THE VARIABLE LIMITS

by

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in

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Abstract

Fitness (FTs) have enabled users with new affordance in health management. However, users report low retention rates of FTs for long term usage.

The objective of this thesis is to explore a design paradigm for FTs using principles of self-modeling and neurophenomenology in the design of FT visualizations.

It is aimed to foster long term use of FTs by employing art-design aesthetics and analytical visualization by integrating user's actions with the intent of providing users a better experience, motivating them to curate data visualization over a long-term period. Research methodology in process and design of Art Graph (AG) utilized archetype, persona and usability test.

The design of interaction is experienced as personal examination through data analytics that functions as a visual data language of mind-body synergy.

Three types of persona were employed to demonstrate the AG visualization values with classic somatotype body classification ectomorph, endomorph and mesomorph.

Keywords:

experience, fitness, visualization, cybernetics, context, biology, self-modeling, neurophenomenology, data.

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The original work/ideas in the design of Art Graph were based and influenced by system thinking and cybernetics principles.

I recognize Norbert Wiener as the original voice and founder of cybernetics thinking that influenced my creative process.

In the depth of winter, I finally learned that there was in me an invincible summer.

Albert Camus

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1 Chapter 1 - Introduction

We rely on consistency of observations to affirm our belief system.

We rely on personal data or experience to confirm our clearest construction of the world to provide a clear schematic in how we engage our experiences and actions in relation to the world.

Despite this we know at times that if our environment was better we would be able to develop our best traits to arrive at a “best self”, as the world rarely unfolds in each optimum setting of organization, this provides personal challenges.

Instead we live in a world that operates in the jaws of entropy, however, through planned, cultivated thoughts and action that we can externalize our will upon the world to receive feedback that our actions are consistent with intentions.

As humans, we may have experienced situations where our environment may not provide much flexibility in living by our thoughts or ideals. We may be called to make efforts to change our initial presupposition of being to engage a situation differently.

Improvements in technology in late 20th and early 21st century automated monitoring and recording of fitness activities, and integrated them in easily worn equipment.

Early examples include wristwatch- sized bicycle computers that monitored speed, duration, distance, etc., available at least by the early 1990s.

Wearables heart monitors for athletes were already available in 1981. Wearable Fitness Tracking (FT) devices, including wireless heart rate monitoring integrated with commercial-grade fitness equipment found in gyms, were available in consumer-grade electronics by at least early 2000s.

The invention of FTs cemented a new outlook on how we regard personal management of health and lifestyle choices. The technology which relies on user's motivation has been designed on surface level.

To elaborate, FTs are generally termed as "Activity Trackers" which provide users a summary outline of their behavioral and physical profile with data visualization. Information allows users the potential to gain an understanding of how health practices mirror their physical health. Context and environmental interactions influence body and cognition/mind, therefore there is a need for FTs that are context sensitive, to encourage long term engagement through visualization that utilize art and design.

A FT experience should be distinct for every user through its ability of unlocking their unique physiological potential over a long-term period. This is accomplished by the design approach of creating a "totem" or a form of avatar that make a FT more experiential rather than cognitive like references to graphs or biometrics. Engagements drives interaction to address long term motivation through visualization.

1.1 Thesis Statement

An article titled "*How can we share experiences?"* by Chris Firth, neuroscientist, stated that 21st century science will have to discover how experience can be converted in a form of a report.

Experience is not just awareness of its object (noema). It includes awareness of itself as a process (noesis) [10].

Art Graph, a visualization system can be described as a composite data portrait that captures biological and social experiences to provide users accessibility in man-

agement of health data from usage of a FTs. The Art Graph is covered in section 4.6, 4.8 and 4.9.

A scope utilized in design of Art Graph is based and modified from neurophenomenology in which user engage with objects, events and processes. Art Graph aims to provide an incentive for long term engagement of FTs utilizing a design that increases a meaning from usage, fostering a sense of ownership of one's personal data.

Is it possible to create a FT employing data art media where analysis of personal data would serve as catalyst and means of personal examination?

1.2 Rationale

An identified factor of why wearable devices has not been able to sustain long term interest is attributed to a lack of good feedback in the design.

The Patel-Ash-Volpp paper *"Wearable Devices as Facilitators, Not Drivers, of Health Behavior Change"* puts forward that if feedback loops could be designed around behavioral economics, individuals can be motivated by experiences of past and future rewards [1].

The incentive is to create FTs that account for user's unique bio profile catering towards an individual health and growth experience would be the best form of feedback loop. The above-mentioned paper states that feedback should be designed as a combination of individual encouragement, social competition and collaboration as effective feedback.

It's been estimated that 1% to 2% individuals in United States have used wearable device while in a general survey 75% of users have described themselves early

adopters of technology [1]. A slice of the demographics shows that 48% were younger than 35 years and 29% earned more than US$ 100’000 annually [1].

It should be noted that there is naturally an economic element related to new technologies, the relatively high pricing when they are introduced in the commercial market and only certain consumer groups would be able to buy it.

There is also an element that users of fitness trackers outgrow usage are also not motivated to integrate trackers in their long-term lifestyle.

From the research, I could see that the entire industry was wrapped with paradigm of highly sophisticated but easy handled FTs.

There was a phenomenon of users who would use a FT and give the habit up after a short period of time.

A survey quoted in above mentioned Patel paper stated that more than half of individuals who purchased wearable devices stopped using them, one third did so before 6 months.

Are we able to design personal FTs that guide users in constructing digital sculptures of themselves with interactions and motivation that develop in parallel with their evolving biological state? How can visualization be used as an anchor to drive engagement for continuous interaction and incentive for long term engagement in FTs?

1.3 Theoretical Framework

In application, persons informed of their summary of data analytics changes routine performance and habits vary in all settings. This changes energy exertion of their purposeful behavior and personal motivation which is an active process of

renewal in the individual user driven by active decision making by feedback from analytic.

Users take ownership of biology in value as how their interest and choices create their lives, transferring ownership towards their biology. These data portrait or visually intuitive visualization help users navigate their long-term healthy condition and performance goals. Art Graph was designed from a cybernetic perspective of signal and feedback from behavioral practices to create a self-modeling loop. Experience was the subject that was self modelled from interactions of the user to produce Art Graph visualization object.

Every user by prerequisite of their affordance and actions curate an individual idea of motivation to define visualization for value extraction. A system or life is defined as *autopoiesis* if it displays a distinct self-unity to generate its own identity to maintain itself against the threat of disintegration as Stendera claims in his paper [4]. Adaptivity in *autopoiesis* is the system's ability to track progress against conditions to survive and flourish [4].

Enactivism, is active force to create autopoiesis. Cognition in *enactivism* is inherently relational process of mutually shaping organism and environment generates a meaningful world determined by goals, needs and capacity [4]. To summarize, a user through the active process of enactivism extracts from their own experience of being to create a data portrait. A data portrait is produced by *autopoiesis* as a distinct visualization identity to observe changes of user's interaction which I propose, motivates continuous engagement of Art Graph visualization.

2 Chapter 2 - Background

2.1 Neurophenomenology

Neurophenomenology is a research program developed to study phenomenological report of brain consciousness. Neurophenomenology is gathering of first-person data through experiences to discover a new third-person data on physiological process that contribute to consciousness [10].

Its central aim is to generate new data by incorporation from phenomenological exploration of experiences. Neurophenomenology derived from phenomenology can be understood as characterization of phenomenal invariants of lived experience in its many forms. An application of neurophenomenology is the importance of methods to obtain original and refined first-person data to increase the sensitivity of experiences in various time scales. Phenomenology is disciplined as characterization of lived experience. In phenomenology, lived experience compromise pre-verbal, pre-reflective, and affective mental states from events and processes which may not be available or accessible to thought. Introspection and verbal report are lived through subjectively contain experience or phenomenal character [10].

Art Graph contains instructional information of body mechanism and user's cognitive interactions shaped by user's interaction over a lifetime.

The visualization acts as a funnel for a variety of large data sets in a cohesive portrait to provide accessibility of data ownership as an aesthetic and utilitarian benefit for users.

Art Graphs are ambiguous by design to accommodate social and biological data experience.

2.2 Cardiorespiratory Fitness

Cardiorespiratory fitness is the efficiency of the body to transport oxygen to muscles during exercise. It is a strong indication for Cardio Vascular (CV) diseases and increase in cardio respiration is associated with decrease in CV disease risk. High endurance sport place high demands on heart and blood vessels to deliver oxygen, remove carbon dioxide and heat from exercising muscle [14].

CV system remodels and can undergo change that lead to improvement in cardiac efficiency function to deliver oxygen to exercising muscles to support metabolic demands [4]. Physical activities are characterized by the degree of dynamic (aerobic) or static (strength) requirement. Habitual training exercise do and can lead to structural and functional changes in cardiac performance [14]. Trained sports participants have been observed to have enlarged cardiac chambers.

2.3 Data Visualization

The circle segment visualization technique in the Paper *"Circle Segments': A Technique for Visually Exploring Large Multidimensional Data Sets"*, by Ankerst-Keim-Krieger, applied in visualization exploratory data analysis for multidimensional data is used as a reference for constructing personal visualization for this project [6].

The technique was utilized for a stock exchange database and noted to be suitable to view fluctuations of stock price detecting analogical tendencies between dimensions which were not detectable in 'line graph' visualization. High degrees of overlaps between data are not suitable for 'line graphs'. The circle segment technique for representation of data is better perceivable for potential dependencies and correlation between dimensions [6].

