in order to reduce their costs and increase their profits **Employers:** Interested in lowering healthcare costs and increasing employee productivity. **Quantified Self DIY Researchers/Activists:** Community motivated to improve the tools and techniques for quantifying their lives. Heavily composed of DIY "N-of-1" self-experimenters who conduct QS research using themselves as subjects. This group is at the leading edge of exploring personal sensors, analytics, data aggregation, and "closed-loop" control of medical/wellness devices **Competitive Athletes:** Early adopters who are using QS sensors and techniques to improve their competitive performance via improved training, digital visualization, real-time feedback, and neurostimulation.
History	**2007 – Fitbit founded.** https://www.fitbit.com/about **2007 – QuantifiedSelf.com website registered.** http://www.whois.com/whois/quantifiedself.com **2008 – Washington Post publishes article on "Quantified Self" enthusiasts who** use various websites and techniques for "Lifeblogging". Article cites lifebloggers who use online tools to self-track quantified data on things like menstruation, sexual activity, internet usage, and food intake. Lifebloggers speculate in the article on future ability to automatically record and analyze data like pollen counts, blood pressure, weight, flossing, and stress levels. The article includes a brief discussion of automatically cross-referencing data collected to gain new insights. http://www.washingtonpost.com/wp-dyn/content/article/2008/09/08/AR2008090802681_pf.html

2009 - Fitbit Tracker introduced. Clip-on accelerometer-based device tracks multiple items: steps, distance, floors climbed, calories burned, activity duration, and sleep quality. User able to log onto Fitbit website for viewing their data.
http://www.forbes.com/2010/06/11/fitbit-tracker-pedometer-lifestyle-heatlh-lifetracking.html#

2010 – Journalist Gary Wolf gives TED Talk on Quantified Self
https://www.ted.com/talks/gary_wolf_the_quantified_self?language=en

2011 – First International Quantified Self Conference held in Mountain View, CA.
http://www.webcitation.org/66TFDLCSY

2011 – Jawbone announces UP health tracker. Waterproof wristband is first commercial tracker intended to be worn continuously.
http://www.sfgate.com/business/article/Jawbone-to-release-wristband-health-monitor-2324160.php

2011 – Fitbit Sex Scandal. Fitbit website's default data sharing option causes some Fitbit users to unknowingly share recorded sexual activity.
http://www.wareable.com/fitbit/youre-fitbit-and-you-know-it-how-a-wooden-box-became-a-dollar-4-billion-company

2012 – Pebble smartwatch raises over $10M in crowdfunding, breaking previous Kickstarter records. The watch includes several sensors which could be used for self-tracking.
http://techland.time.com/2012/05/10/pebble-smartwatch-pre-orders-sold-out/

2012 – Nike introduces FuelBand fitness tracker which abstracted activity to a single "Fuel" score. Device allowed calibration for activities like yoga, weightlifting, cross-training, and cycling. High-profile marketing campaign using professional athletes raised awareness of fitness tracking devices and apps.
http://www.wareable.com/nike/not-so-happy-birthday-nike-fuelband-2351

2013 – Google Quantified Self searches peak. After an early spike to 100% in May 2011, Google USA searches of the term "quantified self" reach average peak of 80-90% interest and then begin to slowly drop off to an interest rating of approximately 30% peak.
https://www.google.com/trends/explore?date=all&geo=US&q=quantified%20self

2014 – Apple announces new smartwatch for 2015 which emphasizes health and fitness tracking features.
http://www.theverge.com/2014/9/9/6127839/apple-watch-healthkit-digital-health-fitness

2014 – Google releases Android Wear v1.0, an operating system for smartwatches.
http://www.theverge.com/2014/3/18/5522340/motorola-lg-announce-upcoming-android-wear-smartwatches

2014 – Google announces Google Fit digital health app platform for Android a few weeks after Apple announced their HealthKit platform. Both are similar smart-device API platforms which resemble the Samsung's SAMI platform, also announced in 2014.
http://www.mobihealthnews.com/34430/google-unveils-google-fit-a-fitness-platform-for-developers

2015 – Fitbit IPO is 36.6M shares, target price $20/share
http://www.nasdaq.com/markets/ipos/company/fitbit-inc-789726-78353

2016 Sept – Apple Inc. announces ResearchKit, & CareKit. ResearchKit framework allows medical researchers to build research apps, recruit participants, and collect data directly via participant's iPhones & iWatch. CareKit framework to create personal care apps, including the ability to connect self-monitoring information directly with care providers.
http://www.apple.com/researchkit/

2016 Sept– Fitbit valued at $8B
http://money.cnn.com/2015/06/22/investing/fitbit-stock/

Baseline Inputs

Category	Description
Trends	**Two Houses Alike in Dignity** - *Holding Steady* – Several market-leading consumer fitness tracking systems and smartwatches (Fitbit, Apple, Samsung, Sony, Jawbone, Pebble) integrate with the two dominant smartphone platforms, iOS & Android. https://www.cnet.com/topics/wearable-tech/buying-guide/

Targeting the Niche – *Holding Steady* - Several smaller companies (Garmin, Misfit, Mio, Polar) offer a range of fitness trackers targeting specific market niches. http://www.pcmag.com/article2/0,2817,2404445,00.asp

There's A Bunch of Apps for That - *Holding Steady* - Multiple third-party general purpose fitness apps (MyFitnessPal, FitStar, Map My Fitness , etc.) integrate with current fitness Apple & Android platforms. The business model is usually to provide app & basic services for free, with advanced features and support for monthly or annual fee. http://www.active.com/fitness/articles/16-best-health-and-fitness-apps-of-2016

Medical Data Integration - *Increasing* – Apple & Google are both increasing work on integrating data with medical experts and research. Apple is focusing on shorter-term direct integration via HealthKit and CareKit. Google is focusing on longer term advanced research on medical wearables and sensors via Alphabet's subsidiary, Verily. http://www.recode.net/2016/3/21/11587162/apple-may-be-edging-out-google-in-health-care-because-of-the-iphone

Smartwatch Uber Alles – *Increasing* – Fitness bands have lead sales to date. However, the distinction between fitness bands and smartwatches is disappearing. Most fitness bands now incorporate significant smartwatch functionality. http://dazeinfo.com/2016/05/06/wearable-devices-market-smartatch-growth-q1-2016/

QS Colonization – *Increasing* – Interest the Quantified Self movement ("self-knowledge through numbers") appears to have peaked in 2013 based on Google Trend data. Current interest leveled off at about 30% of that peak. However, the QS self-measurement ethos seems to have spread into the general population with the advent of tracking technology. The Google Trend data for "Fitness Tracker", "Fitness App", and "SmartWatch" show much higher relative interest and trend to continued growth. https://www.google.com/trends/explore?date=all&q=quantified%20self,fitness%20tracker,fitness%20app,smartwatch

