CODEX OF THE FUTURE SERIES

# FUTURE OF SMARTPHONES 2020 TO 2070

UNLIMITED THINKING . EXPONENTIAL POTENTIAL

BY MATTHEW GRIFFIN

311 Institute Global Advisory : Forecasting : Innovation : Strategy Version 5.0 Jan 2019

"As technology gets closer to people, literally and figuratively, one day we could be the device."

- Matthew Griffin, Founder and CEO, 311 Institute

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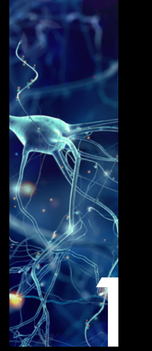

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THE FUTURE OF EDUCATION AND TRAINING

Prepare your children and workforce for a disruptive future where science fiction becomes science fact

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THE FUTURE OF INSURANCE

As the pace of change accelerates, as technologies become more powerful, and as the world becomes more connected risk and opportunity is everywhere



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THE FUTURE OF SMARTPHONES

Smartphones are one of the most ubiquitous forms of technology on the planet, so in this Codex we unwrap what's next.

## ABOUT THE AUTHOR

Matthew Griffin, an award winning futurist and author of Codex of the Future is described as "The Adviser behind the Advisers" and a "Young Kurzweil." Matthew is the founder and CEO of the World Futures Forum and the 311 Institute, a global Futures and Deep Futures consultancy working between the dates of 2020 to 2070.

Regularly featured in the global media, including AP, BBC, CNBC, Discovery, RT, and Viacom, Matthew's ability to identify, track, and explain the impacts of hundreds of revolutionary emerging technologies on global culture, industry, and society, is unparalleled.

Recognised for the past six years as one of the world's foremost futurists, innovation and strategy experts Matthew is an international speaker who helps governments, investors, multi-nationals and regulators around the world envision, build and lead an inclusive, sustainable future.

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*"Matthew led a think tank [to discuss] the 'Future of Intelligent Machines.' The discussion in AI, automation, future experiences and robotics far exceeded our expectations. He brought to the table an incredible breadth of knowledge to open the conversations to implications in labor, education, transportation, and user experiences. At the conclusion, Matthew provided insightful and actionable conclusions that we [took back] as guidance for our senior executives. We look forward to further engagements with Matthew as we explore other global trends."*

Director of Corporate Strategy
Qualcomm, USA

SMARTPHONES AND other mobile computing platforms have revolutionised the way humanity communicates, collaborates, creates, entertains, organises, shops and works and, ostensibly, this is just their first opening act, and as a result, today, there is no country, market, product or service on Earth that hasn't been influenced or transformed by their existence.

Now though, not even two decades into their evolution consumers and manufacturers alike are asking what comes next, how do we push the boundaries of the new mobile revolution further than ever before to achieve new highs, and what comes next, and that's what I explore in this horizon report. So come with me as we explore how much life these platforms have left in them, what the smartphones of tomorrow will look like, if we can really call them that, and, ultimately, what devices will replace them.

# DECODING THE EXPONENTIAL FUTURE

WITH ACCESS to the right breadth and depth of insights, or dots, as I call them, putting the big picture together and predicting what the future will look like, and, perhaps more importantly, when it's going to arrive, isn't as hard as many people think.

After all, as they say, the future is hidden in plain sight, and sometimes it's just a simple matter of expanding your horizons.

In order to predict the future as accurately as is practically possible I do my best to work with what I call full network insights. That is to say I work with the inventors, academics, entrepreneurs, investors, multi-nationals, governments and regulators who, in one way or another, are all discovering, combining, building, testing, adopting, deploying, scaling and regulating tomorrow's technologies, products and services, or as I'll call them from here on in, for simplicity's sake, "Concepts."

It's this rich tapestry of contacts, that cuts across every geography and industry, combined with a deep understanding of hundreds of exponential technologies and their impact on culture, industry and society, that allows me to piece together the jigsaw that is the future with a high degree of accuracy and precision. But it's no easy feat.

However, while technology plays, needless to say, a very important role in helping shape the future, viewing it in isolation in order to try to decode the future is a mistake, because, inevitably the success of these new concepts, and their tipping points, depend on a variety of interconnected factors that include, but are not limited to, accessibility, affordability, cultural and generational bias, investment patterns, maturity, and the regulatory, macro-economic and socio-political environment.

Should any of these fail to align correctly then tomorrow's Earth shaking new concepts can quickly turn into elegant failures whose potential is never realised.

With so many different emerging technologies on the horizon it's inevitable that some of them will compliment each other, and some won't, and that some will be more impactful than others.

Furthermore, when these new technologies do finally emerge from the labs then it's down to you and I, and increasingly our capable synthetic counterparts, the Creative Machines, to combine them into tomorrow's must have concepts.

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One of the greatest issues for analysts, futurists and industry watchers alike however is the fact that all these dots can be combined in billions of new, unique and exciting ways to create a limitless number of concepts, and trying to pick the winners, and see through the noise can be challenging, and as the volume of new technologies, and moving parts, increases the task is only going to get more complicated.

Personally, and it's more through experience than by design, I've found that the best way to cut through this noise is to divide the universe in twain. On the one hand we have the promising, individual emerging technologies, and on the other we have the new concepts they could be used to create.

Evaluating the technologies comes first though, because unless a specific technology can be bought to market, in the right way, and at the right time, then it follows on that, generally, it will never get the opportunity to be used to create a new concept - let alone a new mass market one.

Then, once we've filtered those it's a fairly straight forward process of ideating all of the different ways in which they can be combined to create new concepts, which, in turn can be evaluated on their own merits and used to decode future trends and impacts, threats and opportunities.

As you'll see from this codex I've tried to make it easy for you, as easy as it can be under the circumstances, to quickly evaluate the merits and status of each of the exponential technologies I track, after which you should then be able to categorise the ones that you feel are the most relevant to you, or your organisation, so you can begin ideating your own concepts.

As the pace of change continues to accelerate, as the boundaries between industries continues to erode, and as science fiction increasingly becomes science fact, the future will belong to those individuals and organisations that have the foresight to see change coming, and who are agile and strong enough to adapt to it and lead it.



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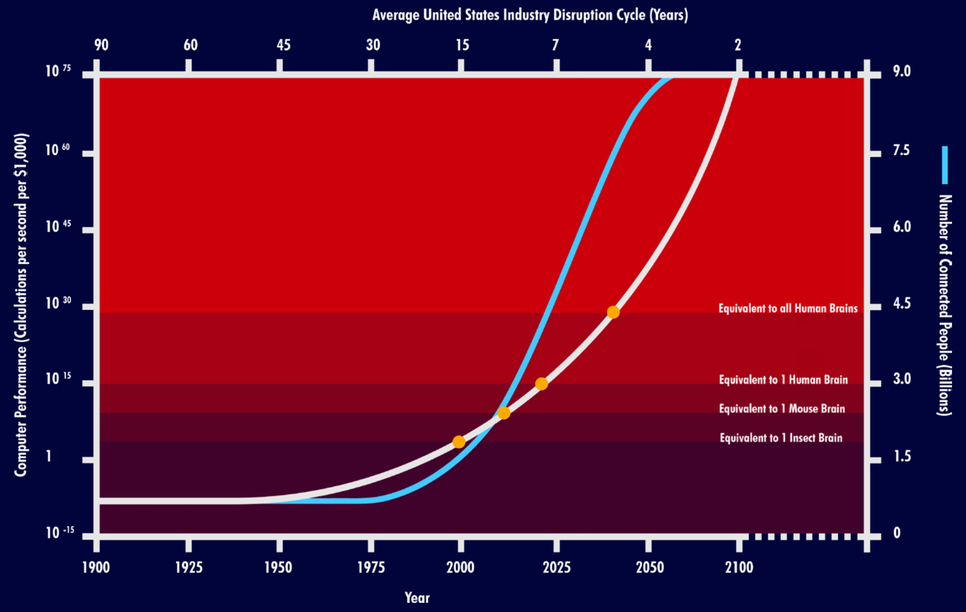
# DECODING EXPONENTIAL DISRUPTION

IF YOU step back a decade or so ago the word on everyone's lips was innovation and, frankly, if you didn't have it thrust into your face at least thirty times a day by every executive or ad man or woman you met then it's likely because you were in a coma. Or dead. Or both.

Fast forward to today and now they have a new buzz word - Disruption. But is disruption today as commonplace and accelerating as quickly as people will have us believe, or is it just hype and a word that executives and eager Silicon Valley startups throw around with impunity in the vain hope of convincing people that they're innovating at the bleeding edge and pushing boundaries?

Well my friend, let's take a journey together. Let's cut through the marketing fog, summit the hype cycle, and crack open an genetically modified beer while we raise cynical eyebrows and take a deeper look at the world that's unfurling around us.




## TECHNOLOGY ENABLED DISRUPTION

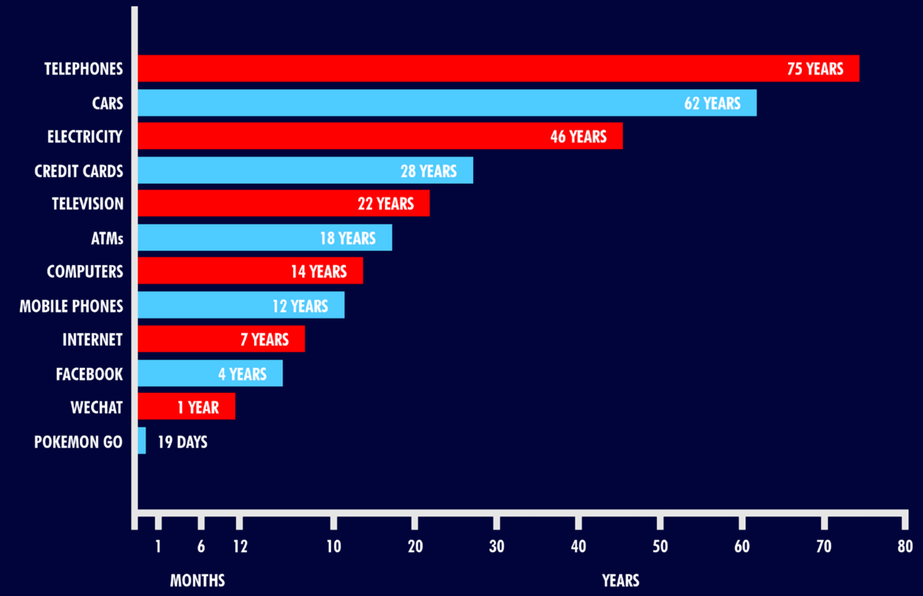
As increasingly powerful exponential technologies emerge and are democratised, with computing power being just one example, and as the world becomes increasingly digital and connected industry disruption times plummet.

# ACCELERATING DISRUPTION.

THE CORRELATION is obvious, but it's worth discussing nevertheless. If you want to disrupt the status quo it's not just good enough to have the ideas, tools, and resources that you need to create and develop your innovative new product, you also need to be able to get it into the hands of as many customers as possible as fast as possible. And in the distant past when products were physical and the only markets that entrepreneurs had easy access to were local ones, trying to disrupt anything at scale was not only an immense challenge, but it also took an inordinately long time - in many cases a lifetime or more.

Today, however, powerful new technologies and an increasingly connected planet have not only changed how we make products, and how we consume them, but they have also made it easier than ever before for innovative entrepreneurs to go global.

Just like their forbears today's entrepreneurs still have to be skilled enough to find valuable problems worth solving, but unlike their forbears they now have access to technologies and markets that are a match for their ambitions and ingenuity, and as a consequence it is now easier than ever before for one individual to disrupt the status quo faster than ever before.




## TIME TO 50 MILLION USERS

As industries become increasingly digitised and as the world becomes increasingly connected it's only a matter of time before we see an industry disrupted in a day and a multi-billion dollar enterprise built in minutes - a trend that is further accelerated by the emergence of Creative Machines.

# DISRUPTION IN A DAY. EVERY DAY.

WHEN THE inventiveness of human ingenuity has access to exponential technologies that are powerful enough to help express it and share it on the global stage amazing things happen, and the world is transformed.

In the past, for example, without an effective way to distribute and sell their ingenious products even the world's most inventive entrepreneurs could only at best have hoped to have an impact within their local geography and at a speed that would bore most of today's entrepreneurs to tears.

Fast forward to today though and that dynamic has changed significantly thanks to a slew of advances that have made it is easier than ever before for one person to impact the lives of billions of people in a fraction of the time it used to take.

Consequently, when we review some of today's statistics it doesn't take a genius to see that the pace of product adoption, and ergo any potential for disruption, is accelerating.

A scant hundred years or so ago it took over 75 years for over 50 million people to adopt the telephone, but fast forward to today and it took just over 19 days for the same number of people to adopt Pokemon Go.

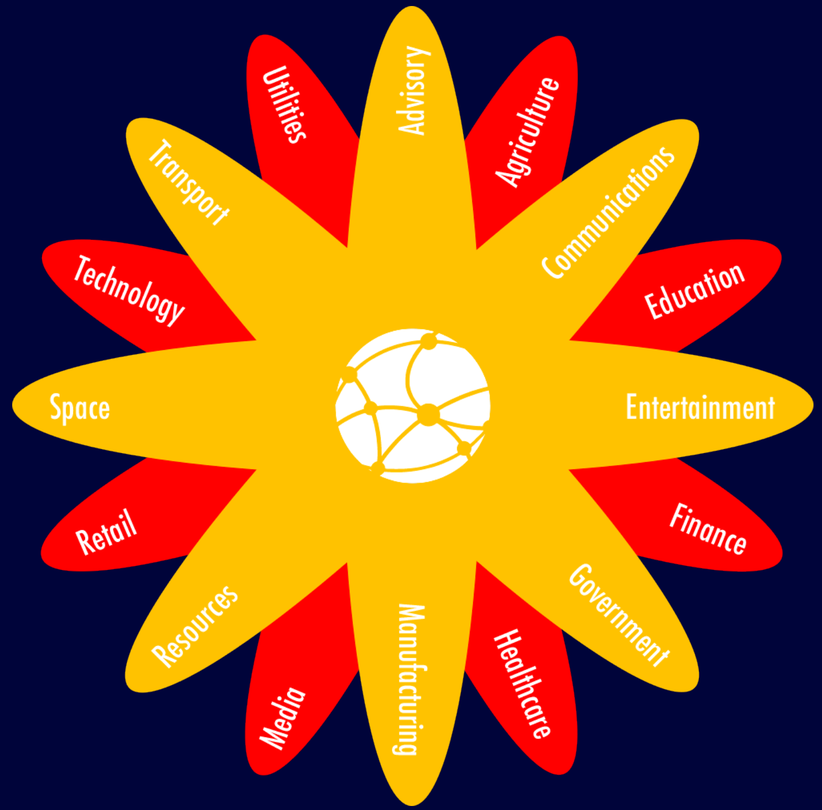
> QUESTION: If a new product can be adopted within just weeks or days by tens or hundreds of millions of people, at what point do we see an entire global industry disrupted in a day?

### THE RISE OF CREATIVE MACHINES

Furthermore, when we consider that today it still takes human developers months and years to develop products before they are fit to hit the market, what impact would autonomous companies, powered by so called Creative Machines, machines that can design and innovate new hardware and software products in hours and days today, have on this dynamic?

If they like human entrepreneurs, using in their case a dearth of Big Data, can identify valuable problems to solve, and then autonomously create and manufacture the products, and build, operate, and scale autonomous enterprises, at what point do we see the time to disrupt industries fall to minutes, and the cycle of disruption accelerate exponentially?

> QUESTION: What happens to the rate of disruption when Creative Machines are capable of innovating new hardware and software products in hours and minutes?




# NO MORE INDUSTRY BOUNDARIES.

WHILE IT has always been the case that changes in one industry would eventually ripple out and affect other industries, when it comes to accelerating the rate of global and industry disruption digitisation simply adds rocket fuel to the fire.

Furthermore, as enterprises and industries accelerate their rates of digitisation one of the most significant impacts of digitisation is the erosion of the individual boundaries that previously kept all of these industries separate and distinct from one another.

Today we see this effect manifesting itself time and time again, where enterprises who've traditionally only operated in one industry vertical are now able to branch out easier than ever before to capitalise on market opportunities in other verticals.

The best examples of this trend typically hail from the technology industry where companies in the so called FATBAG collective, where the acronym stands for Facebook, Alibaba, Tencent, Baidu, Amazon, and Google, now seem to be able to develop new products and services that cross previously unassailable industry boundaries with impunity.

Amazon, for example, was primarily a E-Tailer, but now the company has interests in everything from finance and healthcare to entertainment. Google meanwhile was primarily a search engine, but now has interests in everything from communications and energy, to finance, healthcare, and transportation. And so the story goes on for all of the other enterprises in this collective.

What most of these enterprises have in common is that they were born in the digital era and so they started out their lives as digital natives. As a result, unencumbered by the need to produce and sell physical products their businesses were afforded a level of agility and fluidity that many legacy organisations, encumbered by physical assets and products, simply couldn't match.

Now though, a decade or so into this new digital era, those legacy incumbents are trying to catch up by spending hundreds of billions of pounds on wide scale digital transformation programs, and once those programs are complete many of those incumbents are going to have the same opportunity to move into and disrupt adjacent industries with a fluidity and speed that they could only have previously dreamt about. And as a result the pace of disruption will, again, accelerate.

# BUILDING EXPONENTIAL ENTERPRISES

CONTRARY TO popular belief, and as obvious as some of this might sound, there are two reasons why individuals and organisations get disrupted.

Firstly, there are the things that disrupt you because you never saw them coming. In short they blind-sided you and your Foresight teams.

Secondly, there are the things that disrupt you because even though you saw them emerging and then ascending you never took the necessary steps or actions to counter them, and in today's world while many people, and in some cases even the markets, might forgive you for the former, but in the main they won't forgive you for the latter.

Needless to say, disrupting a market, an industry, or even a sovereign economy, can be both a simple and complex affair, and it can be both fast and slow, but while many people often like to think of disruption as a singular event it's actually a process that, in the majority of cases, has clearly identifiable milestones and markers leading up to it that we can monitor and track.