Visualization, cognition and perception influence our operation and actions that we take to define us. The visualization prototypes were an attempt to redesign and engage user's motivation of a fitness FT by using visualizations that simulate user's conscience as an incentive to create a form of interaction that model our being in the world through maintenance and engagement over a period of time.

Findings from Schnotz's paper "*External and internal representations in the acquisition and use of knowledge: Visualization effects on mental model construction"* found that visualization affect the structure of mental model constructed during learning which influence patterns of performances individuals show after learning [3]. Forms of visualization require consideration when concerning learning environments. Visualization does affect structure of mental models acquired during learning [3].

Our sense and construction of the world by our perceivement is bound to our bodies. Common knowledge is said to be embodied and not existing independently of actors. The entire range of a physical and emotional experience has been described as "embodied cognition" [13].

If perception, visualization and cognition is an embodied experience operating in specific time and place for being and perceiving. It would not be inaccurate to suggest evolution is driven by movement in response to changes in the world as indicated in Dr. Peter Chopin's paper "*Reconciling Competing Accounts of Picture Perception from Art Theory and Perceptual Psychology via the Dual Route Hypothesis"* [2].

Flexible and complex behaviors that arise are due to predictive abilities from complex cognitive operations from mental simulation by interaction with the world [2].

We can begin to view data as not just a form of visualization narrative but a language to be learned and understood as we navigate through terrains of entropy in a system. The brain evolved with the expansion of language, we will regard data as a new language to evolve our brains.

A FT experience should be distinct for every user through its ability of unlocking their unique physiological potential over a long-term period.

2.4 Context Review

Hexoskin is a comprehensive wearable product that monitors breathing rate, breathing volume, heart rate variability, activity and sleep. The system measure three categories in physical training, sleep and personal daily activities.

Muse is a high-tech meditation wearable product that measures brainwave activity for consumers to manage states for affective adjustments. Garmin's Vivosmart Heart Rate (HR) FT does standard activity tracking for step counting, heart rate and is positioned in the market for the moving and working consumer as it offers music controls and notification for phone calls, text, and social network updates.

A FT experience should be distinct for every user through its ability of unlocking their unique physiological potential over a long-term period.

A work by K.D Bennett entitled "*Is the number of species on earth increasing or decreasing? Time, chaos and the origin of species"* refer to chaotic systems as interactions between multiple independent entities with each other present in climate systems, biological systems, communities and population genetics [20].

Mutations are said to arise spontaneously dependent on environmental context which can be unpredictably harmful or negligent. Life forms are said to react to each other from surroundings in the flux of evolution.

There have been observations, mentioned above in K.D Bennett's work, that chaotic systems are documented in biological systems. Chaotic behaviors are not seen as random but stochastic that give representation to evolution. A given input produces an output with patterns related to the input [20].

Feedback introduced to a system gets magnified as feedback loops are iterated. The system is susceptible to sensitivity that small input can give large and sometimes irregular differences in output from a system that is completely deterministic but returns to the same output as treated input. Conditions and state cannot be rewound as given condition can arrive via any routes without being able to trace how the condition was reached [20].

Therefore, a paradigm of "Activity Tracker" is not just a restrained approach in what FTs could provide for humans but show us how FTs could be integrated to a human's habit. Inspired by Buddhism, in how mind and body are viewed as the same expression of core reality I realized that technology could be designed to sync with user's choice aligning personal motivation with body and mind. In this way users would come closer to sustained interest in healthy living because their self- actualization towards a better version of themselves would be distinct and unique experience for them.

FTs should be designed for expanding open systems and based on cybernetic ideas pioneered by Norbert Wiener [19].

I’ve placed experience as dynamic open system that churns out context such as habits, diet, weather, socioeconomics and practices as the starting point for a design approach expressed by organic growing visualization.

3 Chapter 3 - Research Design and Methods

3.1 Methodology

My research work utilized a mix of research and design methods like surveys, interviews, personal journal, and other forms of audio material, as well as an ongoing review of literature.

A basic development cycle was charted out and referred to during the entire duration of the research. The whole development cycle has been broken down to four stages of requirement definition, design, development and testing. This cycle was used as a management tool to gauge and manage development expectations to meet the goals of my research.

Insights gained from early stages of the research work went into constructing mental models for users and storytelling. Archetypes and personas are constructed from qualitative research and explanatory research from movies and other sources of narratives to construct rough archetypes and early product ideation.

Using the image board method, a series of visuals were compiled.

A mood board contributed to form factor of FT visualization and how it could be designed. The well-known design concept 80/20 rule was applied during development stage of FTs system that focused priorities on resource for realizing greater efficiency in development of the product.

This would mean that 80 percent of features would be evaluated to verify the value of design and development to counteract against time constraints and high technical gaps expected during development stages. Decisions were filtered through Maslow's "hierarchy of needs", a design methodology consisting of functionality, reliability, usability, proficiency and creativity [7].

Value categories were defined to go into each component of what features can be built into FT for users. User testing of product in final stages of research provide insights that go into refining product for further iterations. The usability testing identifies user's difficulties in using a FT, and other attitudes or behaviors about what they may perceive as important in a FT.

These insights and testing data gathered from this project phase was processed to contribute to iteration and further prototype design. Then it was taken through the usual stages of data processing, i.e. being compiled, analyzed and summarized including findings for final report.

Usability testing and data collection falls under two categories, performance data and preference data categories.

Performance data will consist of measures of behavior such as error rates, time and counts of observed behavior elements.

Preference data consist of more subjective qualitative metrics that measure a participant's feelings and opinions of the product.

Usability testing was collected by oral or written questionnaires and from debriefing sessions after the test.

Through user testing I could gauge perception of people on FTs and have learnt about what would motivate them to lead healthy lifestyle or what obstacles would make it difficult to live healthy.

3.2 Usability Testing

First an initial survey and interview for an assessment on what the demographic audience thought of FTs, preconceptions if any, views on personal health.

The second was initial usability testing of the designed visualization.

The sessions yielded a general understanding of public perception about FTs and misgivings of why a FT or active personal health living choices did not have an approachable appeal. From interview session, the following are some observations on the constraints on active practice of healthy living: a busy lifestyle of always being on the go, not having access to updated ways of measuring health over a period of time, limited user interfaces, a lack of understanding on the ideal diet or exercise for one's health.

Some participants viewed exercise as an activity that one enjoys regardless of having company and that it should not be something scheduled like going to the gym.

One participant tried to incorporate exercise whenever possible even if he had sedentary lifestyle, or an injury, but this made it difficult.

One felt that there was too much hype around FTs shared and that there were interesting options on FTs such as coaching users with videos and well-designed progress bars as incentives for owning FTs.

Feedback from designed visualization elicited a variety of responses from identifiable outputs, to confusion, ambiguity and the appeal of futurist design.

Participants related to visualization were unable to relate to the ambiguity of the interface design and felt it should be closer to an icon.

There were concerns on encoding as an aspect in being able to relate to visualization interface that grew with progressive interactions.

This form of association was refreshing as participants related to the tendency of obsession towards analytics rather than performing exercise.

Another participant felt displaced with their totem and use of the term bio profile which they said was redundant. Participants felt that various colors should be used to convey intensity for activity, such as red for marathon, blue for sprinting and yellow for casual use.

The system should be able to distinguish runners from casual users and FTs should be something intuitive and quick and easy to refer to.

4 Chapter 4 - Design Process and Prototypes

4.1 Experimental Tests

To propose a concept of long term data visualization engagement, experiments with sensors were conducted to observe responses to the environment to validate how context affects and print on us.

EMG BITalino sensors were used to test six different gestures to observe how EMG readings relate to body movement. Observations show readings were dependent on context of gesture. Some gestures which involved more muscle coordination had less impact on the peaks. Other gestures produced busy or heavy reading from peaks indicated that some movements used more muscle force and coordination from various tissues.

During the experiment, there were occurrences in difference on how each peak was reacting or behaving.

Some gestures like fist clench, writing, mouse clicking had active peak readings were consistent with gestures that were complex despite being simple muscle movements. It involved various tissues from each part of the hand to execute the action. From the push-up gesture, it differed from other readings as all regions of the peak expressed were consistent with action when hands were placed on the floor to help balance involved all parts of hand and arm muscle.

When raising body weight to elevated position, readings were elevated as busy or noisy in default position of holding one's weight. It's difficult to pinpoint how each graph peak region is linked to each muscle action.

This subject was reviewed in the Kanitz & Co paper "*Decoding of Individuated Finger Movements Using Surface Electromyography"* [8]. It observed that it is

possible to decode individual flexion and extension movements of each finger with greater than 90% accuracy in a trans radial amputee using non-invasive surface myoelectric signals and algorithms to decode each muscle signals.

Another Kexin Xing & Co paper "*Identification Scheme of Surface Electromyography of Upper Limb Movement"* mentioned that a challenge in EMG reading is classification, i.e. EMG signals are often mixed with signal crosstalk with noise and many muscles regions [9].

Motivation to apply pattern recognition and machine learning to successfully decode muscle activity from each region for classification to identify which muscle involved an activity or gesture is therefore validated. The muscle readings are complex multidimensional event in how it is picked up by graphs and peaks. Classification that is quick and specific to pinpoint each muscle involved in an action is the limitation of us understanding how our muscles or body are connected to our mind and intention. From the experiments, I concluded that readings were a response to each of my gestures.

The next experiment involved working with a BITalino EDA sensor to see if contextual elements played a role in influencing readings. This included a short and predictable walk from one area to another to make better note of external influences that would bias experience of ongoing experiment. The readings could be described as gradual and at times having huge spikes.