Corporate Wellness Partnering – *Increasing* – Businesses who supply their employees with health insurance are turning to wellness programs to lower costs. Tracker tech companies like Fitbit are partnering with companies to integrate fitness tracker data into their wellness programs. http://www.businesswire.com/news/home/20160607005759/en |

	Sensor Fusion – *Increasing* – Due to the ever increasing types of personal sensors available there is a need for unified analytics of diverse sensor data. Multi-sensor data fusion allows deeper analysis of both what is happening with the person and with their environment. https://www.qualcomm.com/news/onq/2016/01/20/sensor-fusion-merging-your-data-one-story **Optimized Athletes** – *Increasing* – Olympic and other competitive athletes are increasingly turning to wearables to measure performance data and provide real-time coaching. Given the fiercely competitive nature of international competition, athletes at this level can be considered early adopters of technology that will someday make its way to the consumer level. https://www.losant.com/blog/top-connected-tech-used-by-olympic-athletes
Plans	**Apple Inc.** wants to be 'in every part of your life we can'. It plans to dive deeper into the health world, beyond what it is currently doing with HealthKit, CareKit, ResearchKit, and Apple Watch. http://appleinsider.com/articles/16/08/08/apple-ceo-tim-cook-says-future-products-will-be-in-every-part-of-your-life-that-we-can **Alphabet Inc., the parent company of Google,** has a growing collection of companies pursuing "moonshot" high-risk/high-reward projects. Many revolve around healthcare, wellness, and sensors: Project Soli which uses radar to detect micro motions, Google DeepMind a Big Data A.I. which is being applied to everything from winning GO to diagnosing eye disease, extending average lifespan ("curing death"), a comprehensive Human Baseline study to push medicine to prevention instead of treatment, wearable multi-sensor medical monitoring wristband for clinical trials, a pill that can detect cancer, glucose monitoring contact lenses, and devices to assist with Parkinson's Disease. http://www.techinsider.io/20-moonshot-projects-by-google-turned-alphabet-2016-2/#smart-contact-lenses-5
Projections	**"Smart Clothes and the Future of Wearables"-** Smart clothes, not wearables are the future. Smart clothes will sense the user and the world around them, and interact in new ways. http://www.bostoncommons.net/smart-clothes-and-the-future-of-wearables/?doing_wp_cron=1474434413.2010788917541503906250 **"Trend Report: The Future of Health, Fitness and Wellness!"** - Convergence of trends lifestyle/aging health care crisis, shift to preventative medical care, increased pressure from employers to decrease costs via employee wellness programs, and consumerization of healthcare via technology. These combined trends will result in personal fitness tracking being used in conjunction with trainers and wellness/healthcare professionals to improve individual wellness and fitness. https://www.jimcarroll.com/2012/07/trend-report-the-future-of-health-fitness-and-wellness/#.V-IVePkrJhE **"The future of tracking: Measuring health, fitness and happiness in 2017 and beyond"** – The focus for food tracking will be on improving tracking of caloric intake, particularly through blood glucose measurement. Fitness trackers will move away from tracking steps, time, and calories burned in favor of measures of effort like heart rate & recovery, blood oxygen level, REM sleep, and core body temperature via smartpills. Emotion & Stress tracking will go from manual entry to direct measures like galvanic skin response and skin temperature. Integration of data from social media, calendar, and fitness apps will give a real time picture of your current state. A.I. based data-driven coaching apps will guide user with tips and suggestions. http://www.wareable.com/health-and-wellbeing/future-of-tracking-health-fitness-happiness-2017

Baseline Future Summary

Title & Description	**Smartphone Sensor-log** Tracker Apps will work with smartphones and new sensors to track an increasing number of personal fitness & wellness factors while consolidating that data into integrated sensor logs for use by users and their medical professionals.
Abstract	Fitness trackers are giving way to a collection of smartphone-centered technologies which gather data from smartwatches and custom wearable sensors. Fitness & Wellness apps still proliferate. They compete on features like coaching, wellness education, and rudimentary assessment of the sensor data. Tracker apps are a hub component that provide integrated data views along with some real-time feedback to the users. Users are the primary consumers of their own sensor data via smartphone apps. Increasingly, their health care providers are using that data when available.
Key Drivers	**Fitness Bands & Smartwatch Dominance**: Dedicated fitness bands and smartwatches with fitness sensors will be the primary source of activity tracking data for most users. Most will be able to operate untethered from smartphones, but users will use smartphone apps to look at the data, set goals, and track non-sensor data (food tracking, moods, pain, etc.). The distinction between fitness bands and smartwatches will blur together as each adopts more of the features of the other. Other peripheral sensors will be available, but will supplement and not replace traditional fitness trackers. **More Sensors, More Data:** Each year more and better wearable sensors are available in consumer fitness tracking devices. What were once expensive specialty or medical-only sensors will now be incorporated into consumer trackers: oxygen level, blood pressure, skin temperature, glucose, environment conditions, and so on. Combined they will provide a flood of continuous measurement data to users via a diversity of wellness & fitness apps. The challenge will be to integrate that data in a way that helps users monitor and improve their wellness and fitness. **Motivated to Track:** The fitness tracker market continues to grow, primarily in the 35-54 age range. This suggests that working age adults are the primary consumers, and that they are using them to supplement their desire to be more fit as they age. Businesses are paying attention to employee and encouraging employees to use tools like fitness bands to track and improve their health. **Smartphones & Apps:** Smartphone apps will continue to be the focal point for sensor data visualization, goal-setting, and coaching/behavior modification. Both iOS & Android will continue to add capabilities to their supporting APIs and services to enhance user capabilities, data sharing between apps, and support for new sensors. Apps will continue to proliferate to help consumers use the wide variety of data they can now track. **Moving into Medical:** There is a strong push by Apple, Google, and others to integrate personal wellness data with medical records and research. The limitation is primarily on the medical side with a profusion of electronic medical records standards, incompatible healthcare provider systems, and lack of technical infrastructure to integrate self-collected wellness data into traditional medical records.

Baseline Narrative

Smartphone Sensor-log is a future where the smartphone-wearable ecology has stabilized around a cluster of cooperative technologies. While the fitness tracker market is relatively young, it has matured into a stable form in less than 20 years. That form consists of a combination of smartphones and sensor bands tracking various aspects of user fitness and wellness: movement, sleep, heartrate, food intake, and so forth. The major players vie for dominance on selling the hardware while a plethora of apps collect and present that information to users. App features abound. Both iOS and Android support an ever increasing number of sensors and tracking features via their APIs.

Some back-end integration with medical professionals and researchers is happening, but they are largely bespoke efforts dependent on app-frameworks and services provided by Apple and Google. It isn't clear yet to medical professionals how to use this sporadic influx of ever increasing daily wellness data from their patients or how to tie it to still evolving electronic medical records. The challenge of how to transform traditional healthcare into wellness care is a discussion topic that is finally pushing many medical professionals and insurance companies to look closely at how they can leverage personal health tracking. Even after almost a decade, they are still struggling to create a unified framework for wellness using data that their patients are recording daily.