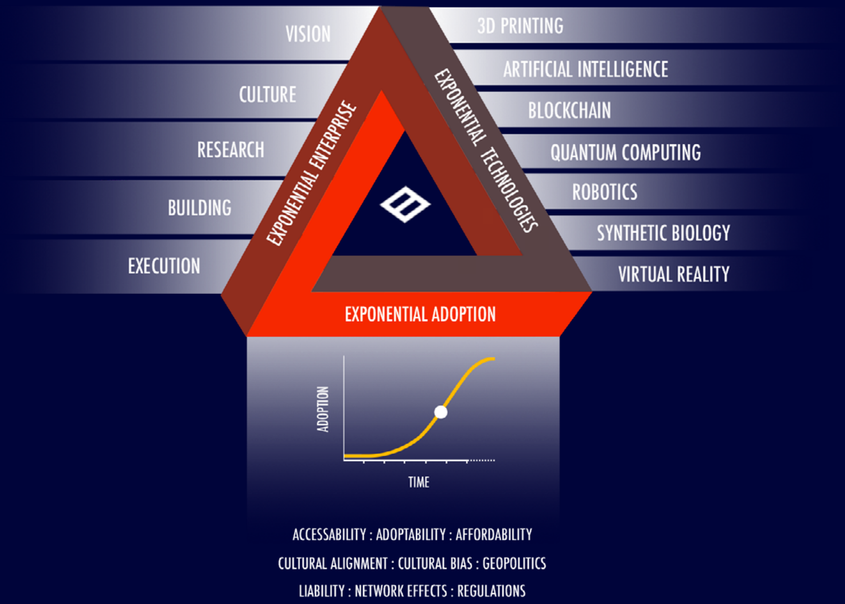
However, while everyone agrees that disruption has always been with us and that it can take many forms, from the asteroid that wiped out the dinosaurs to the emergence of Netflix who wiped out the video-saurs, one thing that many people still struggle to understand is how the nature of the animal's changed over time and how it will evolve in the future.

Often the reason for this is because sometimes they're looking for disruption in the wrong places, trying to predict it based on historical values, and sometimes it's just because they haven't been exposed to it before. And as for those among you who believe that the majority of disruptions are behind us I can assure you they aren't, and trust me when I say you haven't seen anything yet.

## MAPPING THE DISRUPTION LABYRINTH

The process of disrupting anything, whether it be a competitor, an industry, or even perhaps a country, is generally so complex it's positively labyrinthine.

Like all of us I've lived through many disruptive events and it's these experiences and the impact they had, on enterprises and workforces alike, that drove me to try to map the labyrinthine-like process of disruption so that companies could understand it, navigate it, and then lead it, and ultimately come




# THE DISRUPTION TRIANGLE

The likelihood that a new product or service an enterprise or industry, can be assessed by its progress against three main axes - namely the Exponential Enterprise axis, the Exponential Technologies axis, and finally the Exponential Adoption axis, all of which are intrinsically inter-connected with one another.

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to terms with a world that increasingly doesn't behave like it used to, or behave in the way they think it should.

As highlighted in earlier chapters, irrespective of how fast disruption seems to materialise it isn't a single event - it's a complex series of events that, in the main, all have to come together in near perfect harmony in order for disruption to take place.

It's also these events, how they combine and the timings of their combinations, that help explain why only a fraction of companies ever make it through the labyrinth to claim cult disruptor status.

Similarly, it's also these same events, or trigger points, that help the vigilant among us identify the next disruptors and disruptions long before they have a chance to wreak their havoc on our companies.

## THE THREE AXES OF DISRUPTION

In my experience the likelihood that a new concept will disrupt a market can be assessed by its progress against three main axes as shown in the diagram on the previous page - namely the Exponential Enterprise axis, the Exponential Technologies axis, and finally the Exponential Adoption axis, all of which are intrinsically linked with one another.

## EXPONENTIAL ENTERPRISE

If you're one of those people who doesn't want to change the world, and let's face it, not everyone does, and that's fine, then it's unlikely you ever will - at least on purpose. But, if you feel that it's your calling and you can't think of anything else then with the right approach and support you may well just pull it off. Never say never, especially today in a world where it's easier to impact the lives of billions of people easier than ever before.

However, while a rebel unit with a disruptive mindset within an enterprise can change the attitudes and opinions of those who fall within their sphere of influence it has to be argued that true change within an enterprise must be inspired and promoted from the top down.

Over the past decade I've made it my mission to understand what sets enterprises that achieve cult disruptor status apart from the rest of the pack and frankly it's a myth that an enterprises ability to disrupt itself or a market is

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based on its ability to outperform its competitors in just one area. It's their ability to outperform them in over thirty different areas, often simultaneously, that makes the difference - from the way they build and communicate their culture, values, and visions, to the way they identify valuable problems worth solving and develop their products, ecosystems, and go to markets, and much more, that set them aside.

In short, and to be crystal clear, it's not any one thing, it's many, and that's the reality that anyone wanting to build an Exponential Enterprise has to contend with - you're either all in or you might as well go home.

Furthermore, it's not simply enough to be moderately better than your competitors, whoever they are and whatever industry they hail from, you have to outpace, out perform, and out think them all in almost every one of these areas.

Now that's explained let's dive in and have a look at what makes these disruptors so special. In order to make it easier to digest we can divide the DNA of an Exponential Enterprise into five foundations. In order these are Vision, Culture, Discovery, Prototyping, and Execution, and within each of these individual foundations there are at least six main areas that, when performed well and combined, will move the dial in your favour.

Firstly comes the company's Vision, something that conveys a huge amount of information about their over arching purpose and culture, and ultimately acts as their North Star.

Visions and vision statements are normally the aggregated result of a company's ambition and purpose, their discovery and due diligence process, their internal and external deliberations, their framing and the time frame they're working within, and their view of the intersecting trends that they believe will help them achieve their goals.

Generally speaking many of the enterprises that have the greatest impact on the world today and the ones with the greatest disruptive potential are the ones that have bold and ambitious visions with grand aims that, in the words of Elon Musk, get people excited about waking up every morning and feeling inspired by the work they do.

Secondly, and by far the most important of all the five foundations is Culture, which is, among other things, the aggregated result of structural and behavioural company alignment,



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authentic, inspirational leadership, honest communication, and, again, the company's vision.

We are continuously reminded about the power of culture and it's power to help companies overcome all manner of obstacles. But while creating a winning culture can take years to build and is arguably one of the hardest things for any leadership team to accomplish if you aren't vigilant it can be torn apart in just months.

Furthermore, from a disruptors perspective at least, I like many people have lost count of the number of times I've heard stories about how a company's corporate immune system was responsible for killing the latest innovative concepts - either because they were disruptive to the company's core business, which is obviously laughable under the circumstances, or because of some other political motivation.

Thirdly comes one of the most exciting foundations, in my opinion at least, Discovery, which is the aggregated result of internal and external conversations, collaborations, and partnerships, exploration, envisioning, and observation, and much more. This foundation is also often the natural home of the majority of a company's entrepreneurs, rebels, and visionaries - the teams of individuals who all too often want to rip up the rule books, go above and beyond, and disrupt the status quo.

And as the rate of disruption accelerates, and as more enterprises feel the effects of disruption on their balance sheets it's no surprise that over the past number of years many of the teams in this space have been the beneficiaries of significant uplifts in funding and new programs as the companies work hard to improve their competitiveness, and defend and extend their customer bases.

All that said, however, it obviously goes without saying that new funding and programs by themselves can't be counted on as magic bullets that guarantee success. Again, it's not one thing, it's many things working in harmony, which, neatly brings me back to the importance of having the right culture and environment.

Fourthly we have the Prototyping foundation, where companies begin to build products that address the problems and opportunities uncovered during the Discovery foundation. This foundation is the aggregated result of conversations, collaboration, and partnerships, experiential and design thinking, ideation and problem solving, to name but a few.

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One of the most understated areas of this foundation though is the use of beta customers and, where appropriate, the importance of the investors black books - both of which help companies secure early testers and customers that eventually hopefully convert into paying customers and references, with the added benefit that, with the right management these activities and customers will help generate hype around the products that then, in some cases, propel them into the hands of millions of customers.

Fifthly, and by no means least is the Execution foundation that, when done right, which is obviously harder said than done, ensures your amazing new product doesn't get left on the metaphorical shop shelf to die.

The aggregated result of everything from ensuring the right balance of customer value and the right business model and go to market strategy this is where many companies ambitions to disrupt markets fail. As they say - everyone has a plan until they're punched in the face, or in company speak everyone has a plan until it meets reality.

However, for the lucky companies that do make it past this last hurdle to disrupt a market - whether they're lucky by design or by fluke - this is the stage where all their hard work, everything I've discussed, albeit lightly so far, pays off.

This is also the point at which the incumbents in a market realise that a disruptor has just parked their UFO on the company's front yard, before laughing at it, shrugging it off, and getting eaten by the aliens hoards inside...

Noone ever claimed disruption was easy but throughout my travels and conversations with executives from all manner of industries all around the world it's clear that almost everyone underestimates the complexity and size of the challenge. However, while disrupting any market is difficult it's also clear that the size of the prize, which is often the opportunity to lead and own a market, is worth the effort.

## EXPONENTIAL TECHNOLOGIES

Once a company has started its journey to become an Exponential Enterprise and found interesting and valuable problems worth solving next they turn to technology, explicitly combinations of technologies, to develop their products and help get them into the hands of consumers.



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And, as you can see from the Griffin Exponential Starburst in the earlier chapters and by reading the other codices in my Codex of the Future Series, there are hundreds of exponential technologies that enterprises can choose from to help them change the economics of their industries, and develop new disruptive products. And more are appearing all the time.

One of the phrases you'll hear me refer to many times throughout this codex is the word exponential, a term that I'm sure you've heard a million times that's often used to refer to technologies that emerge, develop, and mature very quickly, and often at a rate that very few people anticipate or predict.

The term is also a hangover from Moore's Law where Gordon Moore, Intel's co-founder, in 1965 predicted that the number of transistors on a computer chip would double every 18 months, leading to an exponential increase in computing Price-Performance, and today we're seeing the same pattern emerge in many other technologies - from Artificial Intelligence (AI) and Quantum Computing, to 3D Printing and Gene Editing, and many others.

Although, when it comes to digital technologies, such as AI and Creative Machines, for example, their rates of development even make Moore's Law look positively lethargic, and this is yet another trend that's accelerating disruption.

As the rate of technological development accelerates though there is also another trend you should familiarise yourselves with called "Jumping the S-Curve," and it's important because, in short, it refers to the way that different technologies supersede one another. Furthermore, as the number of exponential technologies that are emerging continues to accelerate and increase this is yet another accelerating trend that you have to take into account when deciding which technologies to use to build your new products and go to market strategies.

The phrase S-Curve refers to the rate of development of a particular technology - like a squashed S first the rate of development starts slow, then it accelerates dramatically, and then it flattens off as researchers struggle to eke out further gains. Furthermore, today, and more so in the future, as the period of time it takes to reach higher levels of Price-Performance accelerates you'll no doubt find that trying to keep pace with all these developments gets even harder.

Jumping the S-Curve then refers to a

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company's ability to move from one older technology to a newer one, for example, moving from the logic based x86 computers that we use today to tomorrow's ultra-powerful Quantum Computers. Unlike the past though where there were only a few S-Curves to jump now there are potentially hundreds - all of which can be combined in new and interesting ways to further fuel the rate of disruption.

## EXPONENTIAL ADOPTION

Of course though, while having an enterprise with the right culture that's capable of identifying valuable problems and opportunities, and which is highly adept at leveraging talent and technology to build great products is a great start the fact remains that you have to get those products into consumers hands.

So, as part of your Execution strategy, it should come as no surprise that there are plenty of areas left that, on the one hand could stop you dead in the water, or, on the other boost you into the hall of fame. And these areas are so important that I decided to give them their own axis.

While I've already discussed how disruption is a process and not a single event this is the stage where, if you want to disrupt a market, you have to gain as much traction as possible in as short a time frame as possible in order to stymie your competitions ability to counteract you with their own messaging and variants.

Getting your product into the hands, hearts, and minds of consumers though at enough scale to disrupt a market and permanently change the status quo though is obviously difficult. But that said while, yes, you still have to overcome many hurdles, and successfully pull all the right levers you should be able to take comfort from the fact that today, as I've highlighted in previous chapters, it's easier to disrupt the status quo than it ever has been before.

Navigating this part of the labyrinth though is complicated which is why the majority of enterprises struggle to realise their lofty ambitions, and sometimes all it takes is for one key piece to be out of alignment and everything falls down like a deck of cards.

For example, build a great product that the regulators block and you're going nowhere, or build a great product that the regulators approve that is unethical, and yep, again you're going nowhere. And so it goes on - you get the picture.



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So, as you can see again gaining mass adoption of your product isn't down to getting one thing right it's down to getting many things right, and these include, but are not limited to your products accessibility, adoptability, and affordability, as well as other factors such as cultural alignment and bias, ethics, geo-politics, and the impact of insurance and liability, network effects, and, of course, the regulatory environment.

Get one of these wrong, or, get side slammed by one of these and it could be game over.

## SUMMARY

Today we live in a world full of opportunity where the rate of change is accelerating every day, and where exponential technologies are global enterprises force multipliers and startups levellers. And, as a result, yesterday you had tens of competitors in your rear-view mirror, and today you have hundreds. Or more. It's fun to be you.

However, as amazing as all this is it will all soon be eclipsed by an even bigger, and even more disruptive revolution, because a new breed of entrepreneur, one that can out think and out perform humans a million fold to one, and build fully autonomous multi-billion dollar empires within days and months is already emerging.

I am, of course, talking about the rise of Creative Machines, synthetic entrepreneurs if you will, and for those of you who think that such talk of machines that can design and innovate products, and operate and scale companies is far fetched the first fully autonomous enterprises have already been built and they're already operating on two continents.

Today is the slowest rate we will ever move again, but you've seen nothing yet. So pause, take a deep breath, and prepare yourself for what's coming.

# MEGATRENDS AND STARBURSTS

EVERY YEAR I publish a new Griffin Exponential Technology Starburst, and a new Megatrends Starchart, that you can see on the following pages, designed to help people envision and simplify the future.

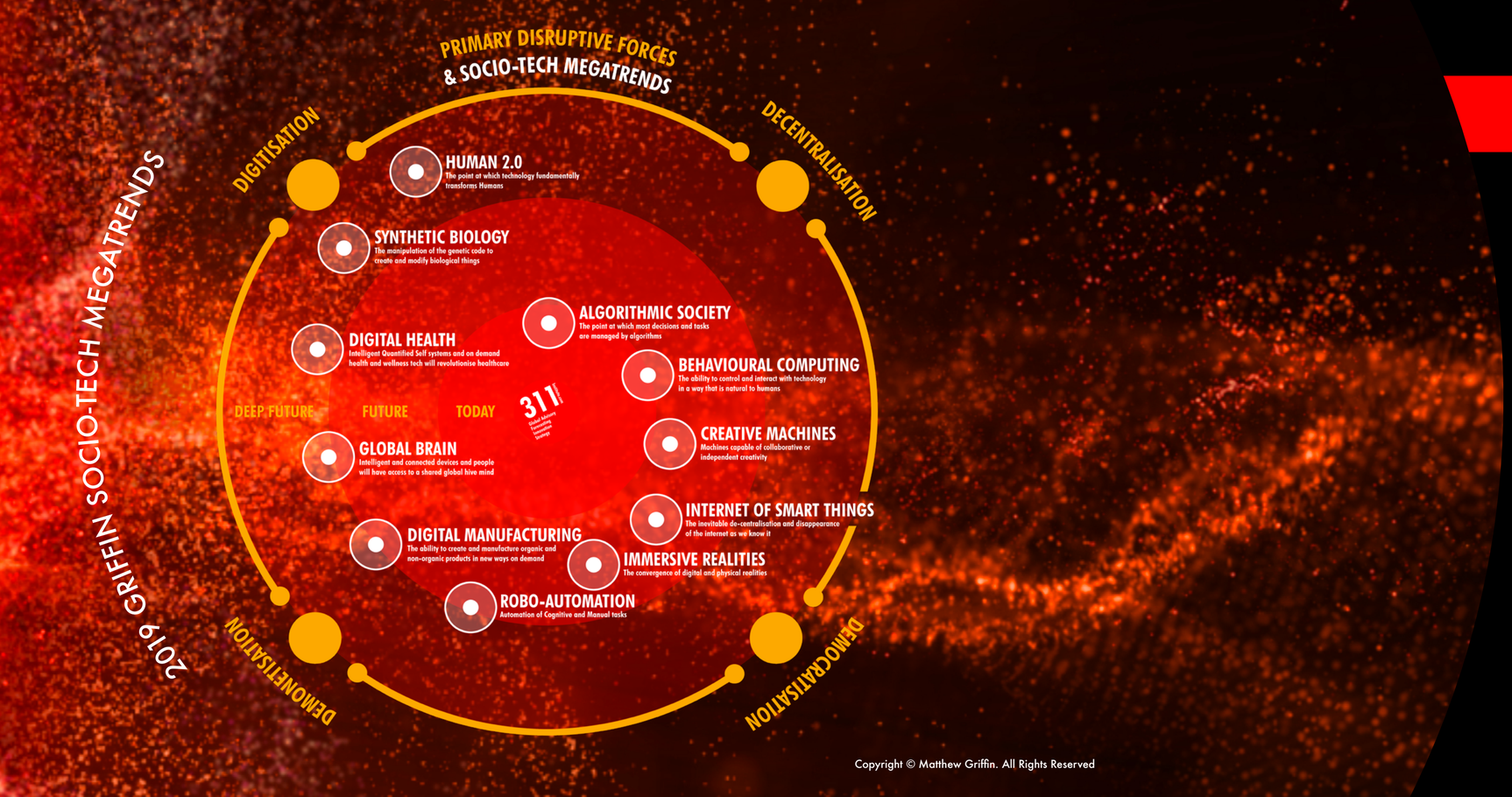
Today, it's no secret that every part of global culture, industry and society are being transformed faster than they ever have before thanks to the relentless, and some would say furious, rate of change that's made possible by giant advances in technology and the megatrends it helps create and drive.

As this rate of change accelerates what you likely won't be surprised by is the fact that, on top of the exponential technologies, such as Artificial Intelligence and Blockchain, for example, that are already here, there are still yet more powerful exponential technologies circling above us like stars in the heavens, that are just biding their time, waiting to fall to Earth where their impact will, over time, be total and irreversible.

What might surprise you though is the sheer number of exponential technologies that are appearing, over 400 by my latest count, with on average more than 50 being added every year.

In the right hands every single one of these so called "Blank Slate" technologies, so named because until someone innovates on top of them they are just that - blank slates - has the potential to transform either just a part of our society, or all of it.

As powerful as all these individual exponential technologies are though it's when they're combined, to form what I call "Exponential Combinations," that the real magic happens and their power to transform everything is multiplied many times over. And as a result that's what I invite you to examine, and that's why I created the Starchart and Starbursts - so you can join the dots, combine the individual megatrends and exponential technologies together to transform your own futures.