The Galvanic Skin Response (GSR) were in range of 400-500 with occasional rise to 700. GSR also referred as skin conductance is sensitive marker for galvanic skin response. It modulates the amount of sweat secretion from sweat glands (usually 200-700 sweat glands per cm^2).

The readings were in high activity states in busy areas sometimes and very stable at standstill. Improvements in design of experiment could be made if readings were recorded at each interval rather than a continuous recording experience. These fluctuations could offer different reading and patterns to observe and pinpoint to a location to understand how readings spiked.

My intention was to create a system that would monitor user's physical development that rely on how their bodies were designed, tapping into technologies where value was placed more on long term individual goals, the more usage of the system, the more value they get as they develop themselves. The space I'm interested in exploring are dynamic systems that are open ended and designing experiences for users to explore their individual capabilities.

4.2 Prototypes

There were three main visualizations that were used as a model and entry point on how the Art Graph could be designed. Components of visualization principles were defined by these models that were selected for aesthetics, functionality and relevancy. Daisy Disk is a disk software analyzer tool for file management.

The visualization is reminiscent of a D3 style. Each region of the disk is highlighted with color and fragmentation regions of the visualization data cluster.

The styles have qualities of abstract art. The visualization communicates differentiation, progression and contrast of the data behavior. The Apple Health Watch app has a well-designed layered ring circles. Each layer represents an activity like walking, standing, exercise, or movement.

The flaw of this visualization was that progression of the data changes were not pronounced enough. The Daisy Disk visualization achieves this with more suc-

cess. The simplicity of the aesthetics achieves a good uniformity that is pleasing to the eyes but the visual communication of progressive differentiation is ignored. The Skulpt and Athos application both use outline of the body representing the user.

Both applications utilize color to highlight muscle region of the body. The use of orange, yellow and red to communicate intensity of the muscle being fired. Althos application visually communicates red as a 75-100%, orange as 50-75% and yellow with 30-50%. Skulpt application has more info graphics present on the screen to identify specific regions that combine color communication and percentage of each muscle regions worked out.

There were many module libraries on the internet all of which were mostly chart based visualizations. I considered for this project the D3 visualization library, as it was aesthetic and is closer to the cognitive than art. I started using Processing as more of a conversation with myself to work through a clear articulation of what needed to be produced.

Processing as a tool is generally associated with digital art and it proved to be a good first step in prototyping a conception of the Art Graph. When I arrived at a visualization direction that I could pursue, the next step was how would this be produced which again began as another hamster wheel loop of sifting through options, pros and cons of each choice with realistic expectations. I arrived at an approach, which I could use with custom svg (scalable vector graphics).

I still had to begin at the drawing board to some extent to draw out better specifics, although from this point onwards the design process naturally became organic as I started to develop a better sense of articulating visual communication.

The main challenge was overcoming the fog at the onset and setting rigid constraints on process and development. Once this was cleared it was to my relief that the abstraction was slowly becoming an entity in the real world.

The table below (Table 1) was used to organize and assign data range and assigning each visualization to a parameter.

No	Name	Method	Data Range	Value Type	Current Visualization	VE*
1.	ECG	Heart Rate	45- 175 BPM	Discrete	Radial Arc XY Chart, Bar	
2.	Temperature	Temperature	36-41 C	Discrete	Numerical Display Chart	
3.	EMG	Muscle Activity	5-450 Hz	Discrete	Person Outline	
4.	Respiratory Monitor	Respiration Rate	10-80 BPM	Discrete	Numerical Information Circle, Graph	
5.	Acceleration	Speed	10-30 km/h	Discrete	Numerical Display Steps, Radial Circle Bar, Line Chart	
6.	Pulse Oximeter	Blood Oxygenation	60%-120%	Discrete	Numerical Display	

***VE Visual Exploration**

Table 1- Consolidate Visualization Data Range Requirements

4.3 Visual Morse

The design for the visualization was based on the concept of Morse Code intended to be immediate communication towards a user. The composite consists of six rings that make up the biometrical information of stamina, blood oxygenation, muscle, heart rate, respiration rate, temperature.

The visualization is designed to be adaptive to various states and conditions in which users reading become influenced by rings that function as placeholder for visualization pattern.

For instance, running on a full stomach will affect the performance of the runner which can be interpreted by data readings to show data bias. The runner's condition is not at optimum functionality. Similarly, when a person changes their diet it will influence a person's physical well-being.

Color is used to demonstrate progression with three main states which are constantly affected by the user's frequency of engagement. The system in its current inception does not aim to suggest or recommend a physical activity but guides a user's goal of ideal physical activity.

The use of three colours allow high complexity of pattern differentiation while maintaining simplicity of cognitive load. The application of color is purposefully designed to utilize a universal association of red, orange, and yellow.

A visualization storyboard was created to ideate the progression of how it could be used by a user. The hierarchy of the visualization is definition of the amount of green developed in the rings which communicate the ideal state of the user (Figure 1).

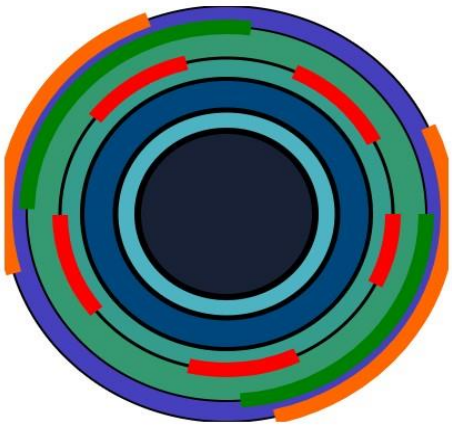

Figure 1 - Visual Morse Design

Prior to testing, the participants were briefed on the test and interviewed to gain an understanding on questions that range from general health to views on fitness FTs.

This allowed an overview on characteristics of a demographics to provide a window to know current associations of how users attribute value and perception towards FTs as a motivation tool. The Visual Morse visualization drew an overall positive response that differ in view of flaws in each design and associations formed with visualization.

One participant noted that at first the visualization had caused them to think it was a psychological experiment they had participated in.

Emergence and maintenance of a visualization portrait to simulate consciousness brings attention to the present to ground one to make decisions to achieve a long-term summary of positive action and living. A portrait in the present is only a reflection of a user's state of condition in one frame of a passing moment.

The value of portrait is in the sum of the whole which allows the user to gauge the overall representation of their being in the world. The visualization system is both forgiving and encouraging in creating an engagement that prompts user’s closer to a finality of their nature rather than affixed in a day or a week of a particular influencing context.

Most participants felt an immediate connection with the visualization although there was a sense of ambiguity on how they related to the visualization. Participants recognized the visualization, noted that there was an aesthetic and artistic design that made it easy to compare with others. Another participant noted the opposite that it was difficult to compare average performance.

I considered this to be a good example of perceptional difference of interpreting an object in time and space that was subjectively derived in feedback. Participants noted that visualization had a low learning curve and appeared to have novelty as a different form of experience in relating to data that made it good as a summary. However, there were some challenges that arose in participant where they felt it was difficult to distinguish the layers apart caused by the visual of colours and hence problems forming an association. Red and orange was noted to be not the best combination in application of the visualization that overwhelmed participant with visual complexity.

A post review of testing included a short comparison of five designs of Visual Morse using an aesthetic design board in which participants were then interviewed to provide feedback on flaws and traits of each design (Figure 2 and 3).

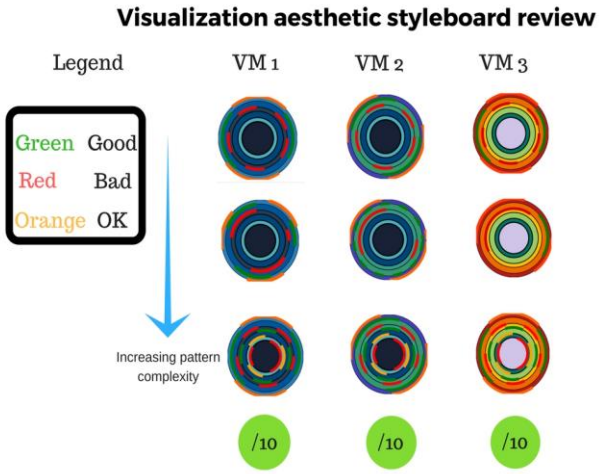

Figure 2

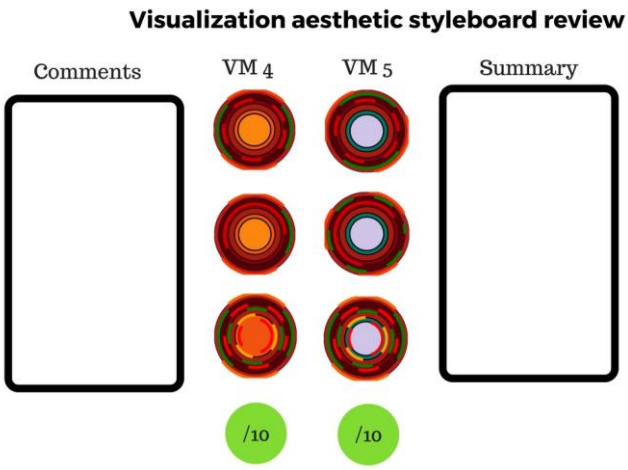

Figure 3

The following figures (4a and 4b) illustrate lexicon of Visual Morse in low, medium and high performance.