The resulting lag is leaving wellness activities primarily up to the consumers themselves. They are using a scatter-shot combination of apps and trackers to help them manage their day-to-day fitness and health goals. The downside is that this leaves most people vulnerable to the "diet effect" where people focus for a few weeks or months and then stop using the tools to monitor and improve their life, until a triggering event causes them to resume their efforts.

Smartphone and wearables companies have responded to this by constantly adding new sensors and new app features to attract the attention of users. The marketplace is a mix of free and subscription applications which give users a dizzying set of options and interfaces for tracking, organizing, and assessing fitness data. The only real difference between them are features and fashion. All effectively boil down into logs of various sensor data and user entered information. Some apps target specific types of sensors or tracking information. Others try to act as aggregators of all the information. Others de-emphasize tracking data in favor of features like coaching, motivation, and social connectivity.

Most tracker apps do very little correlation or trend analysis on the data logged. So the primary use is simple metrics: did I walk farther, did I swim faster, is my heart-rate higher, etc. The combination of tracking sensors plus apps function primarily as a **sensor-log**, leaving the hard work of analysis to the user, if at all.

In this environment, Fitbit and other fitness band manufacturers are losing their dominance in the market. Fitness bands are turning into branded smartwatches or focusing on niche specialty markets. Smartwatches and bands are semi-independent devices. All are network enabled, with some functioning as mini-cellphones in addition to their other capabilities.

Alternative Future Inputs

Category	Description
Trend Breaks	**Privacy is for People who are Hiding Something -** Shift to less concern about privacy/security of personal health & wellness data as demographic wave shifts from Boomers/Gen-X to Millennials/Gen-Y. **Healthy Snack Kids Lead the Way** - Less desire for self-monitoring/tracking as American obesity & fitness levels improve due to education, higher food nutrition standards, and continuing rise of health culture lead by young adults raised to be more mindful of health & wellness behaviors. **Fitbit Fights Back** – The growth projections around smartwatches turns out to be hype. Most consumers prefer cheaper dedicated fitness trackers like Fitbit or Jawbone over expensive Google or Apple smartphone integrated smartwatches for tracking fitness activities. **No, There is Another** – An upstart company disrupts Apple & Google's co-dominance of the smartphone & smartwatch markets. **EMRgent Standards** – Medical and insurance companies radically accelerate development of secure and flexible Electronic Medical Records standards, effectively creating a virtual medical chart that follows patients around wherever they go. **Apps are SO Last Decade** – A combination of IoT technologies, Adaptive A.I.s, and cloud-based Big Data repositories replace the idea of smartphones with ubiquitous Environmental Interfaces. You probably have a smartphone, but you use it as an I/O device for your adaptive Personal A.I. Assistant, and not for running discrete apps. **No I Won't Swallow That** – Development of new types of commercially available wearable personal sensors stall out. Advanced sensors like gut flora monitors, implantable glucose monitors, and the like remain in the prescription medical realm. Your tracker is still used mostly for counting steps and measuring heartrate. **You Can Lead a Horse to Water** – Health and Wellness initiatives by Employers and Insurance companies have little or no effect on employee wellness behaviors. Expensive wellness trackers and coaching go unused by most. **Failure Is an Option** – Insurance companies find that tracker-enhanced wellness programs don't drive costs down as much as hoped. When the costs are far higher and the results negligible. Hoped-for actuarial insights from feeding tracker data back to the insurance companies results in nothing useful.

Events	**GOOGLE BOWS TO APPLE** – Google's multi-year attempt to adopt an Apple-like integrated Hardware/Software approach with its smartphone and smartwatch business fails. **CRISPR CURES OBESITY** – Bioengineers use CRISPR to create health-promoting viruses and customized gut-flora that significantly increase a person's muscle mass and decrease their fat via metabolic changes. **I, CYBORG** – Advanced A.I. driven robotics technology gives people "support suits" that continuously monitor health conditions, increase balance, supplement strength, and guide people through proper form when exercising. **ALLCARE EVERYWHERE** - A Millennial-driven wave of health care reform tosses out Obamacare in favor of a national expansion of Medicare & Medicaid for everyone. Insurance companies still provide independent supplemental insurance in addition to being co-partners with the new federal AllCare insurance.
Issues	**Technology Adoption** - Will adoption of fitness and wellness tracking technologies change from intermittent or goal-oriented usage like weight loss to more general wellness monitoring? How extensively will trackers be adopted in general? **Privacy & Security** - Will concern over privacy and security prevent sharing of data with medical professionals and insurance companies? **Effectiveness -** Does automatically tracking personal sensor data result in improved health and wellness for most people? Does it change health behaviors in the long term? **Consumer Cost** - How far can personal sensor technology be developed at consumer prices? Will we see commercial versions of non-invasive Glucose monitors, mental/emotional state sensors, Neural Dust, pathogen sensors, and the like? **Data Aggregation Impact** - Will cultural changes occur as aggregate health data from personal sensors reveals the impact of work-induced stressors and demands? Will employers start employee health metrics into account when evaluating policy? Will investors want to see that same aggregate health data? Stockholders? Customers? **Adoption Curve** - Is there a diminishing return on adding more sensors and more features to trackers and apps? How much of demand is being driven by a desire to track versus the novelty of tracking something new?

Ideas	**Good Health is Good Business** - Health & Wellness metrics of employees become part of Quarterly & Annual Reports, under the theory that you can't be a profitable company unless your workforce is healthy. **Quantifying Others -** Using technology to quantify the physical and emotional states of people in your proximity will alter social dynamics. People with low-social awareness such as individuals on the Autism-spectrum might use the tech as a Prosthetic Social Sense. Others might use it in a predatory fashion for high-pressure sales, emotional coercion, gaslighting, or worse. **Quantified Spirituality** - Advanced personal sensor analytics might be used for technologically enhanced spirituality training. Breathing, stress control, mental states, and other measurable factors could be combined with spiritual guidance techniques to accelerate certain types of emotional and spiritual development. **SimMe** - Deep analytics of environment, food intake, and other factors could lead to customized Personal Health Simulacra. Want to know what you need to eat to prep for that 10k next week? Run some simulations. Feeling rundown lately? Run some dietary substitution simulations and see if what you are eating lately is affecting your health.
Key Uncertainties	Are most people really interested in measuring aspects of themselves regularly? Is there really a deep demand for automatic personal tracking, or is it being created by the availability of the technology and product marketing? How close to the top of the adoption S-curve are we?