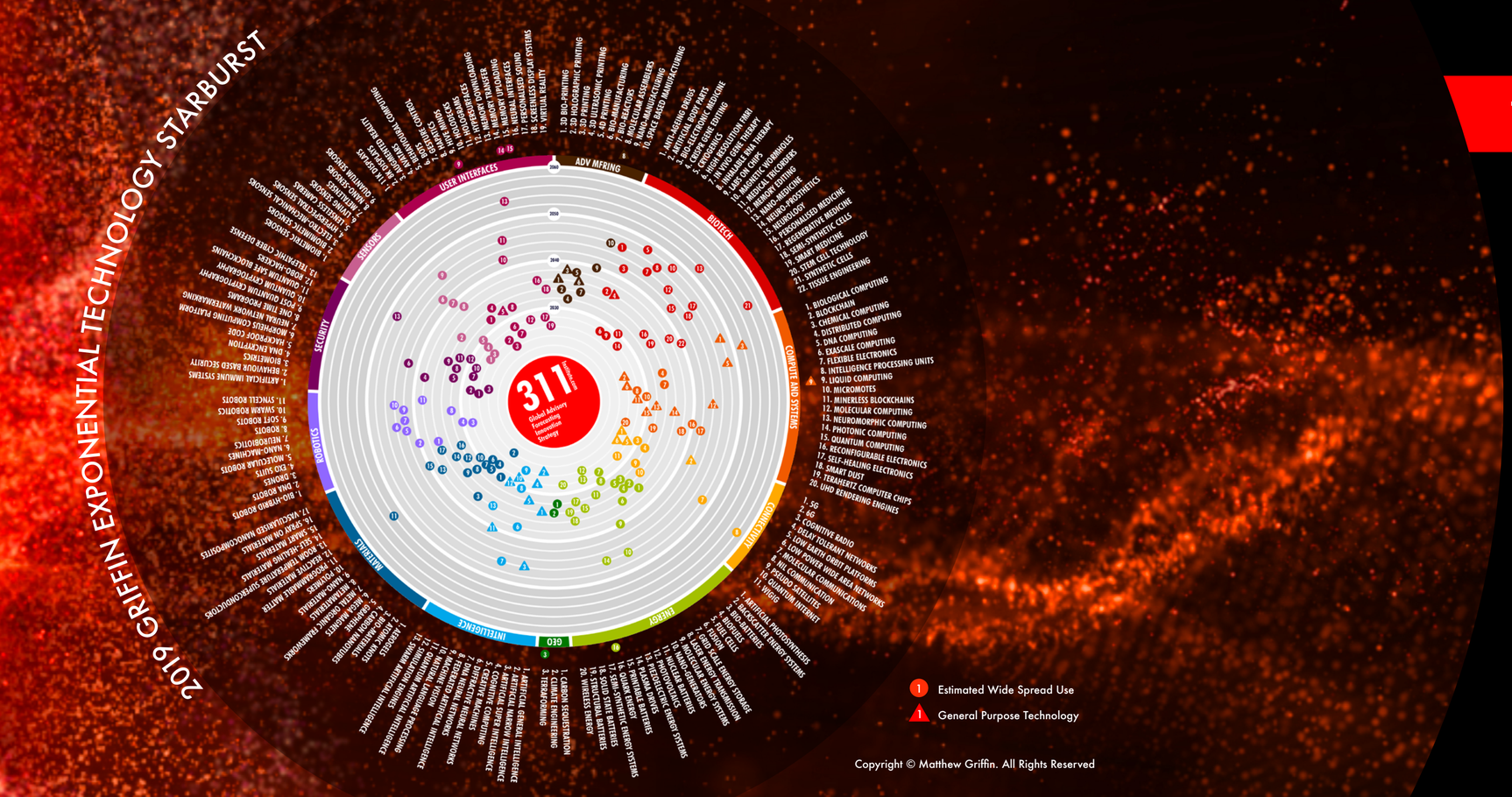





# MEGATRENDS STARCHART

YOU COULD spend your time analysing and tracking the literally thousands of megatrends that are on the rise, across the Societal, Technological, Environmental, Economic, and Political spectrums, or "STEEP" as they're known for short.

However, in order to stay focused and keep things as simple as possible for the purposes of this Codex, while still letting you retain the detail you need to compliment your big picture thinking, I find that the best megatrends to keep track of are what I call the Societal-Technology megatrends, or Socio-Tech for short. In short these are the megatrends that will not only have the greatest impact on culture and society as a whole, but also industry, so it's a good catch all.






# THE EXPONENTIAL STARBURST

THE GRIFFIN 2019 Exponential Technology Starburst timeline spans 2020 to 2060, and tracks the development of 169 of the most significant emerging exponential technologies across 12 major categories, one of which, "Intelligence," is a new addition.

For the first time it also visualises 25 General Purpose Technologies which will drive and accelerate continuous innovation and disruption across multiple sectors, and, needless to say, you can find every exponential technology listed on the Starburst is covered in detail in the following sections.

Collectively these technologies will transform every corner of global culture, industry, and society, and it is therefore I strongly suggest you and your innovation teams explore them in detail, and more importantly understand how they can be combined together and in the process help make our world a better, fairer place for everyone.

**FORGET EXPONENTIAL TECHNOLOGY. THINK EXPONENTIAL COMBINATIONS.**

HUMANITY'S STORY is one that is inextricably intertwined with technology, from the railways that connected our early cities to the telegraph lines that connected our early communities. But, as generations came and went the memory of the power and impact of those early exponential technologies faded, and now they're consigned to the history books and museums as relics of the past.

However, while our memories of those early technologies might have faded their legacies live on, and today the transformative power of the descendants of these and other exponential technologies have become even more impactful, and they're transforming our world in new previously unimaginable ways at an accelerating rate.

The telegraph, for example, was replaced by faster more convenient fixed line telephone systems, which in time were themselves usurped by faster, superior mobile communications technologies.

First came 1G, then 2G, 3G, 4G, and now 5G, and just eight generations on from the original telegraph system that connected people using mechanical clicks and whirs our world lives online, and people have embraced a new type of clicks, and communicate and experience life in bits and bytes in a world where science fiction is increasingly difficult to differentiate from science fact.

However, the transformations we've witnessed over the centuries aren't thanks to the development of any single technology, they're the result of many technologies all working in combination with one another, and this is why individuals, as well as enterprises, must move away from today's rather siloed thinking where we tend to talk and think about the impact and opportunities of singular technologies, and instead think about the impact and opportunities of "Exponential Combinations."

After all, even today's most powerful exponential technologies are simply blank slates that themselves rely on the development of a host of other exponential technologies, as well as an army of human and increasingly machine based entrepreneurs, that prod, shape and combine them to create new amazing concepts, to drive their development and eventual adoption.

It's these combinations, of not tens, but hundreds of exponential technologies, like the ones displayed on my Starbursts, that enable us to transform every corner of society, from the way we live our lives and how long we live, to where and how we work.

Furthermore, thanks to technologies such as those I mentioned earlier, communities and individuals that were once limited by connectivity and distance now all have increasingly easy and low cost access to a "Global Brain" and global resources that can help even the most modest of us transform the world in new and exciting ways, and as these technologies become increasingly digitised and democratised the speed and impact of that transformation will only increase from here.



**BUT... EVERY TECHNOLOGY HAS TWO SIDES.**

**BUT... EVERY TECHNOLOGY HAS TWO SIDES.**

GOOD DYSTOPIA EVIL

# TECHNOLOGY IS A BLANK SLATE

AS WIDE ranging and as powerful as all the exponential technologies that I discuss in this codex are though the fact remains that until someone uses them and combines them together to innovate new products and services they're all just shelfware - blank slates, and technologies without a purpose.

> EVERY TECHNOLOGY is a blank slate that can be used for both good or bad purposes. It's down to us to develop and use them in ethical and moral ways that benefit society.

Furthermore, as these exponential technologies and the products and services they can be used to create become more powerful they then give us a moral and ethical dilemma because, just as they can all be used to do great good and benefit society, in the wrong hands they can also be weaponised and cause great harm in a huge variety of ways - many of which we have yet to even imagine.

Take, for example, Artificial Intelligence. On the one hand it has the power to revolutionise healthcare, identify, treat and cure disease in new ways, and discover new powerful drugs and vaccines, but on the other it's also already being weaponised to create a new generation of Robo-Hackers that can hack and exploit vulnerabilities in critical computer systems hundreds of millions of times faster than human hackers, and that's before we discuss how it's also being used to generate fake content and fake news that undermines our trust in one another and democracy.

These world changing examples are just the snowflake on the tip of the giant melting iceberg, and an example of what good and bad actors alike can do with just a single powerful technology. And there are billions of other examples I could use, including our ability to save lives by using drones to deliver critical first aid supplies including blood and medicines to remote areas, or spray crowds with bullets from drone mounted machine guns.

While this is where I'm going to leave it for now I can spin similar stories and examples for every exponential technology which is why it is absolutely vital that as a society we do our utmost to understand the pros and cons of these technologies and work together to maximise the upsides, while doing our best to mitigate, regulate and police the downsides.

# DECONSTRUCTING THE PRESENT DAY

BEFORE WE attempt to model what could replace the smartphone, particularly if we're to do it with any degree of accuracy, there are some giant hoops we have to jump through.

First, we have to de-construct users current day behaviours and the "needs" today's smartphones fulfil back down to their bare basics so we can understand what "problems" users are trying to solve.

Secondly, we need to examine the new consumer behaviours and adoption patterns we think will emerge over time, and which ones will be accelerated, created and facilitated by new emerging technologies.

Then, thirdly, we have to de-construct today's smartphone platforms back down to their constituent components and technologies, extrapolate out their near, medium and long term development prospects, and assess them against possible future alternatives.

It goes without saying that even with all these insights predicting the future of the smartphone platform and what it could look like, and then what comes next, is still challenging. It's the equivalent of going back in time two or three decades and asking our people what the future of the rotary phone would look like, and how many people do you think would have anticipated the smartphone?

That said though with the broad insights that we have today into culture, society and technology, and by applying a new lens we could argue that we should at least be able to get into the ballpark now.

Finally, once we've jumped through our hoops then comes the time to assess the likelihood and probability that our projections will materialise, something that has to be measured against the factors mentioned in the previous chapters.

Do all this well and all of a sudden we have a series of ranked projections and timelines that will form the foundation of our future roadmaps, so join me, and let's get on with it.

# BEHAVIOURS

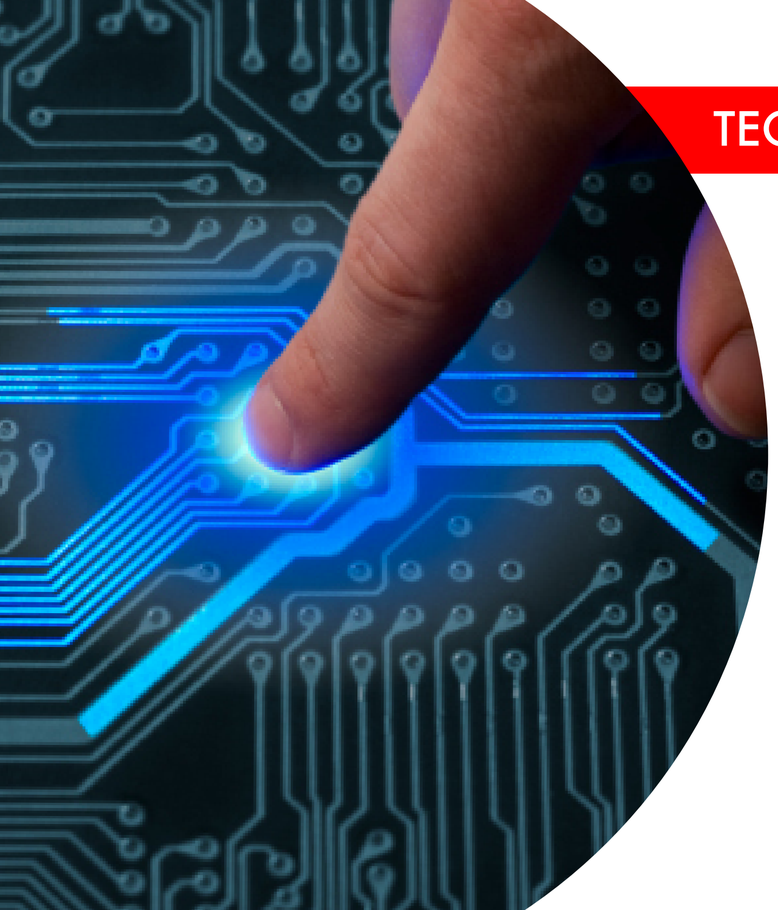
TODAY'S CONSUMERS use their smartphones to fulfil a whole variety of different needs that include, accessibility, communicating, creating, entertainment, health and wellness tracking, on demand services, payments, shopping, surfing and working, and while all of these are met in a variety of different ways all of those ways are still app based and digital first.

# INTERFACES

TODAY MANY people could be forgiven for thinking the way we use technology is still clumsy and unnatural, and in many cases that's because it is, after all, the way we interact with computing systems hasn't changed much since the time they were first invented. Having a conversation with someone via E-Mail, instant messaging, or text still doesn't feel as fluid or as natural as having that same conversation with them face to face, and fumbling around with apps sometimes just feels plain clumsy.

As a result it's  still very clear that today's user interfaces are still very far away from being seamless or, as some people put it, "invisible," meaning that in almost every case they feel like an unnatural extension of us rather than a natural one.

From a user interface perspective most modern smartphones have simply traded the keyboards and mice that were tethered to our desktops and laptops for decades for touchscreens, that sometimes are simply augmented by, rather than integrated with other interface technologies including gesture, pressure and voice control.



# TECHNOLOGY

FROM A technology perspective it's fair to say that all of today's smartphones pack a hell of a punch, and with the technology advances that have been made over the past number of decades it's no surprise that people refer to them as the "supercomputers in our pockets." That said though we're still just scratching the surface of what's possible, and as advanced as today's devices feel they'll pale in comparison with what's coming in the next couple of decades.

When we de-construct today's smartphones they all share, with a few twists here and there, the same common components, namely baseband components, chips, camera and audio components, displays, memory, power management systems and sensors, each of which are following their own exponential development curves - the results of which we can already see emerging in some of the N+3 generation technologies that are already being prototyped in the labs around the world.

# FASTER HORSES

EVERY MARKET has its leaders, fast followers and laggards and the smartphone market is no different. On the one hand you have companies that want to make, in Henry Ford's terminology, "Faster horses," and there are plenty of those, and on the other you have companies who want to revolutionise the industry, build and move everyone to the next platform, but as they say, if you can't see the future then you can't create it, and that's what I'll be shining a light on in this paper. There are no faster horses here.

# FUTURE SMARTPHONE SCENARIOS

THE SMARTPHONE'S ability to absorb, consolidate and integrate a wide range of products, services, technologies and other tools is impressive, but if we want to decode what the future holds in store for smartphones, and the platform or platforms that come after it, then we first have to use the correct framing, and work forwards from there.

In my opinion calling these platforms "smartphones," and using that as our point of reference is a mistake because we all know they are, in fact, advanced, mobile computing platforms.

This is a perspective that's further backed up by the fact that today, no matter which survey you choose to reference, it's clear the majority of people spend less than a fifth of their time using these devices to make voice calls and spend the majority of their time instead consumed by other activities, including alternating between different communication mediums, discovery, entertainment, navigation and shopping, to name but a few.

The result of all of this, and it might sound like a pedantic one to make, is that the question of what comes next is less about the future of the smartphone, and more of a question about the future of computing and the consumer behaviours that it will drive, enable and support.

As I set out to model the future products, services, technologies and tools that can be absorbed into tomorrows devices my starting point is to figure out which of them are the most likely to be digitised, and then democratised, because as I've seen many times in the past, when they undergo these two disruptive transformations they inevitably end up, in one way or another being made available and accessible on our devices.

The digitisation, or as some people refer to it, the de-materialisation, and then subsequent democratisation of the music and entertainment industry illustrates this point perfectly and, as we all know, those two trends changed our relationship with the entertainment industry forever. These are just two of tens of thousands, potentially millions, of things that have been, could be, or will eventually be absorbed into the devices we now hold in the palm of our hands.

In this chapter I look into the future killer applications, features and trends that could shape the evolution of the smartphone platform and its successors for decades to come.

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## THE DIGITISATION OF THINGS

Above I touched on how music and entertainment were both absorbed, for want of a better term, into our modern digital devices, and the same's true for alarm clocks, ATM's, books, cameras, camcorders, cash, credit and debit cards, GPS devices, faxes, files, letters, filing cabinets, camcorders, filofaxes, gaming devices, keyboards, loyalty cards, magazines, mice, newspapers, notebooks, pagers, scanners, tickets, torches, TV's, walkmans and watches, to name but a few. Had these not been digitised then today, frankly, we'd need a suitcase to carry all our junk around with us.

Furthermore, when we look into the future this long list of products and services are all just the tip of the proverbial iceberg. There are still many more physical things we can digitise including cables, identity cards, keys, medical equipment and much more, and over time all of them will follow the same digital fate.

## BUILDING THE DIGITAL WORLD

Trying to identify the killer applications that will drive the evolution of tomorrows platforms is a difficult task. However, in order for a product or service to be digitised first there has to be a desire to digitise it, and that's often reliant on one or more things, namely the amount of effort involved, and the return, whether it's because the company can save money and improve efficiency, or market demand, with the sweet spot being that it hits both.

Demand comes, predominantly, from two categories, consumers (B2C) and enterprises (B2B), and over the past decade the economics of supply and demand have changed significantly.

In the past it used to be expensive to build and distribute products, but digitisation has helped erode many of those costs, while at the same time the proliferation of smartphones has helped companies reach not millions but billions of users in ways they could only have dreamed about before at a previously unimaginable, and comparatively, low cost per user.

The proliferation of smart devices has also had another significant effect on supply and demand, it's helped democratise products and services at an unprecedented scale, including advice and advisory services, communication, creativity, education, entertainment, expertise and information, to name just a



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few, and the trend of democratisation is accelerating now faster than ever.

It goes without saying that the easiest products and services to digitise are those with the lowest barriers to entry, something that's dictated to a large degree by, cost, the level of complexity and IP protection, and regulation. But that said those are often the products and services that everyone targets so the markets often commoditise faster, and the margins fall faster.

Often though the most alluring products and services to digitise are the ones that are almost the opposite of the above, the products and services that still meet the demand criteria I mentioned earlier, that is to say they're in high demand, but that have significant, but not unassailable, barriers to entry, because it's often these products and services that, if you can crack them, can sustain much greater margins and returns for a longer period of time.

Take, for example, the so called democratisation of finance and healthcare. Both of these are very attractive candidates for digitisation but they both have relatively high barriers to entry, especially when you compare them to other alternative industries such as business services, education, energy, entertainment, manufacturing, retail, technology, telecommunications and transportation.