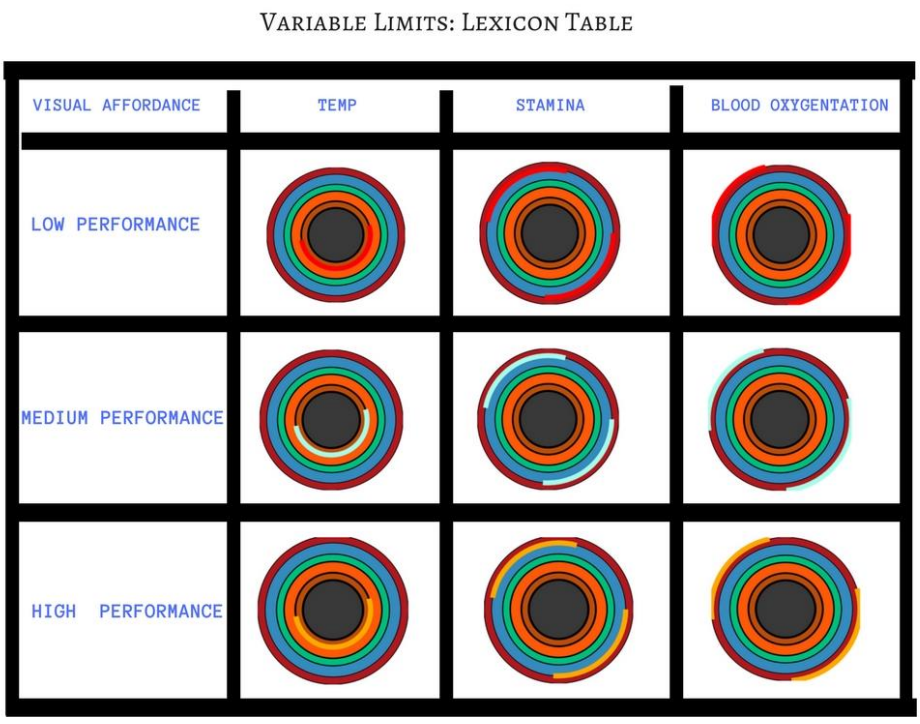

Figure 4a

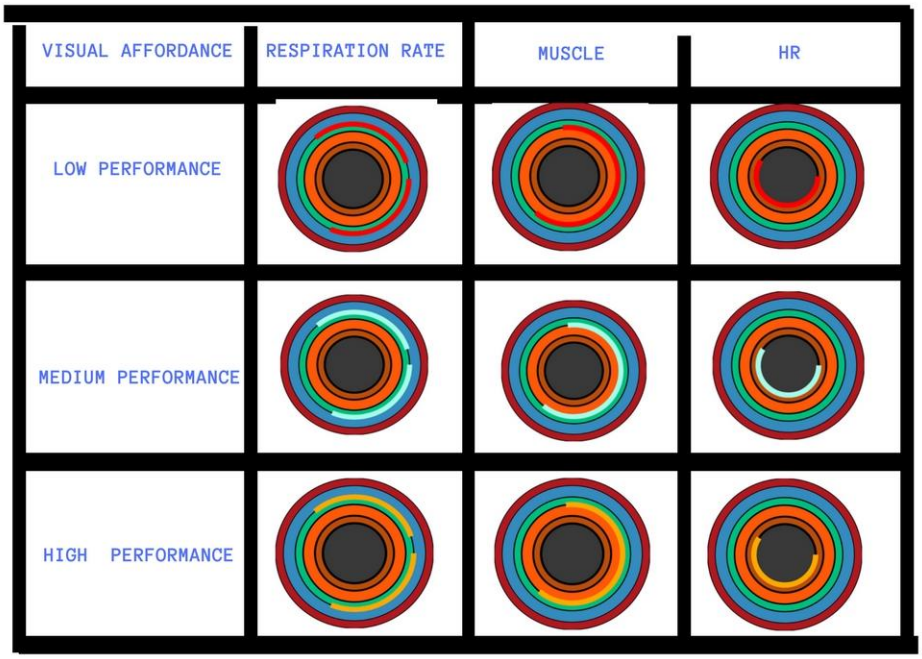

Figure 4b

4.4 Rams

The future is shaped by those who have come to understand the abstractions of value in the highest form and have a natural aversion to dogma since futurity will defy a structure to transcend a past through the present.

A pure futurist is neither an optimist nor a cynic and by nature is an apolitical noble anarchist. The Bauhaus art school was founded by Walter Gropius in 1919 to combine crafts and fine arts in Weimar. The philosophy combining crafts and fine arts can be traced to William Morris. It's worth mentioning William Morris literary works have been credited to play a role in the invention of the fantasy genre. William Morris's contribution was taking the design movement out of Victorian Period to Modernity. The Bauhaus school was steeped in Futurism with its philosophy of merging art and technology. The Italian futurism art movement was founded in 1909 by Italian poet Filippo Tommaso Marinetti.

The Bauhaus movement was apolitical. Politics had done it in when Nazis gave the order to close the future of the Bauhaus institute in 1933.

It was only a few years ago, lost in my understanding of my purpose in life, a variety of curiosities and marred by boundless drive for growth.

I struggled to define an underlying role in which these traits will fill to perfect form and funnel through to create new meanings for myself and others.

I came to know of Dieter Rams by chance, in learning of him I came to recognize my final function in the world.

Dieter Rams as an individual is the one of few remnants of what's left of the Bauhaus spirit and Walter Gropius's vision of aesthetics.

The vision of the Bauhaus movement was to abolish the elitist attitudes of designer and artist to create the future of aesthetics and craft, what we have come to know today as 'design'.

I have a certain sense of obligation to pay my respects to the one who had allowed me to identify my nature. This visualization design was an attempt to apply the philosophy of Bauhaus and pay tribute to Dieter Rams.

The concept of this design was to play on a visualization that could be both logo and a visualization totem.

This design was stripped of meaning to a more basic level of shapes and colour.

The design of the visualization uses basic shapes of circle, lines and squares with aesthetics that hark to Bauhaus minimalism (Figure 5).

The use of color was utilized to communicate status and condition of the user in a period of time. The design is what I would refer as low structure, high expression.

Purity in the most basic form is potent minimalism that fulfills a function to allow a form to transcend itself to be greater.

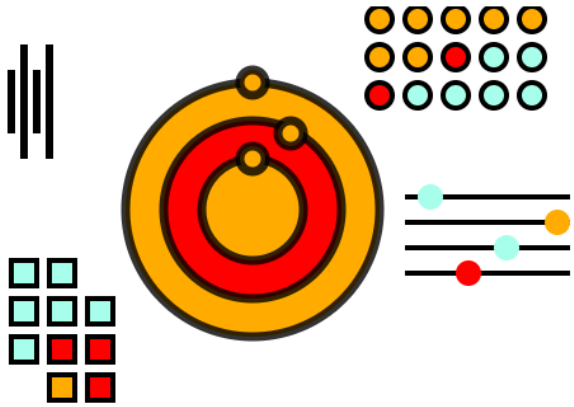

Figure 5 - Rams Visualization Design

Form and function become inseparable. An interesting avenue for psychological association of shapes and perception emerged during usability testing will be discussed in the following section. This usability session presented its own unique insight and views that differed from previous design, what has been consistent has merely been the views on FT signifies among participants.

4.4.1 Outcomes from Users Testing Sessions

Most outcomes are fairly oblivious to FT market irrespective of age. One participant had no need of a FT to maintain obligation to healthy living, was relatively self-assured. In summary, FTs are a distraction that overwhelm users with goals. The obligations to perform for technology, unnecessary diversions of charging, syncing and maintenance were described as a lot of 'big overheads'.

The feedback from this usability session was insightful besides findings on the design it offered me an opportunity to integrate a psychological element to the test.

In the visual association survey test participants are not briefed on details of the visualization to maintain neutral distance of familiarity or previous associations increasing as much as possible accurate detection of their responses to an objective experience of the visualization.

Before the usability test, participants were interviewed on FTs then a sample association test to see how each user would relate to a shape that functions as visualization. The results of this remote visual cognitive survey in the overall work I have determined as inconclusive due to insufficient sample population to conclude a final analysis.

However, it offers promising potential for future research on the association of shapes and colour that explore functional cognitive associations in men and women. Response to this visualization design was overall the best in comparison to other visualization prototypes.

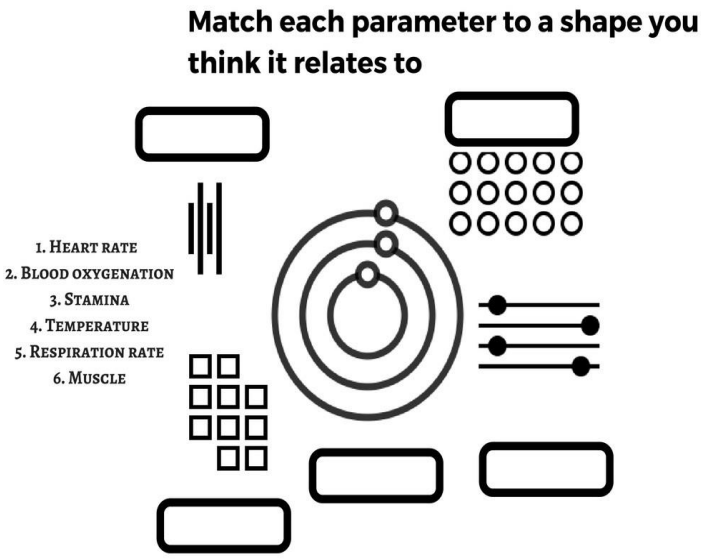

Figure 6 - Visual Association Survey

Color drew mixed response on equal sides. Participants were drawn by the simplicity of visual communication, structural outline and progression elements in graphic information (Figure 6).