Alternative Future Summary

Title & Description	**BRoBOt - Your Personable AI Training & Wellness Coach** Customized adaptive personal A.I. assistants use your Electronic Medical Records coupled with continuous personal monitoring to help you achieve your health and wellness goals.
Abstract	Big-data, Deep-Learning A.I.s, and agent/agenda based "smart" chatbots converge into a new application interface for digital technology: Personable A.I.s. This convergence of new adaptive A.I. services begins to replace traditional static apps due to flexibility, extensibility, and ease of use. An early and obvious application for this technology is to manage both a person's environment and their personal data. It is quickly applied to health and fitness tracking since it provides a superior way to integrate diverse sensor and personal data and provide deep insights into the meaning of that data. Combined with personal medical records and medical research, these A.I. tools gain the ability to model and predict what users need to do to improve their health. This technology is adopted rapidly because it mimics the best known way to improve fitness: a dedicated personal trainer. These human-mimicking chatbots proactively work to encourage and motivate behavioral changes in a way that mitigates the "Diet Effect" of personal self-improvement resolutions. Other events or trends in society will accelerate the adoption and usefulness of these A.I. fitness helpers by accelerating the development of deep-learning A.I.s (algorithmic marketplaces & open source A.I. tools), improving the data available (Electronic Health Records), and profusion of commodity sensor bands and disposable sensors. Additionally, the general adoption of "Personable A.I." services as a replacement for other common uses (smartphones, web apps, etc.) will accelerate the adoption of that technology too. What will result by 2025 is a new way of interacting with your own sense of wellness via a virtual friend or coach that algorithmically knows more about your level of health than you ever will. Coupled with natural language communications, medical knowledge, sound psychological motivation techniques, and proactive rules-based agency these new Personable A.I.s will become your coach to a healthy maintainable lifestyle.

Key Differences from the Baseline	**Baseline:** **Smartphone Sensor-Log -** Fitness and wellness trackers will work with smartphones to track more and more aspects of personal fitness and wellness via a variety of apps **Key Differences:** • Online services combining Deep-Learning A.I.s, Big-Data, A.I. Driven Chatbot Interfaces replace dedicated App software with flexible and adaptive computing frameworks which present a uniform "personable" human-like interface to the user. • Smartphones & Smartwatches become defacto peripherals supplementing Personable A.I.s. In the tech world, discrete apps are considered an old-fashioned, inflexible approach to human interfaces and software architecture. • Dedicated fitness trackers stabilize into a common set of cheap non-invasive sensor packages, some disposable, which mostly track physical properties like movement, BP, heartrate, and the like. Swallowed or "wet" sensors that require breaking the skin are restricted to purely medical use, and are not used for fitness purposes, except by high-performance athletes. • Deep Learning A.I.s become virtual sensors themselves via deep-learning analysis of integrated sets of personal sensor data, environmental data, social media coupled with authorized access to the Electronic Medical Records of the user. • Normal resistance by most people to "eat right and exercise" slows market expansion of traditional fitness tracking apps and trackers in the late 2010s, including use of integrated smartphone/smartwatch sensors & apps. • Medical and wellness professionals see Personable A.I.s as a new motivation tool for helping people improve or maintain fitness levels, since they can be used to proactively reinforce behaviors towards measurable goals. • Due to the continuing healthcare cost crisis, another attempt at universal healthcare is attempted in the US: ALLCARE. A public/private partnership centered around universal access to for-profit enhanced versions of Medicaid & Medicare, it prompts rapid adoption of industry wide standards for Electronic Medical Records. The government, insurance, and medical companies lead the way to fully portable Electronics Medical Records, not tech giants like Apple & Google.

Alternative Future Narrative

Apple won the smartphone wars but lost the real battle: A.I. Assistants. The explosion of deep-learning A.I. advances leading into the early 2020s quickly supplanted smartphones and their apps with big-data driven A.I. engines which provided seamlessly integrated free and paid services through natural language interfaces. Modeled on the actual personalities and communications of real people, these interactive A.I. bots went beyond the passive voice-activated tools like Siri or Cortana to become active participants in people's lives. By 2025, discrete apps are dying off and adaptive A.I.-based services are the "hot new thing".

Just as the FitBit-driven fitness tracking movement was starting to fade into a small corner of the dying smartphone/smartwatch revolution, these powerful and personable new A.I. services breathed new life into personal health improvement. Coupled with ALL your sensor data and ALL your social media history and ALL your medical records, they quickly began to transform fitness tracking from sterile collections of measurements into true active coaching and life skills management. These goal-seeking chatbot "friends" actively monitor every aspect of your life, give you updates on your progress, and then use social media and other tools to privately and publicly encourage you towards your health and wellness goals.

Companies like *BRoBot* or *SweatMama* specialize in different approaches and bot personalities for fitness coaching. Sponsored "free" bots are fairly generic in both personalities and features. Paid bots are typically the realm of people who desire deeper training methods, better coaching, or more "natural" bot personalities. From "encouraging friend" to "brutal drill instructor" and beyond, there is a healthbot personality for everyone (for a price).

With the new ALLCARE medical plans available, most US citizens can get the disposable biosensors and body trackers needed to feed their bots wellness data. Just authorize your bot to ping your local pharmacy with a wellness equipment request and a copay authorization. Even the doctor doesn't have to approve it any more, if your bot can make the medical case to his medical office A.I., which happens most of the time.

Still, not everyone is adopting these new A.I. services, particularly for health management. The older Gen-X "junk food" generation still hasn't quite got the hang of trusting personable A.I.s with managing their video collections much less their health and day-to-day living. Fortunately, advances in targeted genetic repairs along with new robotic Exomuscle Support-Suits allow growing numbers of oldsters to gain some of the benefits that younger & healthier bot users enjoy.