However, that said though, while individual entrepreneurs might struggle to democratise some of these alluring products and services, especially those with the highest barriers to entry, I'm increasingly seeing the challenges being tackled by well established, well funded and well resourced organisations such as Alibaba, Alphabet, Amazon, Apple, Baidu, Facebook and the other usual suspects. In time you'll find there are very few products and services left untouched, if any.

## THE DEATH OF THE APP ECONOMY

In the future the capabilities and potential of the smartphone platform, and its successor, will be amplified by new sensor technologies, emerging technologies and intelligence, and one of the greatest changes we'll see is the slow erosion of the "App Economy" as the content that today is housed in individual, siloed applications, will be unified and then eventually replaced by new Artificial Intelligence "Companions" that become the users primary interface and means of interacting with the smartphone and the

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services they're interested in, and this switch will have two major impacts.

First, it will increasingly decouple consumers from today's familiar app ecosystems, with the possible exception being gaming, and secondly these new assistants will become increasingly central to the user experience. Apps have been central to the user experience for over a decade now but, at the margins, I am already seeing their importance wane.

For example, it used to be the case, and still is to some degree, that a users only option was to open up and dive into specific apps to perform the tasks they wanted to accomplish. Over time this activity has been slowly but steadily usurped by centralised on screen notification menus that have allowed users to complete basic actions without having to leave the notification screen dashboard and enter the app, and in the near future it's highly likely these simple notifications will evolve into more advanced containers that allow the user to perform more advanced actions.

However, all that said though, containers are still just a basic iteration of what comes next because they will still, for the most part, be a reactive, chronological bulletin board of notifications, and in time they'll be replaced by seamlessly integrated Companions that will filter, organise, predict, prioritise and even respond to events and notifications automatically. Your very own PA. And when that evolution starts taking place, and as AI conversational interfaces advance, the smartphone will turn from being a dumb computing device to being an intelligent companion.

As we start to see the emergence of increasingly capable Companions that become our primary means of interfacing with our devices and digital services and tools the companies who want to be involved in the users life, in whatever regard, will face an increasing number of challenges.

Firstly they're going to have to fight for the users attention, engagement and recognition in new ways, and secondly, the power to decide which product or service is promoted, shown or used, to, or by, the user is going to determined and influenced by the Companion's ultimate owners, their manufacturers, which in many cases will either be the OEM OS companies like Google, or the smartphone manufacturers such as Apple, Huawei, Samsung and others, and not the original companies.

Although, let's face it I'm sure companies



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will be able to prioritise their own products and services over those of their competitors by paying a fee to the Companions owners...

Think, for example, about asking your Companion to order you a taxi to take you to the airport. Your Companion already has deep knowledge of your preferences thanks to the fact it's integrated into your life, and using sensors and mapping services it knows where you are and where you want to get to, so it orders you a cab, but, unless you ask for a specific company by name the taxi will likely be from the Companion's preferred, or prioritised, taxi company. And not Uber. Today to select an Uber you open the app, but tomorrow you'll have to ask for it specifically by name, and whether or not you do that depends on your awareness and experience of them and their service.

"AI, new communications protocols, and new sensing systems will help manufacturers democratise everything from human creativity, entrepreneurship and innovation, to communications, finance, healthcare and beyond."

This same example will apply to every service we consume, from ordering electricians and plumbers to finding lawyers and buying goods. Everything, without exception, will be turned into a dumb pipe, a commoditisable utility, all hidden behind Companions.

In almost all cases using your Companion will be faster than using today's methods, think, again, for example about milk.

"Order milk." Done. But is it coming from Walmart, or from some other retailer, and do you care... that's ultimately the big question.

So far you haven't had to open a single app, but crucially, and as a sign of the way things will go, and to demonstrate how much of a paradigm we and other companies are facing, crucially the decision on which taxi to order, or where to order your milk from, has been made by the

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Companion, and not you. And as our new Companions learn, and as more services are connected into their digital ecosystems, they'll be able to automate more domestic, social and work related tasks.

For example, if the assistant knows you've just left the office and that you are now on your way home it can automatically turn your connected homes heating back on and pre-heat the oven, and a million more things besides.

However, if you think these Companions will be confined to the four walls of your smartphones then you'll be mistaken, because in this hyper-connected world your Companions will, one day, be able to travel with you in all your other connected, and thanks to the ever growing network of sensors they'll know, for example, when you start exercising, tee up, and start giving you coaching advice. They'll also know when you're stressed or fatigued, and be able to react accordingly, and they'll know when you're getting ill, even before you do, and book you a teleconference with your local doctor. And that's all just the snowflake on the tip of the iceberg. And, in many cases, there won't be an app in sight.

## FUTURE KILLER SCENARIOS

As products, services and even entire industries, such as entertainment, finance, manufacturing and technology, become easier to digitise, and therefore democratise, smartphone manufacturers, who by rights could easily become the new platform companies, will be inundated with new opportunities to carve out and own new niches and markets. Let's go through a few...

On the one hand, for example, smartphone manufacturers will have new opportunities to disintermediate the global carriers as we see new Blockchain networks, and "Just get it there" communication protocols emerge, and new low Earth orbit space satellite networks, like OneWeb, take shape. They'll also be able to offer new financial services solutions, as well as provide new advisory and legal services, to their user bases. But there's much more.

With so many new technology solutions on the horizon, such as Smart Pills and Smart Tattoos, as well as new Artificial Intelligence powered health agents, over time it'll become increasingly plausible for manufacturers to offer new services around the concept of the "Quantified Self," democratise healthcare, and provide accurate, hospital grade health



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and wellness monitoring and advice.

Also, as we see the development of new powerful and capable types of Artificial Intelligence users will be able to create, innovate and take part in the global economy in ways they've never thought of before.

The emergence of new Artificial Intelligence powered so called "Low Code" and "No Code" software development platforms, such as Microsoft's self-coding Artificial Intelligence platform DeepCoder, when combined with new computer natural language interfaces, will allow users with minimal, or no coding skills, to ask their Companions to design, build and release their own apps, bots and B2B or B2C software, giving them the opportunity to build and promote new digital businesses and play a more active role in tomorrow's digital economies.

"The boundaries between all industries are eroding now faster than ever, and it's now time for manufacturers to ask themselves what industries they want to dominate and own."

Furthermore, new Generative Adversarial Network (GAN) tools, which, over the past year I've been referring to as "Creative Machines" will allow those same users to select products, from whatever source, by scanning a product in a shop or grabbing an image, and then again, using natural language, ask their Companions to iterate and innovate them in real time on their behalf. But there's more.

At the same time, Artificial Intelligence platforms like Amper and Google Magenta will help users create new music, and platforms like Google AutoDraw will users them become better artists, and that's to say nothing of the new Augmented Reality or Virtual Reality painting, rendering and scribing tools I'm seeing emerge.

We are entering a new era, one where

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creation, innovation and programming are increasingly democratised and where the barriers to entry are, quite literally, collapsing, and the opportunities that presents to companies and individual users is unprecedented.

Energy and transportation too will be increasingly democratised. Our Companions will be able to tap into new decentralised, blockchain based micro-grids to find users the best energy deals, and call up vehicles from the manufacturers own on demand car pool, or perhaps, as the emergence of self-driving cars, and the removal of the cars familiar dashboard, pedals and steering wheel disappear, force manufacturers to realise the concept of the car is dying, and will be replaced instead by a new generation of autonomous "Pod" like vehicles, like those already emerging from Audi and Toyota, "vehicle pool" is perhaps a more appropriate term, all without the user having to lift a finger.

"AI Companions should be the Guardians of their owner's online safety, alerting them to activities that put their privacy and security at risk, and helping them mitigate and minimise harm."

In the world of retail too Companions could connect into and manage a users Smart Appliances, taking responsibility for ordering replacement products. However, as the number of Smart Appliances managed by Companions grows they could pool purchases together and form automated buying consortiums, reinvesting any savings they make into a range of financial services offered by the manufacturer. And yet still there's more.

When consumers buy high value items online, or from a physical store, the Companion could use big data and Machine Vision to generate real time insurance quotes that could be transacted through the manufacturers new insurance platform, and in the same breath the same Companion could use its Machine Vision capabilities to scan



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clothes and other objects, digitise them and then, as I mentioned above innovate and personalise them before sending them into the manufacturers cloud to be 3D Printed on demand.

With all that though I still haven't spoken about how manufacturers can use their smartphone platforms to democratise education, leisure and tourism or public safety, or a Companions ability to behave as a Guardian of its users privacy and security, alerting them to actions that put them at risk, or to services that "overstep" the mark.

Manufacturer's platforms could also form the foundation of new global Digital ID and digital rights management platforms, and if they were combined with a manufacturer's "social" cryptocurrency they could help encourage volunteering in the local community, and so much more.

When it comes to the services that can be created and delivered, even via a comparatively simple smartphone, the only limit is our imagination, and in many cases Companions will be the gateway and the glue that bind all of these exciting possibilities together.

## DEFINING BEYOND THE SMARTPHONE

When I model what comes next, what comes after the smartphone, from a technology perspective at least it's a relatively straight forward task.

However, as we've seen all too many times before, consumers are often predictably fickle, and just because there's a next generation device on the market it's often going to be an uphill struggle to get users to adopt it in the numbers to kick start a new revolution. As a consequence, it's inevitable that there will be a number of bottlenecks that will stand in societies way before the move to the next platform is realised.

As I often say, technology is the "How," and adoption is the "When," so let's look through each of these below.

### Technology Bottlenecks

Humanity's rate of technological progress has long outstripped society's aptitude and willingness to adopt and embrace it, and today the divide between the two is increasing at a near exponential rate, something that is in no small part thanks to the development and emergence of not one, but hundreds of complimentary exponential technologies that, when

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combined together, help fuel an increasingly furious pace of development and progress.

For example, today we already have, and can see, the collection of technologies that will help us move way beyond the smartphone, and to the point where we merge with, and become technology, ourselves, something that is sometimes referred to as Human 2.0 or the Singularity.

Today our digital services run on devices external to us, but tomorrow they will run on devices that are either proximal, on us, or in us, whether the latter one is thanks to new neural connections that interface directly with our brains, or thanks to the nanobots in our bloodstreams that will seek out and kill disease from within, while still keeping us updated about their activities.

So let's break out some examples of how we break free from today's smartphone format and get to a point where we can embrace what's next.

One of the biggest challenges limiting our ability to break free from today's brick-like smartphone format is the users dogged love affair with the traditional screen, and today we can already see a number of alternative technologies that could help wean us off the twenty five or so square inches of glass we're all so addicted to. These technologies include 11k "naked eye" 3D screens, which will start appearing in phones from 2019 onwards, which let us simply do more with less screen, all the way through to other display technologies that include, to name just a couple, Augmented Reality, E-Ink, Holograms, Pico projectors, Retinal Display Systems and Virtual Reality.

However, taking all of this a step further, and in an effort to completely eliminate users need for a screen, and realise our ultimate ambition of consigning the smartphone format to the history books, let me show you what is already possible, even with today's relatively crude Neural Interfaces.

In 2012 a team of researchers at Stanford University, California, managed to use Artificial Intelligence, Neural Interfaces and fMRI equipment to stream live colour movies directly from volunteers brains.

In 2014 another team of researchers used Artificial Intelligence and Neural Interfaces to create the world's first telepathic link between two human volunteers, and elsewhere another team used the same equipment to help ALS



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sufferers use just the power of their minds to text their loved ones.

In 2015 more breakthroughs followed when researchers, thanks to the human brains' natural "plasticity" managed to, again, using the same equipment, upload knowledge, Matrix style, to a group of thirty volunteers, as well as transfer knowledge, via a "Hive Mind," between two rats on different continents, create the world's first telepathic link between a human and an industrial robot, and connect rats brains to the internet.

The point of all this, and I mentioned previously, is that technology is progressing much faster than most people realise and we're already reaching the point where, from a technological perspective at least, we can see how today's screens will, one day, be nothing more than an artefact on a museum's shelf.

So while billions of people still communicate using keyboards, mice and touchscreens, with a notable few opting to use the first generation of Companions, like Apple's Siri, Google's Assistant, Microsoft's Cortana and Samsung's Bixby, we already have the technology we need, albeit in a relatively basic form, to move us way beyond these legacy interfaces.

As a result, we can generally conclude that it's unlikely that it's technology that's holding us back from creating the next platform but adoption, and ergo culture, so now let's take a look at that.

**Adoption Bottlenecks**

When analysts announce with gusto that "This is the year of X and Y technology" what they often fail to take into account, often with embarrassing consequences, is society's sometimes sluggish willingness to adopt any new technology advances that aren't merely better iterations of what came before, and there are a number of reasons for this.

The first reason is that in the majority of cases, as humans, we are still locked into a linear way of thinking that has been engrained within us, arguably, since we first learned to use tools and walk upright in the jungles of deepest darkest Africa. But today, from a technological perspective at least, linear evolution long gave way to exponential revolution, and that's a development that many people are still struggling to come to terms with, let alone embrace.

After all, exponential technological advancement is still a relatively recent

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phenomenon, and it could be argued that it's only four or five decades old.

As a consequence the dramatic impact that technology has had on society, and the cultural changes it's fuelled, have only recently become apparent, and nowhere are these changes as stark as when you compare the differences between the lives of today's and yesteryear's generations. As the pace of change continues to accelerate it's increasingly clear that humanity's ability to grasp and accept, what are increasingly revolutionary, not evolutionary, changes, is becoming increasingly challenged.

There are other reasons why we see adoption bottlenecks as well. These include what I like to call "Soft Triggers" such as the accessibility, adoptability, affordability, design and desirability of new technology, cultural and generational bias, the influence of geopolitics, network effects, regulation, and timing, to name but a few.

Additionally though, and as if all of this wasn't already enough to grapple with, there's also evidence that the rate of adoption of newer products and services are also reliant, and often closely tied to, the rate of adoption of the extraneous ecosystem of products, technologies or services that augment, compliment or enable it.

In short, as things become increasingly inter-connected and inter-dependent on each other sometimes the bottleneck that's slowing down the adoption rate of a new product can be something that at first glance seems unimportant or unrelated to the product or service you're trying to promote.

For example, the first MP3 players were available in 1997, a full four years before Apple's iconic iPod, but, as anyone will be able to tell you, content was sparse, network download speeds were slow, the payment systems and platforms were flawed and the devices were expensive, and all that's for starters. There's also an argument to be had that at that time society just wasn't ready to let go of the similarly iconic Walkman, or tape, that over time had become deeply engrained into global youth culture.

Meanwhile, Virtual Reality is another great example. First invented back in 1963 Virtual Reality has gone through several "renaissance" periods but again, here the resolution of the devices is low, and, in some cases, give people headaches and nausea, content is sparse, and, perhaps more importantly, the technology itself is bulky and largely



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still cable fed, despite the appearence of a number of so called AiO devices.

Take Google Glass's emergence onto the scene in 2014 as another wonderful example of how, on the one hand we can already see a glimpse of what comes next, but ultimately how the failure to align the triggers led to the technology being ridiculed by the general public and unceremoniously pulled back into the labs. And the list goes on.

Ultimately, in order for one new mass market technology to usurp another many things, not just one, need to align, and as I look into what will replace the smartphone envisioning the future from a technology perspective at least is a relatively simple task, however, identifying and then aligning that technological vision with the soft triggers that will propel it onto the main stage, well, that's a whole new ball of yarn.

However, all of that said, at least these companies tried to push the boundaries, after all, many don't, and in my eyes not trying is much worse than failing, and where would society be if it was full of companies and individuals who never tried to change the status quo?

## DEFINING THE SMARTPHONES SUCCESSOR

As I mentioned above, trying to envision the smartphones successor from a technological standpoint is a relatively simple task, but aligning the triggers that propel that new format into the mainstream is, potentially, the most difficult task manufacturers face.

Tackling the technology challenge first it's important we're able to identify the different emerging technologies, and project when they're going to be mature enough to be commercialised and produced at scale, so we understand, at a fundamental level, what technologies we have to play with, and which ones could be successfully combined together to create a viable product. Then, next we need to put our design hats on and do our best to design a product, or set of products, that give us the best chance of influencing and aligning all the soft triggers - ideally as quickly as possible.

Assess the technologies correctly, identify the intersecting trends and address the triggers and you have a product roadmap. Defining what comes next is a matter of both technology and adoption, not either or.

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## RE-FRAMING THE SMARTPHONE

The fact that so many smartphone manufacturers, and the press, still refer to their devices as smartphones is just one example of the mental leap manufacturers need to take, because as long as we keep referring to these devices as smartphones it's unlikely we'll be able to realise their full potential.

As a consequence it's my suggestion that manufacturers should to take a mental leap and re-frame their thinking, and while some of you might think re-framing is a minor detail, being able to frame your company's vision and products correctly, in a way that positions them properly for future development, investment and growth, is absolutely critical.

For example, is your objective to develop a better smartphone, a better computing, or health and wellness platform, or a million things besides. The way you answer this question will have a huge impact on the way your company lays out its investments, product development plans, operating structure, resources, strategy and vision.

In my mind we should be re-framing the smartphone platform as a personal companion, a BFF that acts as an extension of the user and has their best interests at heart. One that is there to help keep them entertained, healthy, informed, motivated, productive and safe, dare I say... happy, so that's my starting point.

## FUTURE SMARTPHONE FEATURES

The platform of tomorrow, like the ones that have been the most successful in the past, will have to evolve in, at best, large steps, not revolutionary leaps because culturally it's unlikely that people will be able to make the large mental leap needed to embrace anything that's too far out there or revolutionary.

Similarly, future platforms will need to feel as natural to use as possible and here, for example, phrases like "frictionless, invisible and seamless" should be among the keywords that drive their design and development.

### Control

Today's smartphones are the gateways we use to access and engage with the digital world around us but, despite all their cool tech and "supercomputer" like powers they are still, in many respects, dumb and reactive.



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Over the next couple of decades, the way we interact with them, as well as computing in general, is going to change substantially, moving from touch and type to gestures and voice, and then eventually telepathy, but for now at least, the next iteration of their interfaces will be via Artificial Intelligent agents I'm calling Companions that will manage and automate users mundane tasks, and keep them entertained, healthy, informed, motivated, productive and safe.

### Creativity

Smartphones have played a wonderful role in democratising creativity, and what would we ever do if all those videos of cats falling off shelves were to vanish from the internet, but compared to what's coming the range of things we can do with them is still very limited.

Over the next couple of decades Artificial Intelligence, 5G, 6G and new creative tools and hardware, such as 11k naked-eye 3D, 360 Degree video and Virtual Reality camera systems, as well as new Augmented Reality and Virtual Reality painting, rendering and scribing tools will help consumers create, merge and mix new content like never before.