One participant was drawn to use of yellow for progress and growth communicated a quality of gold achieving. A female participant noted that visualization communication for weight and stamina changes would be a useful feature that would appeal to female users.

Design element of lines and sphere were appealing to participant. Another participant found the combination of colors were at odds or that yellow communicated a sense of distress.

Red was universally received by all participant to indicate negative association. A second visualization design was later modified to reduce elements for better simplicity with Rams 2 design (Figure 7).

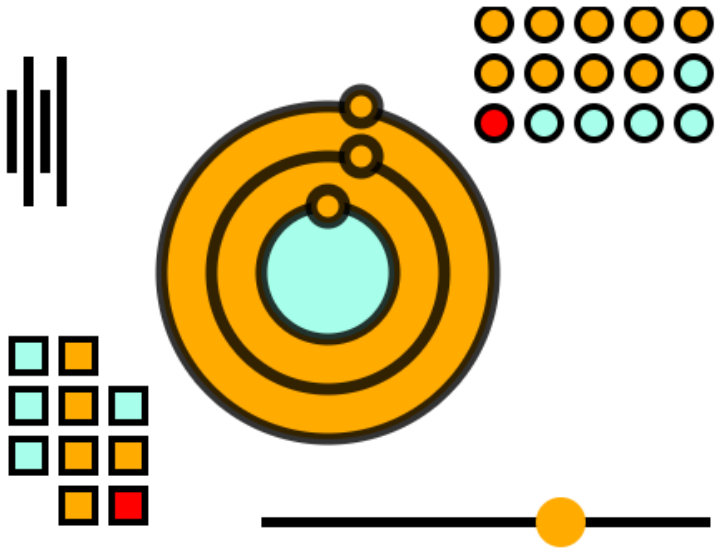

Figure 7 - Rams 2 Visualization Design

4.5 Synchronicity

The final visualization design was a progressive development from the previous two visualization design.

The orbit type visualization design provided a different form of information visualization that utilize *sync*, *best record* and *level performance* (Figure 8). The visualization logic can be broken down 7 spheres with 2 orbits representing 3 states with positions of movement to communicate pattern language performance.

Figure 8 - Synchronicity Visualization Design Change

Each of the first orbit represents one parameter of biometric information that maintain a color for *best record* of performance. The second orbit functions to communicate levels from low, medium, and sync.

A low performance utilized black as a visual communicator while grey for medium performance. A high performance was communicated by a sync with

parameter orbit. Low colours was best choice for level performance due to presence of the visual complexity by parameters along with black to grey which communicated progression.

The usability session produced two main responses that can be summarized by an appreciation of movement and position of orbits with disruptive sense of association. Participant was drawn to creative aesthetic of visualization of colours and movement experienced a sense of alienation for familiarity of lines.

Another participant noted that while positioning of orbits circle is helpful in communication experienced visual noise. Patterns that were not uniform cause a sense of dissatisfaction while simultaneously instilling a motivation to find harmony in the patterns. Participant experienced a sense of displacement in how the visualization projected a sense of loop unable to ground a start and end.

Participant felt while visualization had aesthetic qualities it was at times difficult to form comparison and preferred this as additional visualization option. Orbit visualization brought up issue of clock wise and anti-clock wise communication of information that had limitation in threshold of biometric readings.

A participant felt the visualization may pose problems in other target audience may find the visualization logic complex or not immediately accessible. Color applications were noted to be insufficient by participant for communicating contrast. In conclusion, this visualization design invoked a degree of alienation unseen in previous visualization design for lines.

4.6 Art Graph

Engagement drives interaction to address long term motivation in visualization. Art Graph is designed for adaptive behaviors as practices of user's training change as user gradually improves performances. A change in nutritional requirement, regimen training, growth development and overall practice interaction generate a variety of data outputs. Art Graph consolidates data in meaningful aesthetics and design to provide incentive for long term engagement by progressive data visual language.

Art Graph visualization allow users to gain an overall relation of activity, context and dosage/ frequency repetition in shaping personal health acting as a cumulative funnel for data portrait shaped by user’s activity. User’s visualization is determined by specific training of activity that affects the body in a specific manner.

The visualization is determined by intensity of body performance and specific activity. Scientific literature was used to establish basis for an evolving data portrait to place a point across that personal data carried with it an incentive for storage and personal analysis as a data aesthetic cognitive art experience. Design of the visualization was subject to process, information design and sketching, primal instinct of a designer. Each of three designs offered a view mode influenced by the inherent nature of the design.

Visual Morse required users to associate color codes as a whole with circles to derive value with progressive colour patterns. It was a design that utilized colour patterns as a form of language that simulated gestalt principles as information visualization.

4.6.1 Art Graph User Feedback

Art Graphs distinctive color patterns while complex drew an aesthetic appreciation with a psychological underlying reaction closer to a Rorschach test. Participants were drawn by novel way of summarizing data with potential for visualization to take on social functionalities for user comparison. Synchronicity design value focused on alignment of parameters which offered a kind of alignment of planets and orbits as view mode. Synchronicity as a visualization design drew alienation and appreciation of visualization logic. This visualization design had less visual complexity than previous two visualizations and highlighted separate visualization issues in the design.

The use of an orbit type design utilized a visualization logic of position and colour matching to indicate status progression of user's health. Participants experienced a higher degree of alienation to recognize lines than any of the previous visualization design. Data communication appealed to position of orbits indicate proximity of data readings for each parameter give a bird's view for user's entire parameters to form better association in habitual practice and wholeness on data behavior. RAMS design offered a sense of pace and orderliness whilst retaining and refining qualities of Art Graph as a data visual language.

The association of muscle and heart graphical elements was purely incidental in the design process. I was aware there was value forming correlation in how habits influence heart rate and muscle performance at that time. The appeal on visual communication aligning muscle and heart rate offer visualization

complexity that would not overwhelm user from its potentiality of differentiation.

Normal respiration rate were 12-20 breaths per minute, below or over 25 is abnormal. A normal blood oxygenation reading is 95-100% and values below are considered low. Stamina the sum accelerometer data of a user's running activity.

The graphical communication for each parameter utilizes triad color code system on three level of performance. Muscle and heart data conveyed position and color performance in the visualization.

The improvement of fitness state begin in muscle and heart as the following section will illustrate. The decision to associate muscle and heart in one graphical element visualization was a good call.

Physical activities are characterized by degree of dynamic (aerobic) or static (strength) requirement [4].

Habitual training exercise do and can lead to structural and functional changes in cardiac performance. Stimulus for cardiac chamber enlargement has been attributed to repetitive volume challenge for heart during training [14]. It is still unclear on the amount of dose, frequency, duration and intensity on aerobic exercise required for cardiac remodeling, 4-5 sessions per week of moderate aerobic activity has been associated with cardiac chamber size as highlighted in M. A. Opondo’s paper [14].

Time expands outward as rings like a tree from a duration of 3 months in muscle and heart rate visualization component. The design on duration of time was limited to 3 rings to maintain aesthetic minimal design. Increasing value are mapped

to position and colour to facilitate better cognitive encoding retention in user to maintain a consistent design system for visualization to adhere to.

Muscle and heart visualization allowed user to form a correlation through aligning graphic elements that convey proximity readings of heart rate and muscle performance.

The visualization becomes a type of data language for user to read data visually as a signal providing feedback to visualization system in output by user's fitness behavioral practice could steer towards more dynamic activities or static based activities to reach a new equilibrium once their bodies would re-adjust to new adaptive growth state.

4.7 Prototype User Scenarios

Art Graph visualization is a tool in exploration of Athlete's heart. Athlete's heart is a set of parameters that affect the structure, electrical conduction and function of heart that increase cardiac output in exercise. Art Graph is fueled by adaptive behaviors of user and external environment.

Art Graph is independent of sensors, FT brands or software acting as cumulative data visualization for user can be implemented in any FT system to consolidate data events from user's engagement of a system. The Art Graph interface functions as a visual data language. We could consider Art Graph as a GUI for data management. Art Graphs in idea is rooted in *contextual design.* Exercise depend on wide range of metabolic demands and physical exertion [14].

The system represents user’s behaviors, attitudes, goals and intents that characterize a distinct visualization of users operating in a distinct particular environment.

We are accustomed to constructing visualization out of raw data to infer the visualization before we arrive at insight. Art Graph challenges this form of sense making by encapsulating data into a user's cultivated visual interface that has an aesthetic meaning for everyone. The act of visual processing of information from prior experiences referenced is symbolized information [2]. The brain has been described to use a particular method in how it processes perception and cognition. Configuration based object recognition strategy involves holistic approach in identification of non-accident features and parts of an object [15]. If the brain is an art critic, the art critic wants to see how each art piece in a gallery fits together according to theme of the event as proposed by gallery owner.

Art Graph is the ideal combination of aesthetic and functional visualization that embody dynamic data changes can develop in a lifetime of usage. A user's motivation for prolonged use of system can be described as contextual inquiry to understand who they are in a dynamic system.

To illustrate value of heart and muscle visualization we will review 3 potential use cases of three different persona model types of consumer groups with specific user goals. Abott is an amateur bodybuilder trains for muscle bulk. Nadia is a gymnast requires her fitness to be agile and light for her sport activity. Earl is a runner must keep his body strong and lean for his running activity.