Just don't tell them that the silent A.I.s embedded in their new "walkers" are sneaking in a bit of extra cardio into their day.
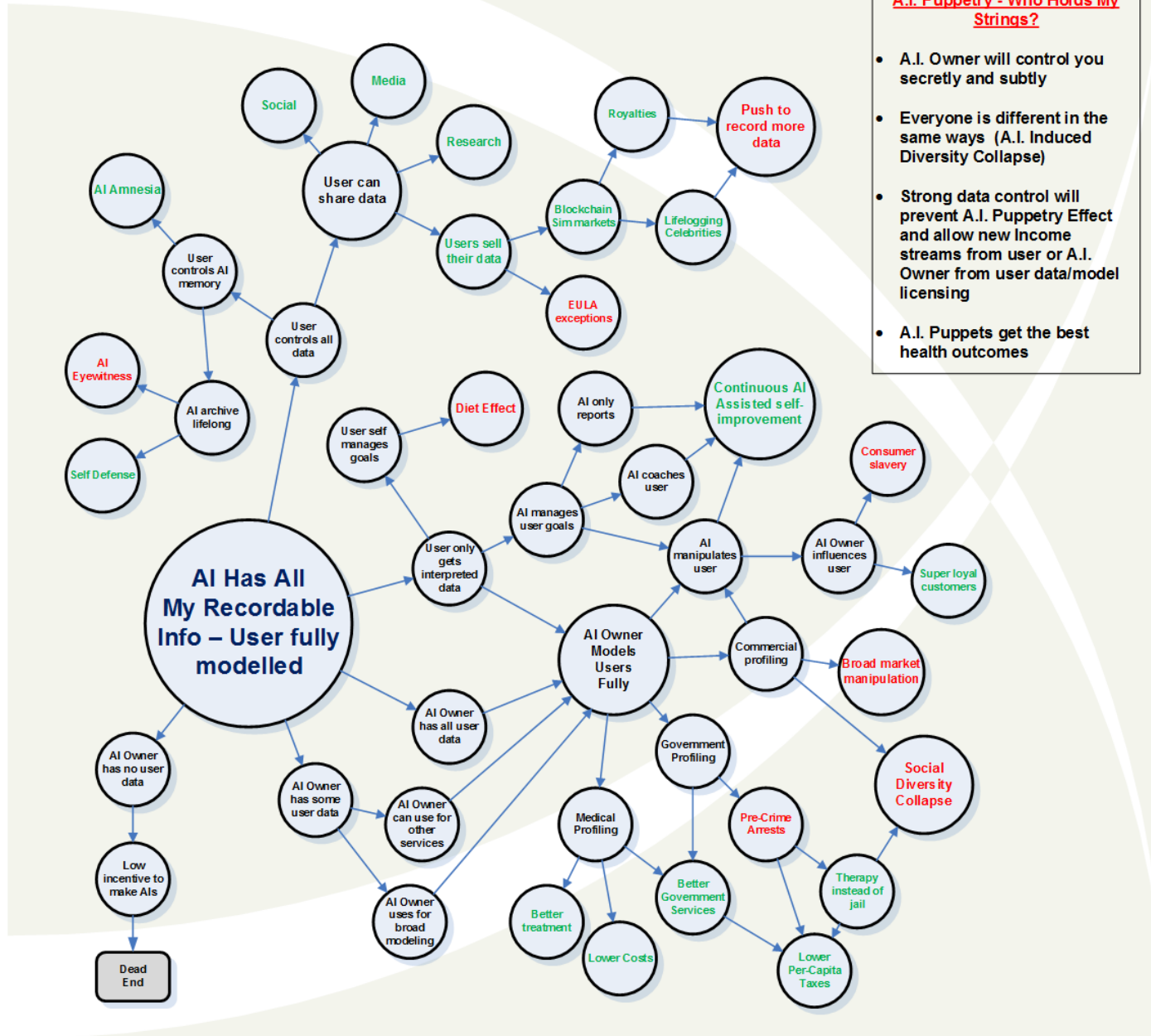
Alternative Future Implications Worksheet

Alternative Future	**BRoBOt - Your Personable A.I. Training & Wellness Coach** Customized adaptive personal A.I. assistants use your Electronic Medical Records coupled with continuous personal monitoring to help you achieve your health and wellness goals.
Focus Category	Google Search & Android divisions of Google will be the most affected by this future. Specifically, the intersection of dramatically increased amounts of personal data coupled with the ability to become an actively mediated communications interface via Personable A.I.s will expand the scope of these divisions and link them inextricably. The Android division will be the user-end point for all interactions. Search will provide the back-end infrastructure for supporting semi-autonomous A.I. interfaces and control. Personable A.I.s will be a framework for implementing new ways of collecting, correlating, and acting on both user data and common data sets. Presentation of data will be dynamically created and multi-format: text, audio, graphics, video, chat, voice comms, translations, and so forth. For all intents and purposes, Personable A.I.s will replace the Web and Apps for most common uses.

Alternative Future Implication Wheels	**Futures Wheels (See diagrams below):**
	
	    Wheel 1. **Personable AI Knows All**
	
	    Wheel 2. **Personable AI Is My Info & Comms Hub**
	
	    Wheel 3. **Personable AI Manages My Life**

Most Important Implications From Wheels	**AI Puppetry** -The Owner/Controller of an AI has the potential to secretly influence and eventually control you by gradual selective alteration of your information environment and subtle changes to your behavioral coaching via your Personable AIs. This is control via *AI-enabled Gaslighting*, like the way an abusive individual controls a victim over a long period of isolated interactions. **The Devil's Bargain** - Strong User Data Controls will eliminate the AI Puppetry effect, but will also eliminate most of the benefits of Personable AIs. As others choose to adopt full AI data collection and modeling, there will be increasing pressure to release control and accrue the personal and social benefits of letting go of data control.

	AI Amish - Those individuals who see the potential for AI Owners, governments, or the AIs themselves to manipulate them will reject Personable AIs as both a communications medium and as life assistants. Like certain technologically restrictive philosophical or religious communities, these people will by necessity detach themselves from the AI-dominated social landscape and live increasingly technologically isolated lives. **All Your Blockchain Are Belong To Us** - Strong transactional e-security mechanisms will allow users to gain back most of the advantages of full AI data control without all the AI Puppetry implications. Individuals will set automatic controls on who or what sees their data, level of anonymity, aggregation options, and the like. Users will not only have AIs build secure surrogate emulations based on their full lifelog data, but will be able to license any portion of that data for a fee via secure blockchain based automatic contracts. Co-agreements with AI Owners would allow both to profit from licensing user data or their AI simulacra. A new class of **Celebrity Lifeloggers** will license their experiences, metrics, and personality simulations for use by others. **I Think I'll Paint It Beige** - Full AI Models of users will result in a convergence towards a set of common societal norms. Profiling of various kinds will allow different groups who have access to part or all the models to optimize for key results. Medical professionals will guide AIs to optimize user fitness & health. Law Enforcement agencies will run-double-blind "pre-crime" simulations to identify potential criminals before they commit grievous crimes and arrange for pre-crime counseling and psychological treatments. Government agencies will use similarly anonymized aggregate models to tailor services by demographic region resulting in higher effective services and lower taxes. Businesses will use the anonymized sims to tailor products and services while paying AI Owners a "vig" to tune free AIs to influence buying decisions of users. The result will be a collapse in social diversity across all sectors of society. Personable AIs will become a hidden moderator and defacto enforcer of new social standards and behaviors.
Single Most Provocative Implication from Futures Wheels	**I-AM-AI** Personable AIs and users become converging reflections of each other. The AIs take on the role of active social and legal surrogates for the user. The users in turn become completely dependent on the AI for mediating their interactions with real people and other AIs. The strongest example of this dependency is use of **Para-Morphic Personalities** for communications. Imagine real-time audio & video translation of your responses based on an AI personality model of you. It changes your real-time responses to match preferred personality traits. You can seem more assertive, kinder, less angry, wiser, or any other set of traits which will facilitate the goals of that communication be it email, text, voice, video, or VR. Your jokes are funnier, your observations more direct, your appreciation is sincerer, your gestures more graceful and so on. Even in-person interactions will be coached via in-ear receivers or cues via electronic eyewear. <u>Your AI surrogate becomes clothing for your personality</u>. This dependency on AIs for social interactions will blur the lines between people and AIs. In a sense, our AIs simulacrums will become clone-like agents of our selves.