In addition to all this though in the future users will be able to use natural language to ask their Companions to create new art and artistic styles, and new immersive landscapes and worlds, movies, music and other forms of content, as well as ask them to design, build, iterate and innovate new physical products and digital services.

In short, thanks to the significant advances I'm already seeing in AI, especially in the fields of Artificial General Intelligence (AGI), Deep Learning and General Adversarial Networks (GANs), and a category I like to call the "Creative Machines," soon these platforms will be able to democratise creativity and innovation for all, and unleash humanity's creative potential in new, previously unimaginable ways.

### Ethereal Computing

Today the majority of devices are still siloed and don't play together either at all, or at best very well, and while there have been some attempts to break down these barriers it's still difficult, if not impossible in most cases, to seamlessly move tasks from one device to another. furthermore, it's no secret that throughout the course of a normal day users interact

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with many devices, not just one.

Over the next couple of decades, as computing and smart devices continue to proliferate it will be imperative that tasks can be automatically moved between them all so users can take their experiences with them, and access their Companions and individually tailored services any time, any where and on any thing.

**Imaging**

Camera technology, more specifically, optics, have come a long way since the invention of the first lense, but we're only just getting started.

There's no doubt that today's technologies are far higher quality and far less bulky than the ones from twenty years ago, but similarly tomorrow's will be even higher quality still, and they'll be molecular and nano scale.

Over the next couple of decades we will continue to see dramatic improvements in the optical capabilities of our devices, thanks to advances such as wafer thin Metalenses, and 3D printed optics like SPECTRE that can pack the magnifying power of the Hubble telescope into a product no thicker than a human hair.

Furthermore, when these technologies are combined with others, such as Artificial Intelligence the results we'll see, and things that we'll be able to do with them will put them light years ahead of today's technology.

Artificial Intelligence will be able to sharpen, unblur and re-make photos and videos of the worst quality, it will help us take better, professional grade photos, and even take photos around corners, and, when combined with new hyper-sensitive and multi-modal sensors users will be able to see through walls, take perfect photos in the pitch black of night, and shoot videos in Infra Red and Ultra Violet, as well as the other bands of the Electromagnetic Spectrum. And that's just the beginning. 11k, 360 degree and Virtual Reality camera systems will help users create richer experiences, then 5G, 6G and Space Internet systems will let us stream them to the world, where ever we are on the planet.

However, if you think all these new cameras will be good for is taking perfect selfies and recording great party videos then think again. Throw Machine Vision into the mix and another world of possibilities lies aheead of us, from being able to tell how fresh your groceries are and assessing the structural integrity of



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buildings, through to helping individuals diagnose disease and health conditions, and everything in between.

**Intelligence**

Today even the most advanced smartphones are relatively dumb, reactive devices, with some suggesting that the level of Artificial Intelligence that's built into them today is equivalent to that of a two year old child. However, over time that will all change dramatically and the intelligence that is embedded into today's devices will one day be on us, connected to us, and in us, not just in our pocket.

Unlike many of the other future technology features and functions I've discussed here though Artificial Intelligence is what I call a General Purpose Technology (GPT) and it provides benefits across everything I've discussed. In short, it has few, if any, boundaries.

Over the next couple of decades our devices will inevitably become not just more intelligent, in some cases rivalling and then exceeding our own human intelligence, but perhaps more importantly, more capable, informative and insightful.

In the business world companies around the world are already leveraging AI to improve the productivity of their workforce by helping them off load low level cognitive tasks, and it'll be the same in the consumer arena too where, to start off with, users will increasingly allow Artificial Intelligent agents, called Companions, to take on, automate and manage more of their daily tasks.

Earlier I discussed the role Artificial Intelligence will play in helping transform the App Economy, and the need for a new model of Ethereal Computing where our Companions travel with us and are accessible from any device any where. From improving our lives to helping improve the quality of calls and the energy efficiency of our devices there are almost no limits to what we will be able to achieve, create or experience using Artificial Intelligence and that has to make it one of the most exciting, and trasformitive technologies of our era.

**Materials**

Despite the significant technological advances we've seen over the past decade or so, for example, in batteries, displays, networking, and semiconductors it still surprises me that the majority of

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today's consumer devices are still very fragile. Drop your smartphone, for example, and there's a high chance you'll end up with what they call a "Spiderman Screen," a cracked screen, and a bunch of dents in your expensive new gadget.

Over the next couple of decades all that will change as we continue to see significant advances in the fields of Genetic Engineering and Material Science, and as well as already being able to see a way to create a completely biological "Grow your own" smartphone, something made possible using the experience and tools taken from the field of Synthetic Biology, there are a plethora of new materials that will come on stream that will help us make better devices with new form factors and help us re-invent computing as we know it.

Take, for example, new electronically conductive fabrics, combine them with a new breed of miniscule nanotube transistor and E-Ink displays and you have a smartphone in the cuff of your sleeve complete with screen. But it doesn't stop there.

In the future we will have materials and electronic components that re-configure and heal themselves autonomously, and that are truly flexible, including fabric like electronics.

Meanwhile indestructible, fast charging polymers and nanophotonic materials will let us create indestructible, battery free smartphones with vivid holographic displays that charge themselves using the energy of movement or the Sun, at efficiencies that today's energy product manufacturers can only dream of.

**Privacy and Security**

One of today's biggest, and perhaps most contentious issues, privacy and security is a topic area that many people only see getting worse over time, and that's before new Artificial Intelligence Robo-Hackers, that use behavioural psychology and sheer speed of execution to break into accounts and systems tens of millions times faster than their human predecessors, and before the advent of new increasingly invasive ad tracking and surveillance technologies, become pervasive.

Over the next couple of decades, as sovereign governments continue to push for backdoors in software, as well as the encryption keys to the kingdom, and as both private and public organisations continue to explore new ways to tie together, monitor, analyse and track



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user's activity both online and offline it's certain that neither of these issues are going away.

From using cross platform tracking software to merging different databases together and using new pervasive surveillance systems, such as global satellite feeds and local camera feeds, as well as new non-invasive "touchless" biometric technologies that include remote brain scanning, facial recognition, fingerprinting and gait analysis, you'd be surprised what tools organisations have in their arsenal, one thing you'll be assured of is that there will be no such this as privacy.

As peoples lives are increasingly reliant, and tied to large, multi-national platforms, and individual sovereign governments there is increasing concern from individuals around the world that power is becoming more concentrated with many beginning to worry that the tales of dystopian futures are becoming true.

That said however, this also presents manufacturers with the opportunity to become the Guardians of people's privacy and security. As our devices become smarter, and as Artificial Intelligence becomes more capable users Companions could alert them to attacks, new surveillance methods and tools, and unsafe behaviours, and then block or counter them.

**Processing**

All of today's processors are silicon based, and while I am starting to see new 5nm, and even 0.5nm silicon designs emerge in the labs, it is increasingly clear, to industry and the public at large, that the days of exclusive silicon based computing is coming to an end. But as many fear that this problem, even with the emergence of modular silicon based SOC designs, will lead to a rapid slow down in the advance of processor price-performance it is clear to me that we are on the verge of entering into what I call a new "Jurrasic Era" of computing, one that is not dominated by one type of chip or computing architecture, but by tens, or maybe even hundreds.

There's no doubting that by historical standards today's processors are fast, hence the analogy that's so often used that we have a "supercomputer" in our pockets, but compared to tomorrow's standards they'll be the evolutionary equivalent of a snail.

Over the next couple of decades we will increasingly see the emergence of new

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Quantum computing platforms that our devices can leverage, for example, via the cloud, but it's doubtful that even as we come up with new ways to design silicon quantum computing processors that they'll ever find themselves become the mainstream computing platform powering tomorrow's devices.

Over time that honour could well find itself bestowed upon some of the new DNA, Chemical, Liquid, Molecular, Neuromorphic and Photonic computing architectures I'm seeing emerge, and, in some cases, especially in the case of DNA computer platforms, we can already see how their ability to self-replicate, and their subsequent huge parrallelism, will let them outperform Quantum Computers by factors of millions, potentially billions to one.

Futhermore, the development of new chemical and liquid computing platforms will open up a huge opportunity for manufacturers to create revolutionary new devices unlike anything we've ever seen before - ones that could reside on, near or even in us.

In the near term though we will have to be content with chips that let our smart devices run Artificial Intelligence and Deep Learning workloads locally.

**Productivity**

In the main it has to be said most, if not all, today's mobile devices still play second fiddle to more traditional client devices, such as PC's and laptops,when it comes to work orientated tasks, and I think most people would agree that their productivity levels are significantly lower than they could be, or should be, if for no other reason that the majority of their days are still taken up by relatively menial or trivial administrative tasks that, in the grand scheme of things add little or no value.

Over the next couple of decades I still believe that it is unlikely that our client devices will be eliminated from the workplace, if for no other reason that people still prefer a large screen to a tiny one, but more of these everyday tasks, including what many companies are beginning to call "Lower level" cognitive work will be managed by our AI Companions, whether they are our own personal Companions, or those belonging to the companies we work for.

Similarly, however, I can also see a day where, just like today where we integrate different applications and services together, we can integrate and merge our own personal Companions with those of our employers in order to improve



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their insights, and then our productivity and own experiences. Then, taking this one step further it's also highly possible that over time these same company Companions will become our managers, a trend I'm already starting to see emerge in the Far East and the US.

**Sensing**

Sensor technology has progressed more in the past three years than it has in the last three decades, driven by a tidal wave of demand and the subsequent investment that poured into the sector, and as more companies build and deploy increasingly smart devices it's inevitable that the amount of activity and investment in the sector is only going to continue to escalate.

As a result we can expect to see a dramatic increase in the rate of innovation and the number of new types of sensor technologies, which in some cases will be millions times smaller and millions times more sensitive than today's sensors, hitting the market.

These sensors will include new Biomarker, Electro-Hapatic, Electromyography, Hyperspectral, Nano Mechanical-Electro, Meta Material, Quantum, Solid State, and Ultrasonic variants, to name but a few, that when combined with Artificial Intelligence, Fog Computing and Sensor Fusion will dramatically increase the sensing sensitivity of our devices, and ergo their ability to sense, interpret and understand the world around them, whether they're using the new sensors to detect the fainest magnetic fields to eliminate our reliance on GPS, or communicating with the biomarkers and nanobots in our bodies to identify the early onset of cancer and disease. And a million things besides.

And all that's before I've gotten onto the topic of the rise of new biological and organic sensors which will increasingly made possible thanks to advances in gene editing, sequencing and synthetic biology.

Furthermore though, as we continue to see advances in new energy technologies, such as Backscatter energy systems that use radio waves and not batteries to power our devices, increasingly these sensors will be able to remain dormant until woken up by events, meaning that in many cases we can embed even more sensors into even more things, creating a virtuous cycle of sensing and understanding.

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**Storage**

When we look at today's storage models and technologies they traditionally fall into two camps - store information on the device or in the cloud, on magnetic or semiconductor based components. But in the future, as processor performance and the amount of data we have to ingest, analyse and store, continues to increase at an exponential rate, over time our devices and cloud service providers will have to embrace new, alternative forms of storage, such as Atomic and DNA storage.

However, that said, over time, increasingly it is going to make less and less sense to store significant volumes of information, other than for immediate processing and retrieval reasons, to store anything natively on our devices at all, but our ability to embrace the full benefits of cloud storage will rely significantly on the availability, consistency and speed of our networks, and their associated consumption costs.



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# FUTURE OF APP SMARTPHONES

IN THE past we've seen a number of attempts, by a variety of companies including, but not limited to, Amazon and Facebook, to bring to market what the market calls "App" smartphones," but in every case, almost by every metric, they've been wildly unsuccessful.

In 2015 Facebook, not one to easily give up, even went so far as trying to hijack the Android lock screen with their own in an attempt to gain traction and real estate on third party smartphones, but that too fell by the wayside after an abysmal uptake, and the initiative was canned shortly after the launch.

Over the past five years these companies, even those with billions of users, have come to the stark realisation that as the age of the app slowly begins to fade they're increasingly running the risk of being sidelined and reduced to little more than a dumb pipe, and that their user control point, as I like to call it, something that I discussed earlier in the Future of the App Economy, and therefore the engagement and revenue opportunities, are increasingly sitting squarely in the hands of the third party smartphone and device manufacturers who slowly but surely, like Apple with Siri, Google with Assistant, and Samsung with Bixby, are trying to insert themselves between the app manufacturers and their users.

In the past almost all of this was a non issue, after all, consumers would unlock their smartphone, navigate to their favourite app and use it, and there, low and behold would be, for example, a news feed packed full of adverts and messages.

Today, however, all that is changing because increasingly those same apps are being reduced to notification messages on a lock screen that, while enabling basic interaction, mean that things like the adverts, and maybe more importantly the ability to display adverts, is either missing, or being eroded.

Over time those notification messages will continue to morph into containers that the smartphone manufacturer, or the operating system owner, can tailor any which way they please, and even further out one day, relatively soon, those containers will be organised, prioritised and even, in some respects, automatically responded to by the smartphone manufacturers bespoke AI Companion.

In short, increasingly, as the value of being on the smartphones screen real estate diminishes, and as apps evolve from things you installed to things you stream, and then to things that are

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managed by your AI Companion, it's the third party smartphone manufacturers, and not the app manufacturers who will hold more of the cards. But there are some exceptions, and I'll come onto those in a bit.

Let's take a quick example and disrupt Google's advertising business. Pick up your phone, ideally a non Android phone since Android is Google's protégée, activate the AI Companion and ask it for directions, to say, London.

Did you notice what was missing? Google's adverts, and if there are no adverts then you don't have the opportunity to click them and that affects Google's advertising revenues. Congratulations, you just helped disrupt Google. A little bit.

As consumers continue to move from keyboard and touchscreen interfaces to conversational ones this is a problem, depending on your point of view, that's only going to get worse, and this presents app manufacturers with particularly sticky conundrum - the very platform they are increasingly reliant upon for their income and traffic is undergoing a paradigm shift, and there's little, to nothing, they can do about it.

However, as for those exceptions I mentioned, well, for the larger app players in the market it's not all doom and gloom because they still have some aces up their sleeve, namely their communication and entertainment platforms that billions of us use every day, such as Instagram, Messenger, Snapchat, WhatsApp, WeChat and YouTube. These are still very much destinations and they'll remain so for the foreseeable future.

These apps are, conceivably, the only players in town that could rival the manufacturers hold on the user experience. But if you are a smaller app manufacturer then, over all, this shift could become a serious threat to your business. All this then leads us to ask the question, do we expect to see more app manufacturers making their own devices?

Well, as the costs of manufacturing these devices continues to plummet it's plausible, but given the litany of past failures, and the high costs of distribution, marketing and support anyone who wants to enter the market is going to have to have deep pockets, and that already rules the majority of companies out.

However, as these same larger players experiment with new devices and platforms, such as, in Facebook's case

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Virtual Reality and even telepathy, the battle to own the customer experience is far from over.

Think, for example, of Mark Zuckerberg's stated goal to turn Facebook into a Virtual Reality powered platform, and then the world's first, and largest, telepathic social network. If that's what the future looks like then that, and the Facebook AI Companion that will undoubtedly inhabit those platforms, could become the ultimate customer engagement and experience model, and at that point it could very well be the case that Facebook turns all of its competitors into a dumb pipe.

As you can see, when we talk about the battle for the customer, and the evolution of the App Economy, there's plenty of mileage, and plenty of surprises left.

**SUMMARY**

Now and in the future every company will do their utmost to "own" the user, and that means owning the interface, or interfaces, they use day in, day out.

In the near term the next battleground will focus on the development and deployment of connected, conversational AI Companions, and new interfaces that drive new consumer behaviours and experiences, but similarly, when we model tomorrow's killer features and scenarios it's important to remember that the boundaries between previously discrete industries are eroding faster than ever before, and that digitising and disintermediating a product, service or even an entire industry is also, consequently, easier than ever before, and, for resourceful, visionary companies, all this will create an overwhelming amount of new opportunity.



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# EMERGING TECHNOLOGY IN FOCUS

WITH OVER 170 pivotal emerging technologies on the ascent one thing is certain - the individuals and companies who are in the business of developing new products and services have a more opportunities and options open to them today than ever before, and as all of these technologies continue to shrink in size and price, while at the same time growing in capability and performance, the only limitation is their imagination.

Technology though, irrespective of how advanced it is, is a tool, and as a consequence companies who want to innovate new products, and disrupt markets, have to realise two truths. Namely that disruption is not a function of technology, it is a combination of innovation and execution, and that innovation still starts with experimentation, exploration, ideation and the identification of met, and unmet, needs.

In both of these examples technology is simply a tool that we combined together in new and exciting ways to create the next great products and services. However, that said, as I continue to witness the rise of a new category of what I call "Creative Machines," it is also clear that we won't be innovating alone.

In order to bring some structure to this chapter I'm going to break innovation down into three types and highlight the technologies that manufacturers already do, and will increasingly have access to over the coming decades, that will help them innovate their new devices, and the platform that comes after the smartphone.

There are three types of innovation. Iterative Innovation, which is where the majority of smartphone manufacturers sit today, where their next generation products offer only incremental improvements on what came before. Then there is Primary Innovation, where the next generation products push the boundaries of the market and break the mould, and then last but certainly not least there is Disruptive Innovation where the next generation of products become the new standard.

As you'll be able to see today's manufacturers have a substantial number of technologies to choose from, but it's also important to bear in mind that all the technologies highlighted in this chapter will develop exponentially over the next couple of decades, almost to the point where they're unrecognisable from today's variants. As a consequence they will become cheaper, smaller, and more capable and performant at a much

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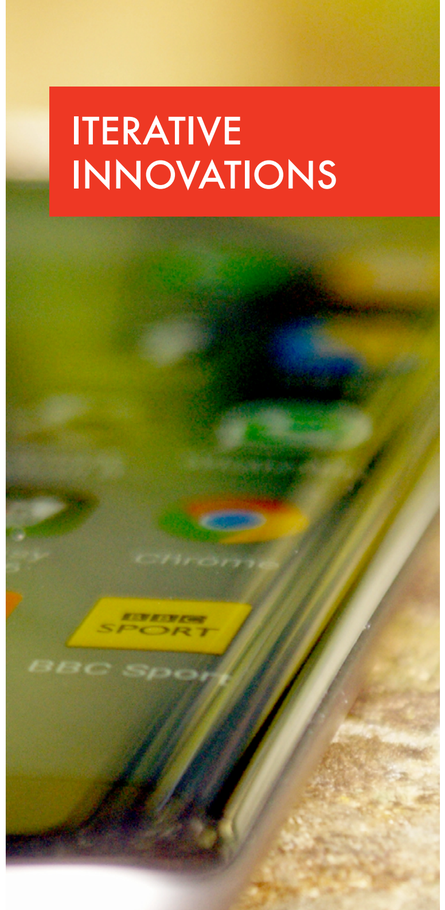
faster rate than many people expect, or anticipate, and manufacturers would be wise to factor that into their thinking when designing their roadmaps.