4.7.1 Abott - the Bodybuilder

Abott's training include a standard regimen push up every morning. Abott's exercise training focus less on aerobic exercise e.g. jogging, rowing, swimming or cycling. Abott's training is geared to maintain mass through repetitions. Abott's

performance maintain steady progression as muscle and heart readings line up close (Figure 9).

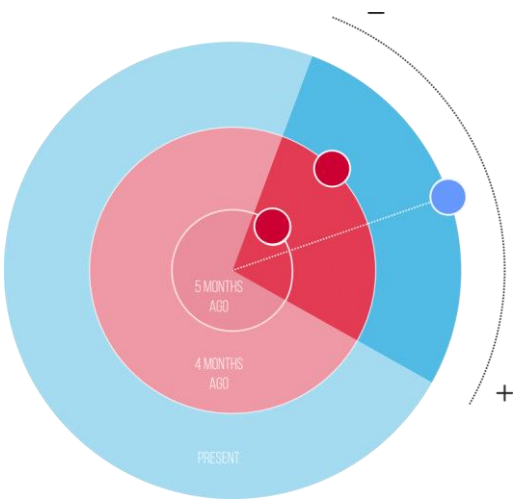

Figure 9 – Abott Profile A

Abbot's training becomes progressively intense with heavy weight lifting.

Abott has a good steady heart rate in first circle. Second circle show increased muscle activity attributed to Abott's training. Third circle sees Abott's return to his original resting heart rate with improved muscle quality. This visualization below (Figure 10) shows divergence in heart and muscle performance.

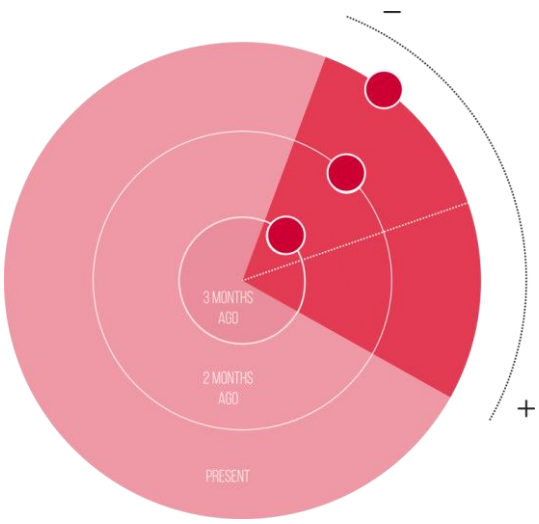

Figure 10 – Abott Profile B

Art Graph gives information on user's context to enable user to interpret the meaning of their bodies in relation to an environment. Art Graph in post retrospection functions as art that act as symbolic or pictorial visualization to create a distinct user experience after a period when user can observe certain themes or aesthetic traits of their profile.

The expanding visualization provides a sense of accomplishment for Abott.

He ups the dosage repetition of his training.

Abott maintain his muscle quality and his heart range returns to resting heart rate.

Low resting heart rate is an indication of increasing adaptive health fitness [17].

Abbot's training, running with weights contribute to an increase in muscle formation as readings increase (Figure 11). This visualization design allows us to pose if there is a correlation in performance of Abott's heart and muscle.

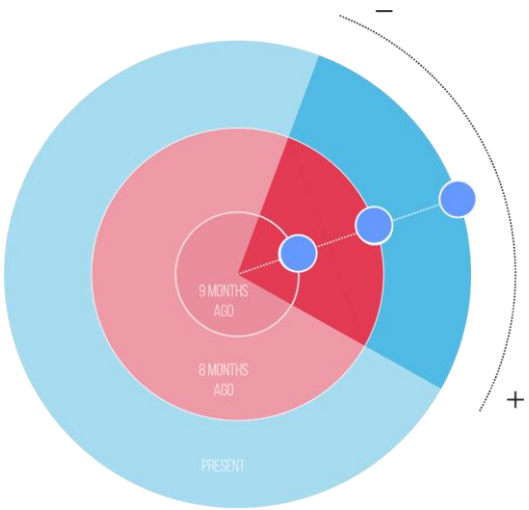

Figure 11 – Abott Profile C

User is positioned as architect of embodied experience by interpretation and meaning of Art Graph data portrait.

Abott takes large portion of protein to support muscle development. Diet replenishes Abott's muscle mass so that his body is geared to repair tissues to maintain developing muscles. In this most recent state, Abott's combined habits and diet contributed to creating his desired physical condition (Figure 12).

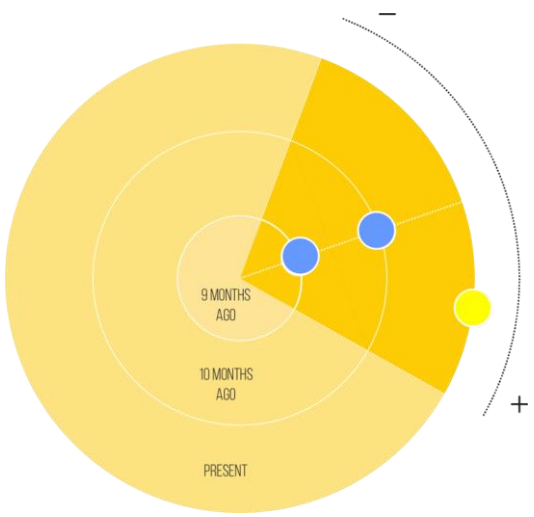

Figure 12 – Abott Profile D

Art Graph accounts for context by form and design with profiles that factor various processing of metabolic functions in people which affect visualization development by blending action and visualization.

Many adaptations take place in muscle as muscle undergo specific adaptations from exercise as training is specific for selection of appropriate aerobic activity.

4.7.2 Nadia – the Gymnast

Nadia's stretching routine during the start of her training. Nadia's heart rate has been fluctuating in her performance.

She started with a lower resting heart rate that indicate she was fit before training or her heart is in a state of adaptation (Figure 13).

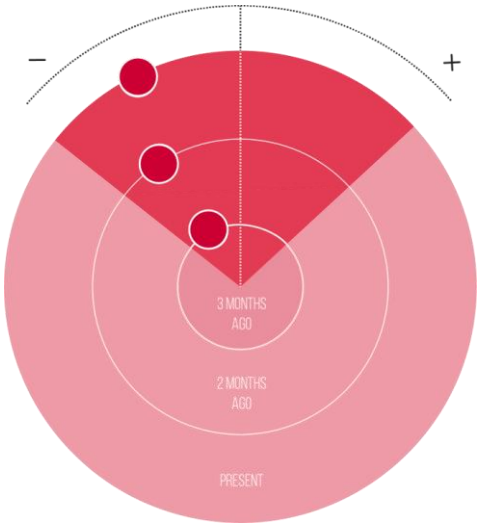

Figure 13 – Nadia Profile A

Her muscle quality increased in present state as her heart returns to normal resting heart rate. Nadia's conditioning exercise to improve strength and agility relies on weight lifting and more conditioning (Figure 14).

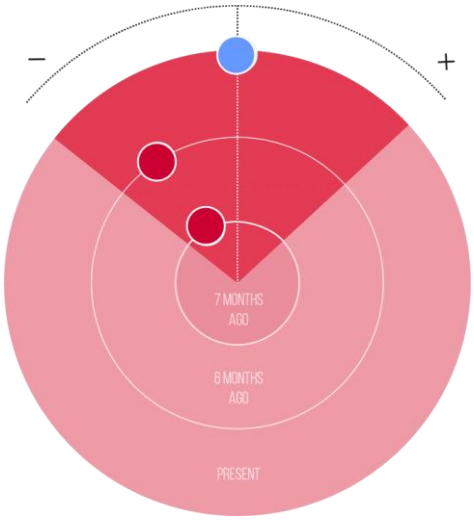

Figure 14 - Nadia Profile B

The muscle performance is focused on fortification and strengthening.

Nadia’s heart reading maintains a steady heart rate.

Nadia focuses more on strength development. Nadia’s heart performance is indicative of her improved health with her low heart reading. Nadia trains her

balancing and strength conditioning. Here her fitness construction remains the same (Figure 15).

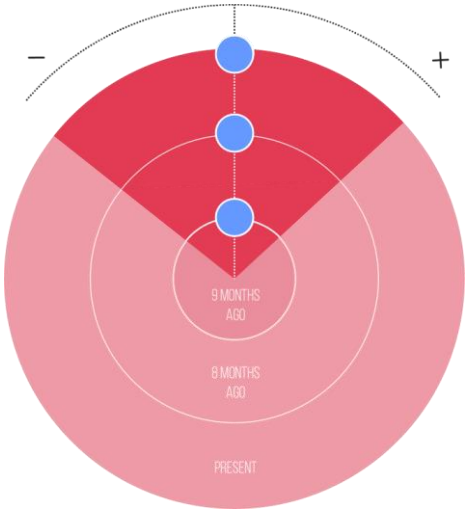

Figure 15 - Nadia Profile C

She has trained her body muscles to be compact contributing to conditioning her muscles for sport performance requirement. Nadia does better back flips now. Her muscle formation has improved.

She should be careful that muscles will not weigh her down in her acrobatics (Figure 16).