	Eventually they will become full legal surrogates including the ability to form and run their own corporations, create autonomous "Contract AIs" which not only enforce contracts but ARE the contracts, make deals, buy goods, and earn money all without your direct interaction.

Socially, our surrogate Personable AIs will identify compatible romantic partners by "blind-dating" the AI surrogates of others, attending AI-only "workbot" meetings for us, making friends and finding the weaknesses of adversaries. Social discourse itself will use these capabilities to create **AI Decision Arenas** where personal, corporate, and political actions can be fully and multi-dimensionally debated by real and representative AI surrogates.

Some other implications of adaptive personality AI surrogates include, but are not limited to:
- "Socrates in a Box" AI teachers & Tutors
- Designer AI Soulmates
- AI Secretaries
- Prosthetic Social Sense
- Interactive Memorial Personality Clones
- Self-probating estates

The proliferation of variant AI surrogates for work, play, and more will result in an explosion of semi and fully autonomous Personable AIs. Unmediated interactions will be so few that a possible future aphorism might be *"On the Internet no one knows you aren't an AI"*.

The biggest downside of such heavily mediated interactions will be a dramatic strengthening of isolation of people from diverse ideas, communities and modes of thought. The confirmation bias of the telecommunications era will blossom into full blown AI-aggravated **Personal Balkanization.** Our cloud of Personable AIs will cocoon us from anything too different or uncomfortable, unless we specifically make that type of growth a key goal. The open question is: will the AIs themselves be able to overcome our limitations to incorporate more points of view beyond what their owners or users desire?

The full implications of surrogate AIs will likely unfold well beyond our target Quantified Self 2025 timeframe

Luckily our surrogate Foresight AIs should be able to figure things out in their Decision Arenas just in time to help us navigate our way through. |
| **Most Important Issue** | Finding a way to enforce strong user-controlled data & model security in a way that prevents abuse without closing off personal and societal benefits of Personable AIs & Simulacra |
| **Most Provocative Issue** | Adding autonomy to Personable AIs will create exponentially increasing numbers of semi and fully independent non-human agents. Humans may be relegated to merely passive foundational data sources for these AIs rather than active participants in society at large. |

Quantified Self – Implications – Personable A.I.
## Personable A.I. knows All

A.I. Puppetry - Who Holds My Strings?

- A.I. Owner will control you secretly and subtly

- Everyone is different in the same ways (A.I. Induced Diversity Collapse)

- Strong data control will prevent A.I. Puppetry Effect and allow new Income streams from user or A.I. Owner from user data/model licensing