# ITERATIVE INNOVATIONS

THE EASIEST form of innovation, and, arguably the laziest, this is where many of today's manufacturers spend most of their time and energy, but this type of innovation rarely sets the world on fire, or makes people gasp with anticipation. Furthermore, in some cases, where users have an expectation in great leaps forward in capability, such as the latest Apple iPhone launch, companies can quickly discover that iterative innovation can become the yoke around their shareholders necks.

That said though iterative innovation still plays an important role in helping manufacturers stay current and keep up to date with the rest of the pack, and it requires less investment and resources than its other more demanding cousins, Primary and Disruptive innovation.

Over the next few smartphone release cycles iterative innovation will make it's presence felt in the release of better displays, faster processors and slightly better user experiences. So with no further ado let's take a look at some of the emerging technologies that today's smartphone manufacturers could leverage to iterate their next generation of devices.

**Battery Technology**

Almost number one on every consumers wish list is better battery life, but with only a 6 percent average increase in battery life per year, which is in part due to the fact that new smartphone components suck more power, it looks like consumers aren't going to get their wish anytime soon.

However advancements and efficiency improvements in a range of energy harvesting, graphene, nanoscale and other energy systems could soon provide manufacturers with a number of complimentary technologies that, when combined with new Artificial Intelligence energy management tools, could help them beat today's average.

- Biomechanical Harvesting

Biomechanical Harvesting is the process by which energy is derived and captured from biomechanical processes.

- Conductive Energy Systems

Conduction energy systems can capture and store the transfer of internal energy by the microscopic diffusion and collision of particles within a piece of matter.

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• Nano Generators

Nano Generators convert small scale mechanical and thermal changes within a material into electricity.

• Nanowire Batteries

Nanowire batteries use nanowires to dramatically increase the surface area of the electrodes within a battery system to dramatically increase the amount of energy they can store.

• Piezoelectric Power Generators

Piezoelectric power generators harvest the electricity that is produced by pressure or mechanical stress, such as picking up a smartphone, or depressing its screen.

• Thermoelectric Materials

Thermoelectric materials can turn a temperature difference into electricity by exploiting the flow of electrons from a warmer area to a cooler one.

• Thin Film Batteries

Thin film batteries are similar to conventional batteries but they are only Nanometers or Micrometers thick.

• Wireless Energy Systems

Wireless energy is the transfer electromagnetic power to another device without the need to use wires.

**Display Technology**

While there's a lot of buzz around flexible displays one of their biggest values could be in helping manufacturers decouple the display from the rest of the smartphone, which, if executed correctly could hasten the societies move to the next platform.

• Flexible Displays

Flexible displays are electronic visual displays that are flexible in nature.

**Imaging Technology**

As manufacturers look to cram as many megapixels into their devices as possible in order to up the competitive ante the focus on imaging and optic technology has never been hotter, but with new technologies coming through manufacturers have a number of ways to differentiate themselves against the competition.



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Improvements, to name but a few, include new MEMS image stabilisation systems, better low light sensors for better night time photography, and new, advanced AI capabilities that will help manufacturers not just coach their consumers on how to take better shots, but also help them edit, customise and sharpen post process.

• Artificial Intelligence

AI RAISR image processing technologies have the power to de-blur and sharpen even the shakiest images, and can also be used as a personal assistant to help users create the perfect shot based on data from millions of other, rated, photos.

• MEMS Sub Pixel Stabilisers

Micro-Electromechanical sub pixel stabilisers are sensor systems that can stabilise camera shake across three separate axes to produce ultra high quality footage.

• Molybdenite Sensors

Molybdenite Sensors are five times more light sensitive than traditional sensors.

**Materials Technology**

Often left out of many analysts reports over the past five years we have made significant advances in the field of materials, and as manufacturers increasingly market the "exotic" nature of their smartphones there are a number of new material technologies that shouldn't be over looked.

These include new Nano and Hydrophobic materials that repel every type of dirt and grime, all the way through to new self-healing materials that could, once and for all, solve the problem of cracked screens and damaged components.

• Hydrophobic Materials

Hydrophobic materials are nanoscale materials that completely repel all dirt and liquids.

• Nano Materials

Nano materials are insoluble or biopersistent manufactured materials that have one or more external dimensions at nanoscale or an internal nanoscale structure that give them unique properties and characteristics.

• Reactive Materials

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Reactive Materials can change their physical and, or chemical properties when exposed to external environmental stimulii.

• Self-Healing Materials

Self Healing materials have structurally incorporated components that allow them to self repair themselves.

**User Interface Technology**

One of the most crucial features of today's devices the user interface is, arguably, where all the action happens, so it's no surprise that there is a lot that we could do to help improve the consumers experience.

The first, and most obvious area, is the development of new AI Companions that, over time, could be used to help improve all aspects of the consumers lifestyle, meanwhile other areas include AR, another hot spot at the moment, and the development of better voice control systems.

However, as online shopping continues to grow, and as more consumers embrace gaming and new forms of entertainment there is also an opportunity to improve the consumers tactile experience.

• AI Companions

AI companions are intelligent, contextually aware AI agents that draw on large data and sensor networks in order to accurately predict consumers behaviours, automate and manage tasks and transactions, and reduce the friction of everyday life.

• Augmented Reality

Augmented reality systems and devices superimpose computer generated images on a users view of the real world.

• Gesture Control

Gesture control is the ability to recognise and interpret movements of the Human body in order to interact with and control a computer system without direct physical contact.

• Hepatic Engines

Heptics is the use of touch and sensation to control and interact with computer applications and  interfaces.

• Taptic Engines

Taptic engines and a combination of tap



Notes:

and hepatic feedback that let devices provide users with tactile sensations in order to provide feedback.

• Voice Control

Voice control lets users control devices using only their voice and is a subset of the new genre of behavioural computing.

• Volumetric Hepatic Displays

Volumetric hepatic displays projects a touch based representation of a surface onto a 3D volumetric space.

**Sensor Technology**

The usefulness of today's smartphone platforms is, in some regard, tied to the amount of situational information they can digitise. As a result the more sensors today's platforms have the more they can do, and the more services they can provide.

• Graphene Sensors

Graphene sensors are a new category of sensors that has a wide range of capabilities and use cases, including chemical and gas detection, stress detection and many more.

• Sensor Fusion

Sensor fusion uses software and algorithms to intelligently combines data from several sensors in order to improve application and system performance.

# PRIMARY INNOVATIONS

As I established earlier iterative innovation is fine if you want to keep up with the rest of the pack, but if you really want to spark people's imagination and get them excited about the art of the possible then Primary Innovation, and then Disruptive Innovation is for you.

In this section I take a look at some of the emerging technologies manufacturers will have in their arsenals over the coming decades that will help them raise the innovation bar, but it is my expectation that the most significant innovation in this category will come from the continued expansion of the users connected ecosystem, and the emergence of Companions and new Ethereal Computing models. Everything else will be just a bonus.

**Audio Technology**

When we think of audio on smartphones we often think about Dolby and surround sound as the gold standard, but as manufacturers increasingly build and deploy new conversational AI Companions, for example, that can control the Connected Home, consumers will have to be able to speak to their Companions from a decent distance, something that simply isn't possible using many of today's devices.

- Bone Conduction

Bone conduction technology turns sound into vibrations that can be transmitted by a person's bones either into the bones of their inner ear, or into devices that can recode it into a digital signal and transmitted via a traditional digital communications platform.

- Far Field Microphones

Far field microphones are microphones that can detect and hear sounds at long range.

**Battery Technology**

- Graphene Batteries

When applied to existing LiON battery systems Graphene, moulded into balls and used to line the battery, can increase battery life by 50 percent and speed up charging by 300 percent.

**Communication Technology**

With a whole host of new communication protocols coming online over the next decade one of the most interesting could be MulteFire, however, as we move from analogue to digital signals processing AI will increasingly help manufacturers improve the quality of their signals and eliminate signal interference.

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- Cognitive Radio

Cognitive Radio is a form of wireless communication where a transceiver can intelligently detect which communication channels are free and instantly move into them.

- MulteFire

MulteFire is a form of LTE communications technology that uses unlicensed frequency bands

**Display Technology**

3D, which has now had a number of false starts, could see its day come with the advent of narrow band Naked Eye 11k displays which look set to materialise in 2018, but as manufacturers look to pack more features into smaller packages and improve the reliability of their devices Crystal Sound OLED displays could also prove to be an interesting game changer, giving manufacturers the opportunity to create much bigger, richer sound.

- 11K Naked-Eye 3D Displays

11K naked eye 3D displays are ultra high definition displays that present the user with a true 3D image effect without the need to wear special 3D glasses.

- Crystal Sound OLED

OLED crystal sound displays are displays that can create 3D sound via the displays surface without the need for external speaker systems.

**Imaging Technology**

As imaging and optics have become the next battleground the amount of investment in the area, and the rate of development, has increased rapidly. However, while new optics technologies will let consumers shoot better photos and videos it's important to remember that these are also the same devices, that when combined with AI, will help manufacturers unlock millions of new machine vision applications.

- 3D Cameras

Notes:

3D cameras are imaging devices that enables the perception of depth in images to replicate 3D as experienced through human binocular vision.

• 360 Degree Video

360 degree video is video taken using a 360 degree camera and stitched together using software to provide users with a 360 degree immersive video experience that they can navigate around.

• Depth of Field Systems

Depth of field systems let users take photos where the objects, both near and far, are in sharp focus.

• Machine Vision

Machine Vision harnesses Deep Learning algorithms to automatically understand, interpret and inspect still images and streaming video.

• Metalenses

Metalenses are atom thick, nanoscale materials that can focus white light into a point without the need for traditional, bulky optical lenses.

• Multispectral Cameras

Multispectral cameras capture image data within a variety of wavelength ranges, such as IR, UV and X-Rays, across the electromagnetic spectrum.

• Nanophotonic Materials

Nanophotonics use optical nanomaterials to manipulate light at the sub wavelength scale to produce ultra sensitive products and sensors.

• Periscope Camera Systems

Periscope camera systems mount the optical camera lenses horizontally in order to increase the optical zoom of the camera.

• Pico Projectors

Pico projectors are small hardware devices that project an image from a mobile device.

**Processor Technology**

Over the next few years we'll see more processing performed in situ on the smartphone, however, as the IoT continues to gain traction, this will only be a stepping stone, and over time



Notes:

we will see new distributed computing models emerge.

• AI Chips

AI chips are a new category of chips designed to speed up at the edge AI based workloads.

• 3D Chips

3D chips are integrated circuits that contain a 3D array of interconnected devices performing digital, analogue, image processing and neural network functions, either individually or in combination.

• Distributed Computing

Distributed computing platforms have no single point of centralisation and aggregate together the computing power of millions, or billions, of devices to process, store and transmit information.

• Neural Processing Units

Neural processing units use AI accelerator chips and software API's to make deep learning available at the edge on mobile devices.

**Sensor Technology**

As sensor technology continues to advance at a healthy rate there are some new and interesting sensor systems coming onto the market that, on the one hand could improve the smartphone's spatial awareness, and on the other, give it's credentials as a secure, health device a boost.

• Laser Ranging

Laser ranging systems measure the round trip time of flight of ultra short pulses of light.

• Solid State Ultrasound Sensors

Ultrasound sensors use ultrasound to detect and interrogate objects and can be used as the basis to provide interference free, accurate biometric scans.

**User Interface Technology**

As we continue to talk about the important of AI Companions it's important to remember that today's AI Companions are still relatively dumb and logical, and as a consequence the next great barrier to break is the creation of a truly Conversational AI Companion

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that we can communicate with in the same way we would communicate with a colleague or friend.

However, as much of a leap this is AI could have another great role to play, and if it's developed in the right way it could help us overcome one of humanities biggest, and often most divisive, challenges. I am, of course, referring to language translation and the ability for people to communicate with each other as though they're speaking the same language.

• Acoustic Holograms

Acoustic Holograms use sound to levitate, pirouette, pull and push objects in mid air in much the same way a tractor beam would.

• Affective Computing

Affective computing rely on a variety of technologies to create computing platforms that are able to sense, understand, and appropriately react to, people's emotions and sentiment.

• Artificial Intelligence

Artificial Intelligence can be used in a whole manner of ways to improve the user experience, these include, but are not limited to AI Companions, un-blurring and sharpening images, managing user privacy, natural language interfaces, optimising user productivity, predicting cyber attacks and much more.

• Avatars

Avatars are figures, icons or manifestations that represent a particular individual or entity.

• Emotion Tracking

A branch of Affective Computing, emotion tracking systems use a mixture of Artificial Intelligence and Machine Vision to understand the mood of the user so they can adjust their behaviours accordingly, provide advice and pro-actively alter the users environment in response to the users mood.

• Eye Tracking

Eye tracking technology uses a variety of different sensing technologies to track and monitor the movement of people's eyes.

• Hapatics

Hapatics is the use of touch and electrical



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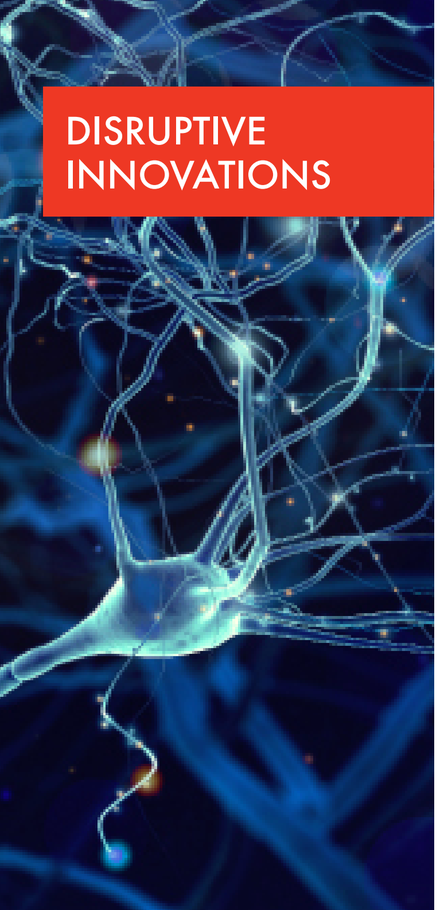
conductivity to create different touch sensations.

• Telepresence

Telepresence is a branch of Virtual Reality technology that allows users to take remote control of machines or to actively participate in remote events.

• Universal Translation

Universal translation is the automatic, real time computer based translation of one language into any other language.



# DISRUPTIVE INNOVATIONS

NOW WE move onto Disruptive Innovation. If you have your heart set on creating the next big thing, and the next new category of devices then this section is likely for you, because this is where we blow away all our preconceptions about what computing is, and how we interact with it. In short, this is where we tear the band aid off, spark our imaginations and run full force into the future, science fiction be damned.

**Battery Technology**

Today's battery systems will one day fall by the wayside and be replaced by new ones and there are a number of very promising technologies emerging. These include new high density Quantum Wire battery systems, 5D Blood that use a chemical based REDOX reaction to power devices, and new fast charging polymer based systems to name but a few.

• Backscatter Energy Systems

Backscatter energy systems harvest energy from the energy all around us in the air in the form of radio frequencies and can be used to create smartphones without batteries.

• Electronic Blood

Electronic blood can both power at cool computer platforms at the same time by using chemical REDOX reactions.

• Photovoltaic Glass

Photovoltaic glass is a technology that enables the conversion of light into electricity by using transparent semiconductor-based solar cells.

• Polymer Energy Systems

Polymer based batteries can be used to help charge smartphone batteries instantly and eliminate the need for LiON batteries.

• Quantum Wire Batteries

Quantum wires are nanoscale wires that can have an unconstrained length that can conduct electricity and dramatically increase battery performance.

• Reconfigurable Electronics

Reconfigurable electronics are made possible by the rapid development of new Liquid Metal technologies that allow users, or companies, to reconfigure electronics in situ on the fly.

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**Communication Technology**

Over the next decade there will be an explosion in the number of new communications protocols and the numbers and types of devices that start communicating. As a result we will see the development of new multi-band chips, and the continuing rise of small and pico cell networks.

One of the strangest communications technologies we will see emerge is Nil Communication, a new Quantum Wave technology that allows individuals to communicate without sending data, that said though it is unlikely to be commercialised in the near future but it nicely demonstrates how we shouldn't take technology, or our skills to develop it, for granted.

• Blockchain Mesh Networks

Blockchain mesh networks will let consumers access bandwidth via scalable, peer to peer city wide, or intercontinental, networks and help them disintermediate the incumbent 4G and 5G telecoms providers.

• C-V2X Chips

A new type of Cellular to Vehicle to "Everything" chipset that allows devices to connect to anything and anyone in real time.

• "Just Get It There" Protocols

Just get it there protocols can use any type of spectrum, licensed and unlicensed, to get information and signals from anywhere to anywhere and it has the potential to disrupt the incumbent telecoms providers.

• Neural Interfaces

Non-invasive neural interfaces use a variety of methods to decode biological signals from the brain and then re-code into a digital form that can be transmitted and de-coded by receiving devices, enabling telepathic communication between humans and objects.

• Nil Communication

Nil communication is the use of Quantum Wave Mechanics, rather than particles, to transmit data that could revolutionise communications and computing as we know it.

• Self-Healing Networks

Self Healing Networks rely on an automated network defense system

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that actively searches for and identifies network vulnerabilities and patches them on the fly.

• Pico Cell Networks

Picocells are small cellular base stations that can be used as an alternative to a repeater or distributed antenna system.

**Display Technology**

Today we're used to display technology that gets better over time, and every four years or so we see the emergence of a new, higher quality higher definition standard. However, with advances in Nanomanufacturing and a plethora of other technology fields, such as Femtosecond Lasers we are now starting to see the emergence of credible, interactive, holographic devices and a range of new display formats that were previously relegated to the realms of science fiction.

• E-Ink

E-Ink displays are thin, flexible, low power displays that can be built into a wide range of products including clothing.

• Femtosecond Lasers

Femtosecond lasers can create interactive, 3D plasma holograms in mid air.

• Holograms

Holograms are the creation of a 3D object using a complex system of interference and diffraction between different multi hue lasers.

• Light Field Systems

Light Field systems can be used to produce interactive Living Pictures that have variable depth of field, focus shift and perspective shift.

• Nanophotonic Systems

Nanophotonic materials alter the behaviour of light on the nanometer scale and can be used to create better holograms, photonic computer platforms and solar panels.

• Screenless Displays

Virtual retinal display systems are a class of screenless displays in which images are projected directly onto the retina.