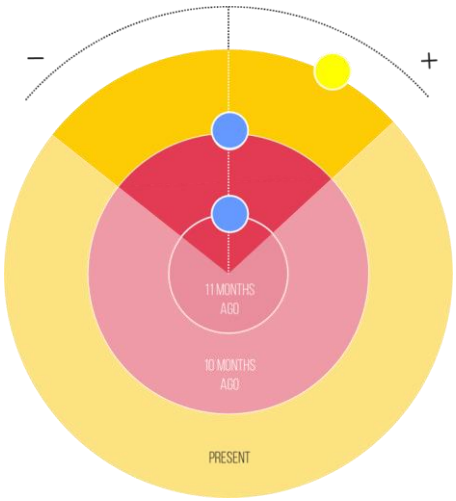

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Figure 16 – Nadia Profile D

4.7.3 Earl -the Runner

Earl uses light weights to keep muscle in active state. He does not want to build mass that might not contribute performance to his sport activity. Earl does some swimming which is a low impact exercise that strengthens muscles. For Earl this is a good alternative. It maintains muscle in compact state and stimulated to perform (Figure 17).

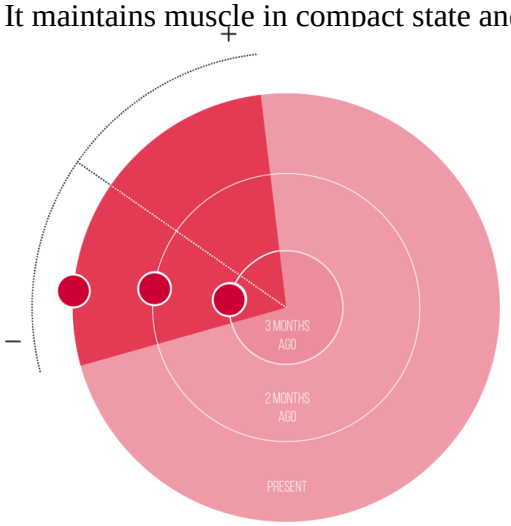

Figure 17 - Earl Profile A

Earl started his endurance jogging expanding and conditioning his heart rating for new adaptation rate. Active exercise expands the heart chamber. He is not gaining muscle as the body should sustain itself (Figure 18).

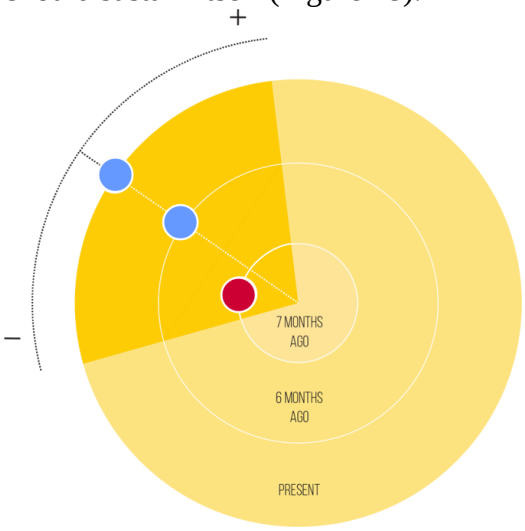

Figure 18 – Earl Profile B

Earl does light-weight lifting. Earl hits the gym only to maintain muscle mass at the current condition. Training muscles to be more compact will let him run better (Figure 19).

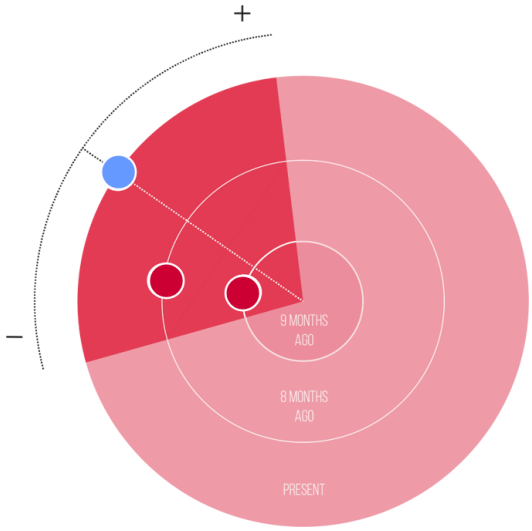

Figure 19 – Earl Profile C

Earl has the ability to maintain his endurance jogging longer. Running keeps the heart active and is good for the cardiovascular system since blood must be channeled through vessels for all organs to be stimulated.

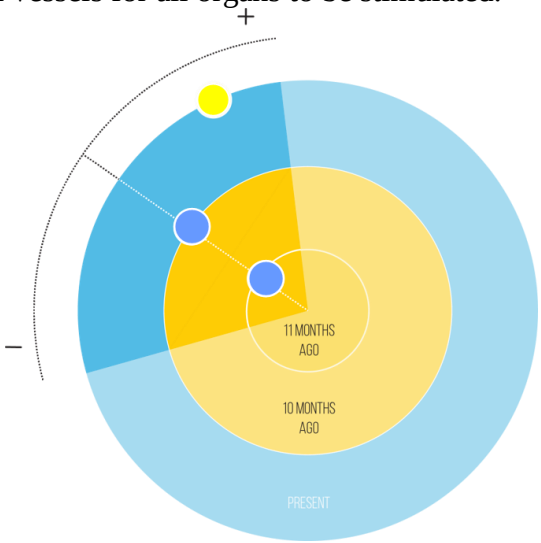

Figure 20 – Earl Profile D

Earl's heart is continuously challenged to function at its best from aerobic activity. The new muscle growth has not affected his performance (Figure 20).

4.8 Art Graph Form

The Art Graph in the most ideal concept I imagined would be a ubiquitous visual representation that could morph, change and extrapolate to become different forms of modular visualization.

A type of medium that would be the unified theory of all visual representation by engagement could invent new ways of representation by using dimensions like time, view mode or speed.

Could visualization be designed to accommodate user's data contextual model merging representation as a single unit of form follows function?

A factor that makes data visualization effective is attributed to its expressiveness. Form is an influential attribute in the communication of data, best form is determined by behavior and attributes of the data. One view has been described as never sufficient to convey information contained in data. A critical component of visualization is to be able to anticipate the types of view and modification that would be useful to the user [18].

This form of data art medium could serve as a conduit to explore human perception not just across individuals but across cultures as aesthetics can lead to understanding the mental models of how we assign value towards aesthetic stimuli and in aesthetic preferences.

Art Graphs could be used in the field of social computing as a research tool to understand collective thinking which are influenced by seasonal events in a specific period of time.

The best aspect of Art Graph is compartmentalization of an individual's metaphysical construct that is molded from a physical existence to provide control for a user to manage one's personal data.

Art Graph is structural data and software as embodied experience, as a potential approach of data study for a "formal language' to exist for the humanities, art, design, science, and computation to commune in an analysis that avoids information distortion that occurs in crosstalk of domain experts in a study.

Gestalt theory provides an understanding of how visual organization occurs by integration of the sum to the whole which is an inherent concept of emergence. Gestalt psychology [11] with its foundation of modern study of perception that the mind seeks to understand the big picture as a whole. One could say that emergence, Gestalt along with biological complexities make for natural affinity in computation and data analysis.

Perceptual consciousness operates in flux directed at an object. The inference is subjective but the objective occurrence of the object is validated.

The study of human perception will allow us to better design effective data visualization which relies on the cognitive aspect of how our brain responds to information.

Imagine the possibilities if we could use a visual interface to quantify and study the relationship of data, visualization, phenomenology all the while contributing to our understanding of our cognition and human perception.

Effective data visualization will benefit greatly when we have begun to map the most effective brain regions that are perceptually susceptible to different designs of mapped data visualization.

4.9 Art Graph Function

The need for an interface that promotes a sense of ownership towards one's data is a much-needed rally cry in a world edging closer to a Data Economy, Big Data and Artificial Intelligence.

The Art Graph is an interface of agency for users to participate in the data system by interaction and compartmentalization of biological and social data.

The Art Graph, a designed closed data interface system is loosely based on the Dataware Model by McAuley, Mortier, and Goulding [12].

In conception, it is designed to accommodate structural and expressional design of an individual construct affirming the principles of human rights and in accordance with domestic and international data protection privacy laws.

The model system is sectioned to three components of the user/object, data source, and data processor all of which function as a singular data container for a user.

The catalogue for users to register new data is communicated by the visualized feedback progression that signal user's accumulating metadata that generate distinct signals or data signatures identified with each user object for dynamic data context generation.

The design decision is driven by stringent protocols by feature design and interaction of its database to provide user sufficient freedom on personal data disclosure to function and interact in the digital economy while retaining personal data registry records.

The Art Graph allows users to reclaim their humanity and participate as active agents in the digital economy by addressing data discovery, data ownership and control, data legibility, and data tracking.

The Art Graph is a multidimensional by nature to simulate the human experience in order to decipher contextual driven multidimensional datasets.

5 Chapter 5 - Results

5.1 Conclusion of Research

The scope of this research project examined the cause of low impact of fitness trackers in users and how application of art and design could be utilized to create an expansive stimulating user experience for fitness trackers. Art Graphs addresses low retention rates in fitness trackers by positioning experience as an incentive of personal examination. The design process in this project addresses aspect that combine motivation, nature, engagement to produce a medium of data visual language.

Usability test sessions and research outcome confirmed that art and design is a viable method to stimulate engagement by data aesthetics visualization.

Art Graph presents data portraits that solve engagement issues by offering intrinsic value for continuous engagement. Aesthetic data visualization increases context and meaning to providing users a way to relate frequency of exercise with physical development. Art Graph challenges our view of the application of data and how fitness in health can be extended beyond the idea of doing more exercise repetition and frequency that implies fitness.

The Art Graph concept of fitness promotes a more holistic outlook on what that would mean on a systemic level over a long-term period. Art Graph compartmentalizes a variety of data by volume and types to allow the observer to ask big questions on the nature of their own health and fitness data. Art Graph examines the role of context to lend credibility that future research may build on by exploration of behavioral practices with data embodiment.