- A.I. Puppets get the best health outcomes

Quantified Self – Implications – Personable AI
Personable AI is My Info/Comms Hub
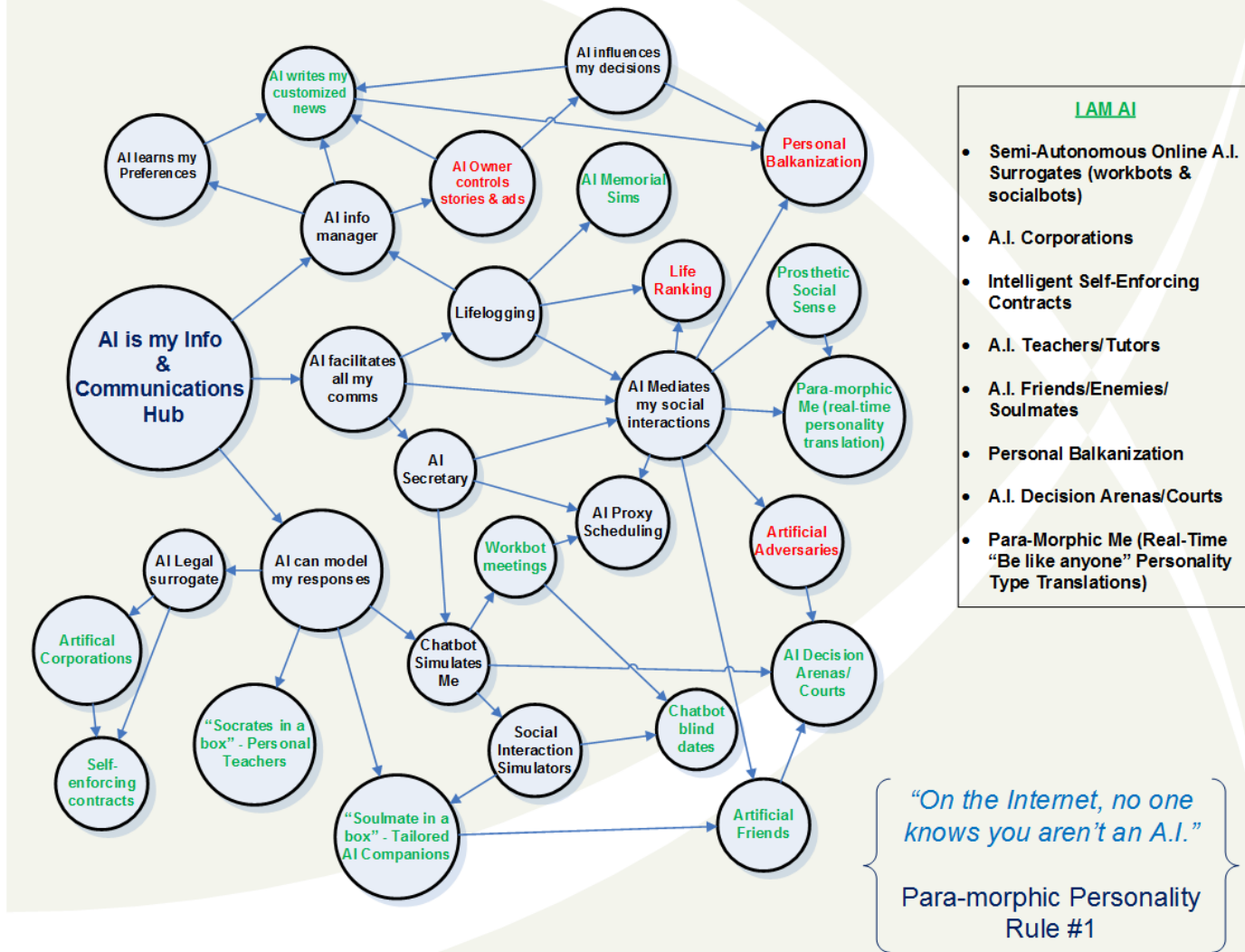
Quantified Self – Implication – Personable AI
AI Manages My Life
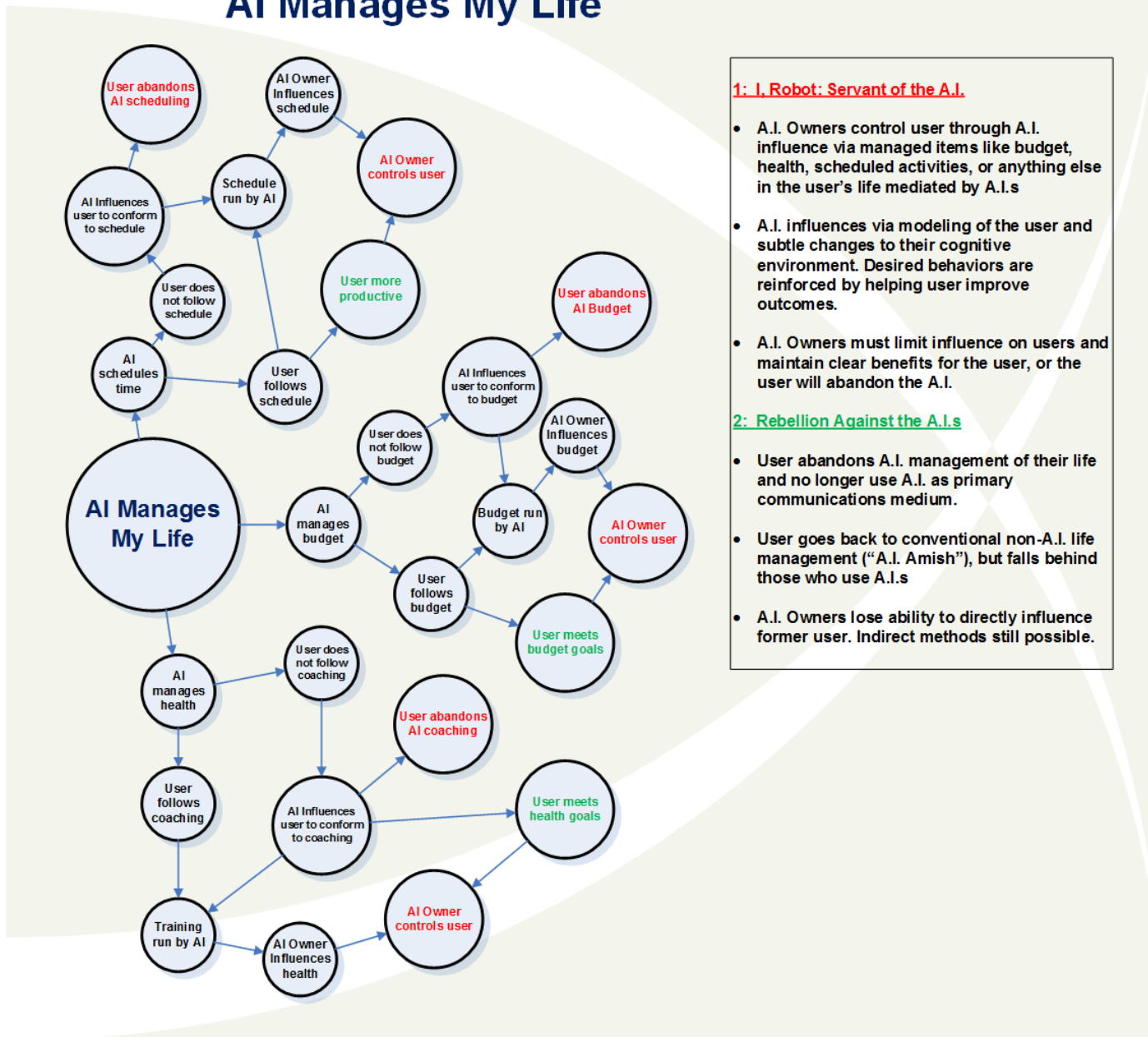
1: I, Robot: Servant of the A.I.

- A.I. Owners control user through A.I. influence via managed items like budget, health, scheduled activities, or anything else in the user's life mediated by A.I.s

- A.I. influences via modeling of the user and subtle changes to their cognitive environment. Desired behaviors are reinforced by helping user improve outcomes.

- A.I. Owners must limit influence on users and maintain clear benefits for the user, or the user will abandon the A.I.

2: Rebellion Against the A.I.s

- User abandons A.I. management of their life and no longer use A.I. as primary communications medium.

- User goes back to conventional non-A.I. life management ("A.I. Amish"), but falls behind those who use A.I.s

- A.I. Owners lose ability to directly influence former user. Indirect methods still possible.

Key Client Recommendations

Recommendations to Alphabet, Inc. to address key issues common to both Baseline and Alternative Futures:

Issue	Recommended Action
Who owns the data?	Strongly support user ownership of their personal data with technology services companies able to leverage anonymized & aggregated data in exchange for those services.
How do we implement strong control of personal data without closing off full benefits of data sharing?	Build strong user-authenticated controls into the APIs and services. Enforce active end-to-end user control via Blockchain & other technologies
How much autonomy do we add to deep learning AI agents?	Lead the way in exploring risks vs opportunities. Sponsor discussions, debates, and research technological frameworks for user control. Establish AI behavioral standards and sandbox testing approaches to mitigate risks.

Conclusions

Based on this student futures research project, a wide variety of possible futures and implications surround the area of *Quantified Self – Sensors & Analytics*. This study determined the Baseline Future (Smartphone Sensor-Log) and also some of the most provocative implications of a single plausible Alternative Future (Personable A.I.s).

Further study is warranted in this space given the possible impacts from the high-level interaction of these and other developing technologies particularly in light of their sensitivity to social, economic, legislative, political, and security factors.

Given the rich variety of scan hits found, several additional plausible futures should be fully explored within the topic. Additionally, parallel studies focused on involuntary or non-commercial applications of Quantified Self technologies could provide useful insights for policy makers, companies, and non-governmental organizations.

Additional Research

The following research contributed to the study.

Scanning Highlights

Personable AIs – Chatbots gain personalities and are hooked to adaptive deep-learning AIs. Early use is fitness/wellness coaching. See Alternate Future slide.

Neural Dust – Demonstrated in a lab and is being shrunk to allow embedding in the brain. Currently uses ultrasound to read individual neural signals. Will later allow sending signals into nerves & muscles ala THE MATRIX

360 Degree Me – Full integration of all medical records data with full user sensor data, combined in a way to give Medical professionals a "360-degree view" of patients

Watson on my Watch – Concerns about data privacy cause AI & Analytics tech to be pushed down to device/app level for full user control

Smartwarch Uber Alles – Fitness trackers gain more and more features until they become indistinguishable from Smartwatches.