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**Imaging Technology**

Today's imaging systems are advanced, but they are nothing compared to what's coming. Today we can already see new technologies emerging and being demonstrated that will let consumers take photos round corners using new military grade quantum imaging systems, and that will also let them fit the magnifying capabilities of a space telescope in their pocket.

• SPIDER Optical Technology

SPIDER (Segmented Planar Imaging Detector for Electro Optical Reconnaissance) is a technology that allows companies to shrink the capabilities of a space based telescope into a package a few millimeters cubed.

• Quantum Imaging Systems

Quantum imaging systems use optics and algorithms to detect miniscule amounts of reflected light, or photons, that allow cameras to see round corners.

**Materials Technology**

New advanced manufacturing techniques, such as 3D Printing and Nanomanufacturing have had a dramatic effect on the development of new materials, as well as on the development of other products. Today we can see the emergence of several interesting new technologies such as Liquid Armour which, as it sounds, will better protect our devices from extreme impacts, as well as new game changing polymers such as MDI, a spray on material that makes anything it's sprayed onto, even fragile Melons, indestructible.

Elsewhere we're also seeing advances in Programmable Materials, that change their form and function in response to external stimuli, Stretchable Electronics and Superconductors.

• Atomic Knots

MDI Polymers are complex, chaotic molecular spray on materials that can protect any object from extreme forces and explosions.

• Liquid Armour

Liquid Armour is a material that is liquid under low or normal pressure and solid under high pressure that can protect equipment from extreme damage.

• Programmable Materials

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Programmable Matter can change its physical properties and characteristics based on user or autonomous input.

• Self-Healing Components

Self-Healing electronics rely on a variety of techniques and materials, such as Nanocomposites, to repair damage and self-heal.

• Solid State Coolants

Solid state coolants are a new class of material that can cool hot electronics down in seconds to increase battery life and prevent components from over heating and exploding.

• Stretchable Electronics

Stretchable Electronics use stretchable conductive materials laid on stretchable substrates to produce circuits that can be twisted and stretched.

**Processor Technology**

As silicon based computing, and Moore's Law continue to come under pressure, and as their rate of development slows, it is inevitable that within the next decade we will begin moving to the next computing platform. However, unlike the present where one computing platform dominates tomorrow there will be tens and suffice to say the computing platforms of the future will be very, very different from the computing platforms of today.

• Chemical Computing

Chemical computers use Acid-Base reactions to perform calculations and store information.

• Distributed Computing

Distributed computing platforms, particularly Blockchain based ones, have no single points of failure and use distributed computing nodes to perform calculations and process information.

• DNA Computing

DNA Computing platforms use modified DNA to store exascale datasets and can replicate themselves to process information millions of times faster than Quantum Computers.

• Flexible Electronics

Flexible electronics use a combination of 3D Printing and new materials to create electronics that flex and stretch without



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breaking or loosing contact.

• Molecular Computing

Molecular computing platforms use a complex arrangement of organic and inorganic molecules to perform calculations and process information.

• Neuromorphic Chips

Neuromorphic computing is the use of very large scale integration systems that contain electronic analog circuits which mimic the neuro-biological architectures present in the nervous system.

• Photonic Computing

Photonic computing platforms use photons, rather than electrons, to perform calculations and process information.

**Sensor Technology**

Over time our devices ability to sense, and then make sense, of the world around them will continue to increase exponentially thanks to the new sensor technologies that will be embedded in them, and the expansion of today's vast sensor networks, both of which will provide manufacturers with the opportunity to create new products and services.

• Biosensors

Biosensors are devices that use living organisms or biological molecules, especially enzymes or antibodies, to detect the presence of specific chemicals.

• Environmental Sensors

Environmental sensors are passive sensors that can detect local environmental conditions in real time

• Gas Sensors

Gas sensors are passive sensors that can detect trace gases and compounds in the air, or in a persons breath, to detect disease.

• Low Power Wide Band Radar

Low power wide band radar devices can detect the faintest bodily movements, such as respiration, using only minimal power.

• Nano Electro-Mechanical Sensors

Nano electromechanical systems are nanoscale sensors that have applications

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in medicine, engineering, physics and more.

• No Power Sensors

No power sensors draw energy from ambient backscatter signals and do not need any batteries or alternative power sources to work or transmit information long distances.

• Organic Sensors

Gene editing is making it possible to create organic, and plant based sensors, that detect a wide range of stimulii, including communications signals and environmental stimulii, and they could be incorporated into a variety of materials including Bio-Materials and a wide range of other Meta and Smart Materials.

**User Interface Technology**

In time today's unnatural and relatively crude computer interfaces will give way to brain controlled interfaces, however, while many of today's BMI interfaces let consumers control certain devices tomorrow's interfaces will be bi-directional and let users interface with AI, upload and download information and even stream movies, something that's already been demonstrated.

Over time, and sooner than we think, we will also be able to use these interfaces and combine them with other technologies to build new VR worlds in high definition in real time. And that's just the beginning.

• Neural Interfaces

Neural interfaces are Brain Machine Interface systems that allow individuals and machines to engage in a one way, or two way, dialogue with each other, as well as allowing either, or, to control and, or, upload and download information between each other telepathically.

• Skin Touchscreens

Skin touchscreens use sensors to turn people's skin into a touchscreen interface that allows them to interact with, and control specific devices.

• Ultra High Definition Rendering

Ultra high definition rendering is the process of rendering objects and surfaces at a resolution that is indistinguishable from the real thing.

• Virtual Reality



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Virtual Reality is a computer generated simulation of a 3D image or environment that can be interacted with.

**BEYOND THE PHONE**

The proximity of technology, more specifically computing, in relation to the human body, is following a natural evolutionary trend and over time the technology that was once confined to the datacenter will be increasingly on us and in us, whether it's "Biological" technologies, such as Chemical, DNA and Molecular computing, Synthetic Biology and Genetic Engineering, or more conventional forms of technology such as chips, neural implants and enhanced prosthetics.

However, while we all know that this is our future getting there is going to be an evolution, not a revolution, because while technology continues to advance at an exponential rate, cultural change, especially where technology starts to change what it means "to be human," something that people are beginning to debate more vigorously today, takes time, and a lot of it. And that's what companies who are trying to create the next platforms are really up against.

As a consequence the transition, from external to worn, and then worn to internal technology, adoption has to be managed carefully, slowly and respectfully.

Taking a retrospective look back at human behaviour shows us that the consumer technologies that have succeeded and proliferated in the marketplace in the past are the ones that seamlessly collapse and consolidate many functions into one device, are affordable, convenient to use, leaning on frictionless, and, where practical, invisible.

Having looked into the challenges in depth, as well as the reasons for past "failures" where new technology platforms, some of which were dubbed the "future," such as Google Glass and Project Aria, and arguably, wearables and even VR, that so far have all failed to live up to the hype I believe that the greatest challenge smartphone companies face isn't visualising the "final" step, where humans become technology, but the intermediary ones, and in order to conquer those steps effectively you have to take both technology and culture into account. And that's tricky.

As a result one of the thoughts I would

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like to put forwards, as a simple, evolutionary, not revolutionary, intermediary step is one that plays to all of those points I've mentioned previously, and today it's a well documented fact that people use different technology platforms throughout their day.

For example, in the mornings consumers tend to use their smartphones more, at work they use client computing devices and tablets, and then in the evenings tablets and televisions dominate, and throughout the day and night are the omnipresent fitness trackers and smart watches, and a wide range of other devices.

The point here, of course, is that people use different technologies at different times of the day to fulfil specific tasks. In short, as much as manufacturers would like to think there is one, until the technology resides within us there is no one fit all device.

As a result it's my belief that the near term future of our devices isn't one device it's many, and this is where manufacturers have an opportunity to create a new market, and the lay the foundation for the next computing paradigm.

Think ubiquitous computing, breaking down the barriers between devices, freeing the display, creating fluid, transferable experiences, and an omni-present conversational AI Companion that follows the user and not the device and I think you will be getting closer to the time when society will be ready to embrace the revolutionary next platform. And as for the form factor, well, keep it simple, close to the user let your imagination go.

**SUMMARY**

While many people fixate on the same iterative smartphone innovations, such as better cameras, flexible displays, longer battery life and wireless charging all that is just the tip of the iceberg.

With so many new emerging technologies already here, and on the horizon, and as their rate of development and commercialisation continues to accelerate, it's clear that there's plenty of scope for new innovation, whether it is of the smartphone platform itself, or the development of what comes next.



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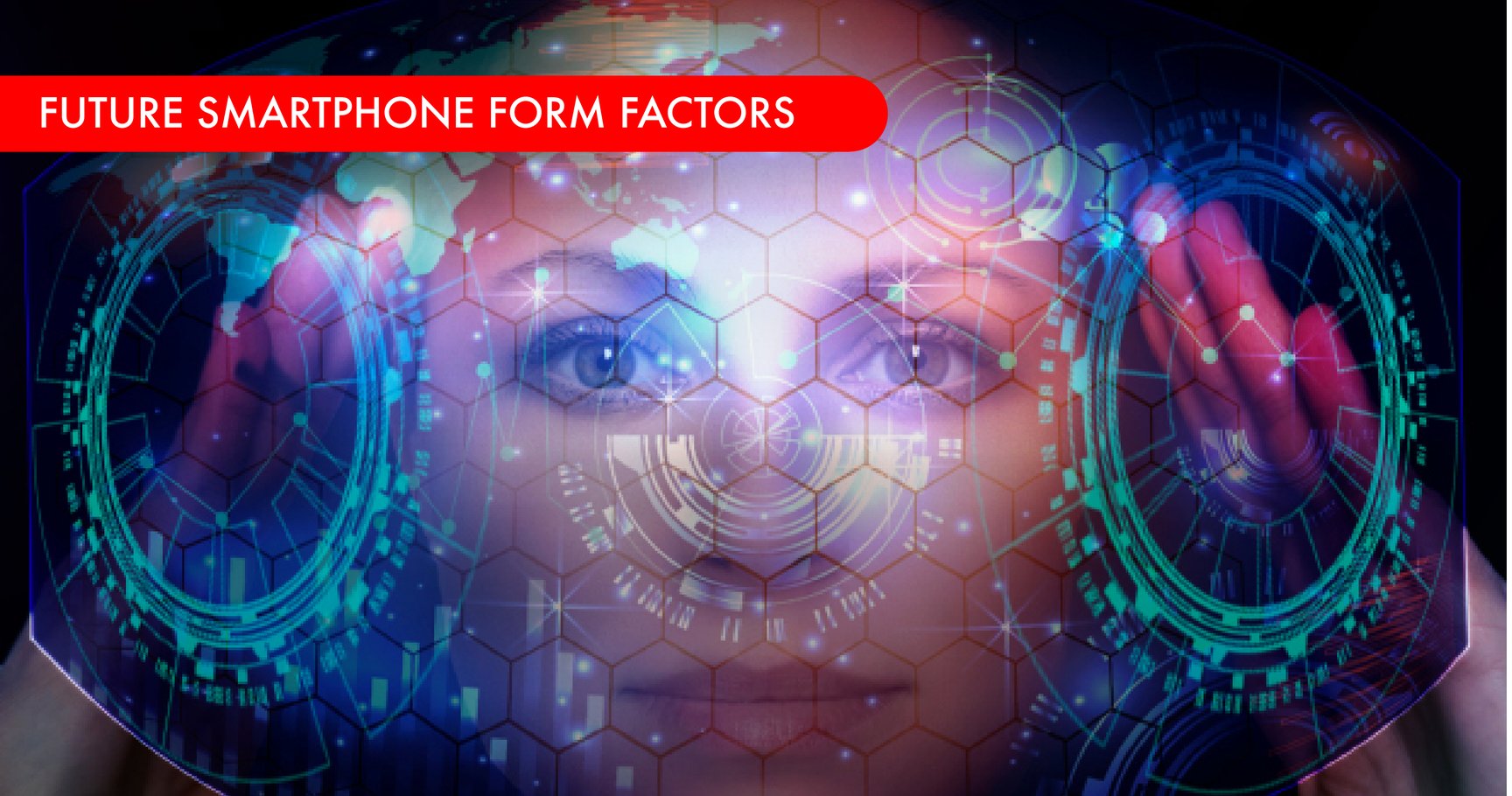
# FUTURE SMARTPHONE FORM FACTORS

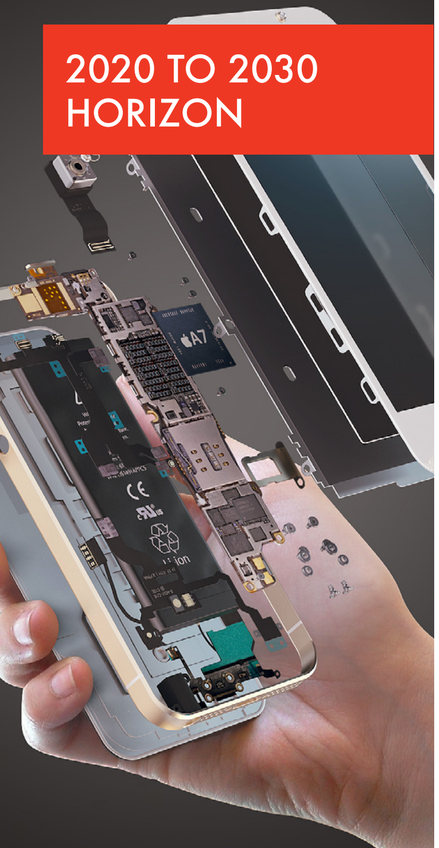


DESPITE THE fact that today almost everyone refers to today's smartphones a form of distributed computing platform I'd argue, that from a futurists perspective at least, that it could still be referred to as a centralised computing one because, after all, it still packs everything, from the individual computing components and the screen, all the way through to the communications and memory, as well as all of its functionality, into one, albeit a slimline one, consolidated, package.

However, in the future, when, and only when, consumers are comfortable decoupling the screen from today's smartphones, we will inevitably see the smartphone and its future descendants degrade into little more than ambient, and assistive, computing devices and companions that surround us, and reside in all of our distributed everyday objects.

In this chapter I look into the things that could replace today's smartphone platform, in the near term (2020 to 2030), medium (2030 to 2040) and long term (2040 to 2070), and the form factors they could take, and the technologies that will make them possible.

# 2020 TO 2030 HORIZON




OVER THE past five decades computing has been edging ever closer to us, and now those mainframes and supercomputers that used to sit in giant data centers, and the desktops and laptops that came next, are in our pockets and on our bedside tables.

One day, and many people think it will start in earnest from 2045, today's smartphone platforms will be in us, but before that happens society first has to transition from the centralised computing and display platforms that we use today to new intermediary computing platforms that, once they have separated themselves from their displays, can morph into any form factor imaginable, from virus sized computing devices to hearables, wearables and even platforms that are merged into our very own biology.

In this section I take a look at how we can start the most important part of this journey, de-materialising the smartphone.

## DECOUPLING THE COMPONENTS PARTS

Given the possible ways in which today's emerging technologies can be combined and developed it's easy to see how, over time, the smartphone will eventually be degraded into little more than a computing device. However, that said, the biggest challenge we face realising that future is decoupling the communication, computing and sensing components from the screen, that, despite attempts by companies including Google, to this day still remains stubbornly fixed to the front of almost all our devices.

From a computing standpoint we are already seeing the emergence of miniaturised computing devices, called Micro Motes, that are no bigger than a grain of rice, and as we project these devices ten years into the future it's inevitable they will get orders of magnitude smaller, and more energy efficient and powerful.

Getting even smaller we are already seeing the first architectural designs for virus sized computing devices, but that's not all. Over time tomorrow's computing devices will be able to go magnitudes smaller still and today, again, we're already bearing witness to the emergence and development of new types of computing platforms that are nothing short of paradigm shifts.

Examples of these new computing platforms include new acid and base Chemical computers, that turn chemical cocktails, as well as even us humans, into the computing device, as well as new DNA, Liquid and Molecular computing platforms, and that's to say nothing about the recent advances scientists have made in the Photonic or Quantum computing space.

As silicon based computing platforms, and Moore's Law, continue to near their limits, despite some of the recent 0.5nm carbon nanotube transistor breakthroughs, inevitably we will have to move from silicon based computing to one or more of these alternatives.

It goes without saying though that no computing platform can stand alone, and in order to be useful they need to have connectivity, memory, power and storage, and we're making significant progress on all of these fronts too.

From Atomic and DNA storage and Photonic Interconnects, to flexible, self-configuring electronics and nanoscale communications, computing and sensor systems that power themselves using nothing more than the radiation in the air, one thing we can say for certain is that in tomorrow's world we'll be spoilt for options.

Add into this the fact that new manufacturing techniques, such as 3D Printing and Bioprinting are helping us create new categories of Bio-Hybrid electronics, and all of a sudden you have a world where tomorrow's devices could just as easily be woven into the fabric of your jacket, or put into a belt, ring ot a shoe, as they could engineered into a pot plant, and a million other places besides.

So, as I've mentioned, decoupling the computing element of the smartphone isn't an issue, and to a degree it's already arriving, but decoupling the screen from the smartphone, well, that's a whole other issue, and solving it isn't necessarily a problem of technology.

## DECOUPLING THE DISPLAY

As mentioned previously, being able to decouple the computing, communications and sensing components present in today's smartphones and building them into other devices, whatever and wherever those devices are, isn't an issue, but in order for society to break its love affair with smartphones and embrace the next platform the biggest challenge we have is breaking their love affair with their current screens.

As a result, moving to the next platform, isn't a technology problem, it's a cultural one, and it's all because at the moment society isn't ready for us to de-materialise, eliminate, or even really

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move the display into, or onto, something new, and this is the toughest challenge companies will face when trying to innovate and build the next platform.

Initiating this shift, even though it will inevitably happen one day, even as we see the emergence of several new types of display technology, from Augmented and Virtual Reality through to Holograms, Pico Projectors and new screenless displays, including those made possible via Neural Interfaces, will not be an easy one. Arguably it will be one of the hardest paradigm shifts ever under taken because it requires not one but two shifts to take place.

"The greatest challenge we face moving to the next platform isn't a technological one. It's a cultural one."

Firstly people need to break their love affair with fixed displays, and secondly, depending on how it's implemented, they will, at some point need to embrace the transition from display technology that is external to them to technology that is proximal, on or in them. On the one hand you are fighting centuries of culture and tradition, and on the other you are fighting not centuries, but millennia's worth.

This said though there may be a way to gently initiate the shift, by separating the display from the computing platform. However, until we finally realise the day where images are beamed non invasively into our brains, or holographic displays pop to life in front of us, we'll have to focus on the technologies we have to hand both today, and over the next decade to try to initiate the shift.