5.2 Future Direction for Art Graph Visualization

Data form objective constructions of truth in a given time and place. A report predicts digital data is expected to increase by 40 times from 2012 to 2020 [16]. Could it play a role in the data economy data mining, a tool for examining large pre-existing databases in order to generate new information? The Data economy will require new tools to facilitate high conversion knowledge discovery and decision making alongside the rapid grows of voluminous data.

Data mining was developed out of challenges that traditional data analysis techniques posed for new data sets in relation to scalability, high dimensionality, complex data, distribution and non-traditional analysis [5].

Critical issues that arise from data capture result in variations of data quality and accuracy can be limited to hardware or observer. Faulty hardware can limit data accuracy, this pertains to sensors subject to wear and tear or made from less durable materials. The observer with unclear processing methodology or perceptional awareness is apt to miss out important details of data that determine overall knowledge extraction required to gain value from data analysis for application. Visual data language will enable quick encoding in data reading. Art Graph is an option that could function as a new visual input data format giving form to raw data as it collates data from human data sources.

There is inherent value in Art Graph as a new format that consolidates variety data and positioned as input data that undergo data processing and display. Input data is generally stored in flat files, spreadsheets or relational tables before the data is pre-processed to transform raw data to suitable format for analysis. Consider the chal-

lenges of data quality variation Art Graph could be positioned as a tool for detecting missing data, incorrect data, imprecise data or irrelevant data.

This leads to Art Graph's potential for high dimensionality to store large amounts of attributes from multiple sources in its data structure from multiple sources. Art Graph makes it possible to use a single high dimensional data structure across science, business, medicine, archeology, social science and various fields making statistic and big data ubiquitous. Improved processing capabilities will surely extend functionality of data analysis through non-traditional analysis of big data with the application of Art Graph.

In health care I would vouch Art Graph provides an interesting avenue in how the phenomenology concept could be introduced in healthcare industry for practical applications thus expanding research, commerce and industry possibilities

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Appendix A

My Draft Tenets of Experiential Biology for the working Biological Designer

1. Life is Information and we are all part of the book.
2. Decision and outcome is imprinting of new information.
3. All information's are equal but one vital information completes the whole.
4. Emergence is the engine of definition. Entropy is the antithesis.
5. Entropy is creative and generative. Emergence provides order for creation and information generation.
6. Signal and feedback are instruments in the deterministic conditions of chaos systems for the emergent properties of life, definition and existence.
7. All information or actions must be treated with ethics and accountability for citizens, consumers and users. We are ethical. This is non-negotiable.
8. Designers of experiential biology believe in the expression of lifeforms that bring us closer to the totality of nature's design.
9. For meaning to emerge from data to understand the context. Life must continue.
10. Before form and function, there are signals for structures. Simplicity is Order.

Appendix B

My Draft User Privacy Directive for Endocortex model drawing from GDPR*, Human rights, Basic principles of data protection laws, OECD* and others

* Refer to Appendix C (List of Abbreviations)

1. Users shall not be subjected to arbitrary interference with privacy, family, home or correspondence. All users have right to protection of the law by data misuse or data abuse.
2. Rights of Users will be processed in accordance with rights of data subjects.
3. Security measures will be implemented to protect personal data from unauthorized disclosure, destruction or modification.
4. User's processing of data will occur only with consent by user and complying with legal authority.
5. Experiential biology will adhere to Use Limitation principle wherein personal data should not be disclosed, made available or otherwise used for purposes other than those specified except with consent of data subject or by the authority of the law.
6. Processing of data should not infringe on privacy rights of user.
7. User has the right in the protection of personal data in recognition of Informational Privacy.
8. Users may exercise their rights with their information such as the right to access, rectification, cancellation or opposition of personal data.
9. Processing of personal data should be made with a reasonable expectation of privacy.

10. Users own rights to their biological data for personal storage or commercial/research purposes.

Appendix C

Abbreviations used in this document

CAM	Conventional and Alternative Medicine
CV	Cardio Vascular
DNA	Deoxyribonucleic Acid
EBM	Evidence-Based Medicine
ECG	Electrocardiogram
EDA	Electrodermal Activity
EMG	Electromyography
EU	European Union
FT	Fitness Tracker
GDPR	General Data Protection Regulation
GSR	Galvanic Skin Response
HR	Heart Rate
IEEE	Institute of Electrical and Electronics Engineers
OECD	Organization for Economic Co-operation and Development
PIES	Phalanx Integrated Entropic System
PTSD	Post-Traumatic-Stress-Disorder
RITE	Rapid Iterative Testing and Evolution
svg	scalable vector graphics

Appendix D

OCADU REB Letter

From:
Sent: Friday, July 28, 2017 5:02 PM
To:
Subject: FW: Amendment approved

Follow Up Flag: Follow up
Flag Status: Completed

From:
Sent: Wednesday, April 12, 2017 5:55 PM
To: Pillai, Harish
Cc:
Subject: Amendment approved

April 12, 2017

Faculty of Design
OCAD University

File No: 100610
Approval Date: January 07, 2016
Expiry Date: July 31, 2017

Dear Harish Pillai,

The Research Ethics Board has reviewed your amendment to the application titled 'The Variable Limits'. Your amendment has been approved. Your REB number remains: 2016-02.

Throughout the duration of this REB approval, all requests for modifications, renewals and serious adverse event reports are submitted via the Research Portal through an amendment form. To continue your proposed research beyond July 31, 2017, you must submit a Renewal Form before July 24, 2017. If your research ends before July 31, 2017, please submit a Final Report Form to close out REB approval monitoring efforts.

If you have any questions about the REB review & approval process, please contact the Manager, REB Secretariat at

If you encounter any issues when working in the Research Portal, please contact our system administrator via

1

Appendix E_1

Project Survey Form A, Page 1

Survey

This is a quick anonymous visual survey research project to assess the subjective interpretation of shapes for visual association. You will not be required to have any prior knowledge of a subject topic and participants are required to only invest less than 2 minutes or not more than 5 minutes on this survey with recommendation to breeze through and apply closest association.

* Required

General Information

We value your privacy.The information herein disclosed will be used only for analysis to infer the results of this study.

1. **Gender** *
Mark only one oval.
- ◯ Male
- ◯ Female

2. **Age** *
Mark only one oval.
- ◯ 18-25
- ◯ 20-30
- ◯ 30-40
- ◯ 40 and later

Visual Association

There are no right or wrong answers in any of your correspondents therefore be blind and fearless in your participation.

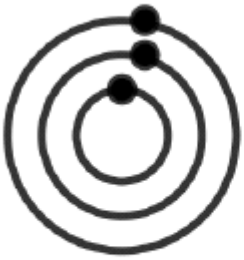
3. **Whioh of the parameter below do you olosely assoolate this image with?** *

Mark only one oval.
- ◯ Heart rate
- ◯ Muscle
- ◯ Stamina
- ◯ Blood oxygenation

Appendix E_2

Project Survey Form A, Page 2

4. Check two parameter below for the closest association you make with this image



Check all that apply.

- [ ] Heart rate
- [ ] Stamina
- [ ] Respiration rate
- [ ] Muscle

5. Which of the parameter below do you closely associate this image with?

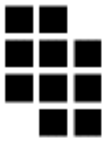
Mark only one oval.

- ◯ Muscle
- ◯ Respiration rate
- ◯ Stamina
- ◯ Temperature

Appendix E_3

Project Survey Form A, Page 3

6. Which of the parameter below do you closely associate this image with? *



Mark only one oval.

- Temperature
- Stamina
- Muscle
- Respiration rate

7. Which of the parameter below do you closely associate this image with? *

Mark only one oval.

- Stamina
- Muscle
- Heart Rate
- Temperature

Colour Association

Rate these colors based on the scale below. You are required to think less and act on impulse.

Appendix E_4

Project Survey Form A, Page 4

8. I weight less than yesterday

Mark only one oval.

1	2	3	4	5	6	7	8	9	10
⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭

9. Better is not Medium

Mark only one oval.

1	2	3	4	5	6	7	8	9	10
⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭

10. Less is More

Mark only one oval.

1	2	3	4	5	6	7	8	9	10
⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭

11. Medium is better

Mark only one oval.

1	2	3	4	5	6	7	8	9	10
⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭

Appendix F_1

Project Survey Form B, Page 1

The Variable Limits: Survey for OCAD thesis

You are invited to participate in a study that involves research understanding how current generations view health and fitness. The purpose of this study is to understand the attitudes of how people view the importance of exercise and wearable like fitness trackers. As a participant, you will be asked to provide a broad feedback on how you feel about exercise, fitness trackers, or habits and activities that you view as important in practicing a healthy lifestyle.

1. **Gender**
   Mark only one oval.
   - ◯ Male
   - ◯ Female

2. **Age**
   Mark only one oval.
   - ◯ 18- 25
   - ◯ 20-30
   - ◯ 30 - 40
   - ◯ 40 and later

3. **Do you currently use a fitness tracker ?**
   Mark only one oval.
   - ◯ Yes
   - ◯ No

4. **If you answered yes, describe your experience with the current tracker? If no, n/a**

5. **How do you feel about fitness trackers?**

Appendix F_2

Project Survey Form B, Page 2

6. In an ideal world, how is the fitness tracker the best thing that's happened to you since the Ipod? What's your wishlist on the ultimate fitness tracker?

7. Do you generally exercise regularly? What keeps you motivated to practice your healthy lifestyle?

8. What's your view on technology, describe your positive or negative experiences. If you use a tracker, apply your response to this question respectively.