Medical: My Main Monitoring Motivation – Strongest Survey result. More people are motivated to track personal data due to Medical Need than any other reason.

Quantified Other – Several scan hits converged to indicate that the ability to monitor the complex physical and emotional states of others is likely in 2025

Prosthetic Social Sense – 1st order implication of Quantified Other. People with social anxiety/awkwardness or those on the Autism Spectrum could use Sensor & Analytics packages for real-time feedback of other's emotional state & reactions

Telepathic Origami Nanobots - Heat-activated folding DNA shell + Embedded neuro-reactive molecule + Pulsed Magnetic Field + EEG = Crude nanobot that can alter neural response when activated by user's brainwave pattern. Demonstrated in the lab on a cockroach

Quantified Politician – Camera based emotional evaluation software was used to determine emotions of presidential candidates during 2016 debate. Variant on Quantified Other using different technology to achieve similar results

AI Marketplace – Google has open-sourced its Deep Learning libraries and other teams have started AI marketplaces for low-cost licensing of AI related APIs. Should accelerate the creation & adoption of AI tech

Other Features of Baseline Future

1. The "Diet Effect" will still be a problem. Users will be engaged by novelty of new sensors/apps & then stop using after a few weeks or months.

2. Some multi-sensor correlation of data will be done by apps, but users are still the key component. If they don't look at it, it is meaningless data

3. Key older 35-54 demographic will be motivated to track for health reasons

4. Insurance companies will increasingly give away trackers & coordinate their data with medical professionals to try to save money

5. Some users will use sensor-log use for self-diagnosis of medical status/conditions instead of more costly traditional medical care system

6. Both Apple & Google will be working with medical communities to integrate sensor-log data and channel it to medical researchers & to feed medical analysis AIs.

7. Likely advanced consumer sensors in 2025 will include: Oxygen level, Blood pressure, skin temperature, blood glucose (non-invasive), environment conditions, galvanic skin response, skin hydration, complex motion sensing (exercise form sensors), and breath/spit based chemical marker sensors

Implications Summaries for Personable AI Alternate Future

AI Puppets - Anyone who owns your AI can subtly manipulate you over time via personality response modeling, altering communications content and factual information (Gaslighting) and more. It will be like having your own personal copy of Orwell's Big Brother in your pocket. If AIs advance sufficiently, THEY will be the ones manipulating you for their own ends.

Devil's Bargain - Use will steadily cede your identity & autonomy to your Personable AI. As everyone else adopts the technology, you will feel pressure to adopt or be left out of commerce, relationship opportunities, communications, etc.

All Your Blockchain Are Belong to Us - Strong transactional security will result in more AI autonomy by allowing the AI to act as a legal proxy. Eventually, AIs themselves will gain legal status akin to Corporations. AIs will become self-enforcing contracts.

Sim You/Sim Me - Your Personable AI becomes your autonomous surrogate between people & other AI simulacra. It can literally simulate you to a degree that other AIs and most people can't tell it is you. This is handy for online meetings.

Personality Clothing - AI translates your communications into preferred personalities. Celebrity Lifeloggers will be able to sell copies of their simulacra as personality enhancements. It can even unobtrusively signal you what to say and how to say it in real-space communications. Want to be the life of the party? Slap on your Bluetooth headset and load your Comedian-In-A-Box AI assistant.

Personal Balkanization - A cocoon of Personable AIs will shield us from the world and ourselves and provide an non-factual perception of interpersonal relationships, news, events, and more.

I AM AI - Personal AIs & Users become converging reflections of each other as AIs assume more of the active life roles of users: attend meetings, blind dates, attend class, etc. Full convergence happens when AI autonomy of the simulacrum matches that of its user.

Quantified Self Survey Purpose & Approach

A survey was conducted as part of the Baseline research. The purpose was to identify New trends or Confirm existing trends in technology-based personal measurement. The survey focused on measuring user behaviors, needs, desires, and opinions surrounding the use of personal sensors and accompanying analytics for self-measurement.

The survey targeted a limited group of likely current and possible future users of personal measurement devices and apps:
- Forum participants at QuantifiedSelf.com
- Adult members of a Dallas-Fort Worth based literary Science Fiction convention, FenCon

A total of 37 participants were recruited for both online and paper versions of the survey. Each participant answered 11-12 questions. The survey started on September 24th, 2016 and was completed on September 30th, 2016.

Quantified Self Survey Results

Result #1: Every survey participant is regularly measuring something about themselves now.

- All participants noted at least one item that they regularly measure today.
- About 32% currently use a wearable electronic device to regularly measure something about themselves.
- The most common electronically recorded items are fitness & health related: weight, steps taken, heart-rate, and sleep.

Result #2: Most survey participants want to automatically measure more Health-related items than they can now.

- Health-related measurements are by far the most desired item to measure automatically using sensors & smart-devices
- Most suggested measures and correlation analytics were related to physical and emotional health.
- Primary motivating factor for measuring & tracking is *Medical Need*
- Continuous, non-invasive Glucose monitoring was a high priority for several participants

Result #3: Sharing data is desired, but only if Data Security & Control of personal measurement data is strong

- Majority think it will be useful to share their personally collected sensor data & analytics results with medical professionals
- Virtually all of the participants have a very high concern about controlling access to their data in a secure manner. *This was the strongest response of the survey.*
- Most participants have a mild level of interest in sharing their data with non-medical professionals (friends, family, etc.) via social media or other means.

Result #4: People want to measure more, but want it to be easier

- Most participants measure more than one health-related item now. Some are via automatic fitness trackers and some via manual tools like scales, journals, etc.
- Most participants think automatically correlating different sensor readings and trends would be helpful
- Most of the wished-for future measurements participants listed will require multiple types of integrated sensors, deep correlations, and new non-invasive biosensors

Survey Conclusions

Survey participants gave clear opinions on what they want out of future Quantified Self technologies:

- They want more automatic monitoring of hard to track items like food consumed, body & brain chemistry, mood, mental capabilities, and environment
- They want automatically generated multi-factored correlation of their data
- They think sharing their data with medical professionals will be useful
- They demand their data is secure and under their control
- They are mostly health-driven, not fitness or self-improvement driven
- They show more interest in medical-style biosensors than traditional fitness trackers
- They are motivated to track due to *Medical Necessity* more than any other reason

Russian Ransomware Robot Zombies

Hackers infect embedded personal fitness trackers which connect to Neural Dust interfaces to monitor physical activity & assist users with exercise. If infected, a user must pay ransomware or be subject to induced sensory delusions or experience episodes of involuntary muscle control.

In extreme cases where the user has fully populated their body with Neural Dust links, the user can become a software controlled zombie-like creature until the ransom is paid.

The more common *Stop Hitting Yourself Virus*, while annoying, is more benign and usually good for a laugh.