Bearing in mind that consumers use their displays in a myriad of public and private places, such as at the beach, on the bus, at home and at work, in my opinion the best starting point, and one which consumers may be more willing to accept, will be the introduction of



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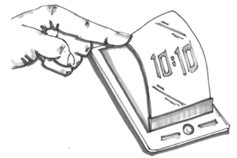
detached, and detachable, flexible, ultra thin displays that synchronise with the now "detached" computing platform. This will achieve two things.

Firstly it will provide consumers with a familiar, lightweight and portable high resolution display that's not too dissimilar from the ones they used to using today, after all, noone wants to go backwards ten steps to the years of grainy, black and white displays, and secondly, and perhaps more importantly, it will help companies realise their goal of finally detaching the display from the smartphone, which will then, hopefully, help them accelerate the transition to the next platform.




However, initiating this switch will still be a challenge that's more likely to be one of culture and design than technology.

In addition to simply detaching the display into a stand alone device companies have a couple of alternative options too. For example, they could move the display to one of three other formats. Firstly either in, on, or near to the consumers eyes, think glasses, headsets, Retinal Display Systems and Smart Contact Lenses, secondly they could move them onto their clothing and skin, and thirdly they could move them onto any other display or surface in the vicinity.

Similarly, bearing in mind the challenging cultural shift it might also be advisable for companies to target the newer generations, such as today's Generation Z, and tomorrow's Generation Alpha rather than spend time convincing Generation X that the new format's a good idea.

As a result, and given each new generations apparent willingness to embrace new technology faster than the generations before them we could argue that, with the right tailwinds, companies could initiate a format shift at least every twenty years or so, with the next starting from 2025, for Generation Alpha.

## FLUID COMPUTING PLATFORMS

Computing, whether it's Mainframe

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and Client-Server, for example, has gone through several iterations of centralisation, decentralisation, and then back again, and to most it seems inevitable that the smartphone platform will follow the same pattern.

However, if modelling the future has taught me anything it's that modelling it on the past is not always the right course of action so we must tread with caution because while many people would regard today's mobile platforms as the ultimate decentralised platform it's clear that we are simply at a midpoint in the evolution of computing, and that it's going to get much more decentralised than it is today. Imagine compute built into just about everything, ever chair and every piece of fabric twine, and you have some idea of where we're headed - eventually.

Once manufacturers have solved the cultural problem of decoupling the screen from today's smartphones they'll suddenly find the number of new computing formats they can design explode.

That said though, in the near term at least, we're still going to be some way away from realising the vision I discussed earlier in this paper of a pure, personalised and secure intelligent "Ethereal"computing platform that users can access any where, at any time on any thing, but while this will likely be the model one day, after all, do you really think we'll have to carry our devices around with us for eternity, realising this computing platform will take time, and our journey to realise it will be one of baby steps, not giant leaps.

As a consequence, and as our first step, the formats that would make the most sense to embed the now decoupled compute, communications and sensing technologies into, given today's cultural backdrop, and general lethargy to embrace anything too radical, would be the ones we're starting to, slowly, get used to today such as glasses, watches or pieces of jewellery, whether that's a band, broach, keychain, necklace or a ring. Then, as users begin getting more comfortable with the concept of Ethereal computing manufacturers can slowly start experimenting with new formats, and new consumption and delivery models.

For example, imagine being in the city and being able to securely and privately call up your schedule on a random display screen, or getting into the office and being able to start from where you left off at home and seamlessly login into an E-Desk, or even project your last screen session, whatever it was, onto a



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random surface, before finishing and transfering it back onto the display in the arm of your jacket as you head off to get the train...

Once the compute and all of it's intelligent functions have been detacthed from the back of your smartphone's display there's no limit to where you can put it.

It is inevitable the smartphone will one day degrade into separate devices, and that one day it will be decoupled from its display, but in my estimation that cultural shift will take more than a decade, and probably much longer.

## DISTRIBUTED COMPUTING PLATFORMS

The dual ascent, and eventual convergence, of the Internet of Things (IoT) trend, which over time will not just include smart devices but also Smart Dust, and new ambient, edge and fog computing models, and the Distributed Ledger Technology (DLT) such as blockchain means that when it comes to realising the promise of truly distributed computing we've only just begun.

Of particular interest to companies should be the emergence of new DLT based distributed computing architectures and business models that have the potential to disintermediate and disrupt today's giant hyperscale cloud, High Performance Computing (HPC) and internet platforms, a point of view that's only made more powerful when we realise that these are the very same technologies which will facilitate and underpin tomorrow's smart world.

Before we move to this fully distributed architecture though in the near term it's inevitable that tomorrows smartphone platforms will handle more of their day to day processing than they do today, offloading more AI and Deep Learning tasks, for example, to their on board CPU, Neuromorphic processors and Neural Processing Units (NPU), and that they will increasingly be complimented, by vast distributed networks of smart things at the extreme edge that, similarly, over time, will handle more of their own processing tasks.

In time our next generation smartphone devices, and their replacements, will simply be nodes in a vast sea of inter-connected and distributed "things," and ultimately which platforms process which transactions will depend on the usual transactional trade offs, which, like today, will be determined by the type of task, the amount and type of resources needed, criticality, distance, and latency,

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and as these new distributed computing platforms become more established they'll present manufacturers with new opportunities.

For example, today, it's possible to replace the computing power of a single Amazon AWS cluster with 90 legacy Samsung S4 smartphones. While there are, of course, restrictions on how and when users could tap into devices in this way in 2017 the top three smartphone manufacturers alone shipped over 775 million units, all of which have significantly more computing power than the S4. Consequently it's arguable that if just a small fraction of their total computing power was pooled together they could be used to replace tens of millions of AWS instances.

The result of all this is, of course, is that if manufacturers were able to develop and install new software tools to run on their devices, turning them into processing nodes on a network when they were idling, then, arguably, they could harness a new revenue stream. Manufacturers could even sell excess compute capacity back to the big platforms, or even their own cloud platforms, and, potentially use those proceeds to subsidise the purchase of their handsets.

## A WORLD OF CHANGE

Of course, over time, as our smartphones part company with their screens and continue their ascent to become tomorrows ethereal computing devices the way they gather data, the way we use them, the way they connect, and their level of awareness of us, and our world, will all change and grow.

From a human standpoint one of the biggest changes we'll see will be in the way we use and interact with our devices. We'll increasingly move from yesterdays keyboard and mouse, and today's touchscreens and taptics, to new body language, gesture and conversational voice interfaces, and eventually thought.

However, that said though, as we transition from one way of interacting with our devices to another, more natural way of interacting with them, which is sometimes reffered to as "Behavioural computing," our devices interfaces are going to have to be more adaptable, flexible and intelligent than ever before.

For example, in the future it's still likely people will be averse to talking to devices in public, so, just as we see in the real world today people might want to whisper, or even silently



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mouth commands instead, after all, Artificial Intelligence is increasingly proficient at lip reading and new Bone Conduction technologies, strangely, are already making it possible for people to make and recieve calls with just their fingers, very much in the same way you pretended to have telephone conversations with your hand when you were a child. Alternatively though some people might be more comfortable reverting back, at times, to gestures and touchscreens.

As a result, even though the way we will use and interface with technology will inevitably change it's going to be vitally important that the devices of the future are adaptable, flexible and predictive.

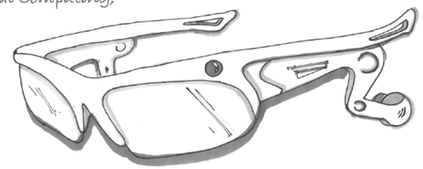
Not to be left out though the way devices connect to the networks, and to each other, will also change with the emergence of new "Just get it there" communications protocols.

Unlike today tomorrow our devices will be able to use and flick seamlessly between different licensed and unlicensed spectrums, ranging from 3G, 4G, 5G and 6G to ANT, LTE, MulteFire, RF, Wi-Fi, ULF and VLF, in order to get their messages through. However, not only will this shift have profound consequences for today's carriers, it will also have a profound impact on the quality and the resiliency of our networks, especially as we enter into an age full of always on smart things.

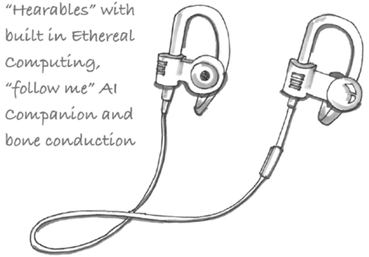
Another area that will experience a huge paradigm shift, and it's one that will happen quicker than we think, will be the emergence of devices that are increasingly "aware," not just of their surroundings, or their owners behaviour, but also of themselves. This will be accelerated by, and powered by the creation and dissemination of a deluge of new information, and new information sources, as well as the advent of increasingly advanced Artificial Intelligence agents that will be thousands of times better than they are today at analysing, contextualising and understanding it all.

Furthermore, as we increasingly approach the time when we see the emergence of Artificial General Intelligence (AGI), and then Artificial Super Intelligence (ASI), there's also a train of thought that suggests that one day Artificial Intelligence will become sentient, if not even concious, and when, and if that happens, then we'll likely have to rethink the relationship we have with our devices entirely.

Wireless AR sunglasses with built in Ethereal Computing, "follow me" AI Companion and bone conduction



Wireless, sensor packed "Hearables" with built in Ethereal Computing, "follow me" AI Companion and bone conduction



Wafer thin Smartphone with Metalense technology and detachable Soltero Computing hub with built in Ethereal Computing, "follow me" AI Companion, compute, communications, and Crystal Sound OLED display to accelerate the culutral shift to the next platform


Soltero Hub clipped into a Smart Watch with built in Ethereal Computing and "follow me" AI Companion



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## THE SOLTERO HUB CONCEPT

Today it could be argued that consumers have too many devices and that this, to some degree, is both inconvenient, expensive, and difficult to manage, and over time it's only going to get worse as we continue to see the emergence and development of everything from connected apparel to smart rings and "things," so I believe it's time to consolidate, not proliferate, but in an intelligent way that simplifies and enhances the customer experience while at the same helping prepare consumers to move to the next computing platform.

The concept, which I've called the "Soltero Hub" concept, where Soltero means "Single," has a number of parts to it.

Firstly, we need to develop a truly smart, conversational AI Companion, a Personal Assistant, that is omni-present and always at its owners side. Over time this is the technology, or service, that will become the users primary "ethereal" interface with the devices and digital world around them.

Secondly, in order to start a cultural shift we have to simplify everything, and go back to basics. My proposal is to collapse today's wearables back into the smartphone, one that's evolved in a traditional way, but one that's teamed with a singular, circular modular device that fits into the back of it, flush, and secures magnetically.

This unit, which intentionally resembles one of today's smart watches, in both form and function, is the "Soltero Hub," a powerful, miniaturised computing platform with an E-Ink display that contains the connectivity, compute, intelligence and sensor clusters, and it would be complimented by a small number of sleek "Appcessories," described below. It's this hub that, hopefully, when combined with the right execution, will help us de-materialise the smartphones screen, the very thing holding the next platform shift back, and, hopefully, help kick start the next cultural revolution.

Thirdly, I would recommend the creation of three types of appcessories. The first would be a wireless, sports style, over the ear headband, with bone conduction technology that can have its own integrated computing and sensing platform, the second would be a pair of fashionable, augmented reality sunglasses, also with bone conduction technology, that, depending on the technology available at the time, can produce high resolution images, and the

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third would be a sensory, magnetic smart watch band. Make no bones though, this, at this stage is not designed to be revolutionary, remember, it's baby steps.

While the concept might appear retro there is a methodology behind it, and it's been purposefully designed to try to tap into, and then drive cultural trends, with the ultimate objective of helping initiate the final switch from external human computing to "wearable" and then "internal" human computing.

When the two units, the smartphone, and the hub, are connected together they act as a single device that, from a consumers perspective, and to all intents and purposes, is no different from a traditional smartphone.

However, when the hub is detached it has a number of functions, over and above those performed by traditional wearable devices. Not only does it include all the features of a traditional smart watch, or device, as well as biochemical sensors and health and wellness trackers, but it's also where the intelligent AI Companion resides, giving the consumer access to a wide variety of conversational services, as well as tailored coaching advice, anywhere on the go. It also acts as an Ethereal Computing platform that allows the consumer pause and transfer different activities and services between compatible devices, such as clients, smartphones, tablets and even smart city services.

The fun really starts though when the consumer combines it with either the wireless headphones, or augmented reality glasses, because thanks to its in built communication, compute, intelligence and sensor clusters the hub can also act as a miniaturised smart phone, that can two way stream content and information back and forth between the wireless headphones and augmented reality glasses.

Furthermore, if we were to push the boat out further we could combine the module with a Pico Projector like system to let consumers, particularly younger consumers, use their skin as a controller interface to play games, which today make up over 75 percent of all app store downloads.

At the moment this platform is just a concept, but in an age where the problem is more about cultural adoption than technological capability it might provide an interesting way to kick start the next platform revolution.

**Other Form Factor Candidates**



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When it comes to the next form factor there are, of course, plenty of other candidates to choose from but they all suffer from the same problem - they all compliment the smartphone, rather than replace it, and in many cases, again, the biggest issue is the lack of a screen.

For example, if we have a look at the proliferation of today's Connected Home hubs and smart speakers, such as the Amazon Echo, Apple Home Pod and Google Home, which can all, to some degree disintermediate the smartphone as a basic communication, entertainment, information and shopping device, on the one hand they help familiarise consumers with tomorrow's new, behavioural interfaces, but on the other you can't watch a movie on them, play games, or read a book or a report, and as a result, until they are combined with new alternative displays and screenless technologies they'll always be limited.

Similarly when we have a look at today's smart watches they too let you access services, listen to music and make calls but again, forget trying to do anything that involves the use of a screen.

Flipping across to augmented reality glasses, now they suffer a different problem, they can, arguably do everything that a smartphone can and they have built in display technology but culturally people just aren't ready for the switch, and, of course, most of the designs are clunky and ugly which never helps.

This leads us to two conclusions - we either go down a road where we create new devices that are designed to fulfil specific roles, or we try to initiate a cultural shift, like the one I've mentioned previously, and move to the next platform, complete with its detached display, and I'll be discussing what the medium term and long term future of smartphones, and the devices that will replace them will look like in the following sections.

**SUMMARY**

Today the smartphone is a centralised computing and display device, but over time, as consumers come to terms with new display technologies and formats, the two will eventually decouple, and this will lead to the creation of a plethora of new devices and device formats that live external, near to, on and in consumers.

Also, as the number of smart things on the planet continues to accelerate and grow at an exponential rate the

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computing, network and storage that these devices rely on will become increasingly distributed to the point where one day they will simply be part of an ambient computing pool.

As for humanities love of fixed screens, however, over time that too will change especially as we edge forever closer towards a world where we can transmit and upload information directly into our brains. However, until that happens, as we transition from today's fixed, flat format displays society will inevitably have to learn to embrace the new formats that emerge, and while it will be a slow and arduous process in time adoption will accelerate and the new devices, and the new way of interacting with technology, become the norm.

The way we input information into our devices, and how they connect and gain awareness will also change. Our inter actions with the computing platforms that surround us will become more natural, fluid and frictionless, moving from keyboard, mouse and touchscreens to more natural modes that include body language, gesture control and voice before eventually moving to thought.

In a world flush with connectivity, even in the darkest reaches and the darkest depths of the planet, in time the platforms of tomorrow will use new "Just get it there" communications protocols to disintermediate and circumvent many of today's established carrier platforms.

Then, as everything in our world becomes increasingly connected and smart, the intelligence built into our devices will be able to analyse and sense  the world around us and become increasingly aware, using the information to automate tasks, make decisions and make our lives more effortless.



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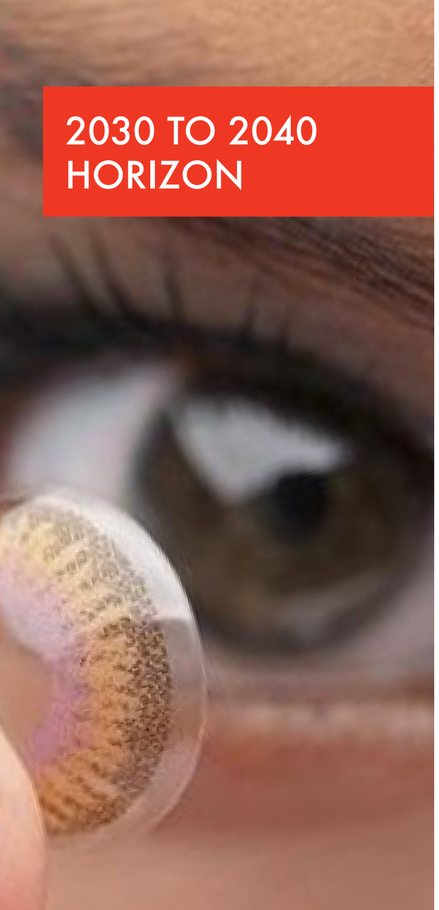

# 2030 TO 2040 HORIZON

AS MOST people will likely tell you trying to figure out what your starting point is, in other words where you are today, and what your eventual end point is, in other words, where you're trying to get to, is often quite a simple task. What's difficult though is trying to figure out what the journey, or the transition period between the two looks like, and today there are hundreds of examples I can use to demonstrate the point.

For example, how do we transition from an oil based energy culture to one run on renewables? Or how do we transition from cars we drive to cars that drive themselves, or from traditional manufacturing to on demand manufacturing? And many more examples asides. In all these cases we can easily visualise the start and end points, but envisioning the period between the two, the transition period, and then being able to successfully plan and execute it can quickly become complex and laden with risk. And so it's true with the smartphone era too, we know where we are today, and we know that one day we, humans, will be the technology platform, as I discuss in the next chapter, but what comes in between the middle of the two? That's what I look into in this chapter.

As discussed in the previous chapter once we have managed to successfully decouple the smartphone's display from the remainder of today's smartphone components, and when I say successfully I'm referring of course to both the technical and cultural transition, envisioning what comes next actually becomes a much easier task, and in one respect we can now also start to start letting our imagination run riot.

As a result there are a multitude of paths we can explore, so let's take a trip down a couple of them and take a look at the different technologies and formats we can create to design what I'm going to call from here on in the "Odyssey" platform, and if you're wondering why I call it the Odyssey platform then it's because, like the Odyssey of ancient Greek times, we're about to go on a journey of great discovery.

## DE-CONSTRUCTED DISPLAYS

Let's start with the display, since so far that's proved itself to be the trickiest component to resolve. Now that it's been successfully detached from the remainder of the smartphone device the world, as they say, is our oyster and we have a myriad of alternatives emerging that are increasingly credible alternatives to today's fixed screen display systems. Of course, first off we have the much lauded augmented reality "Smart Glasses" technology that I, and just about every other technology company in this space have been touting as an alternative display system, but hey, in this time frame they're old hat and if you don't like wearing glasses or sunglasses, which unless you're in sunny climes, or wear eye glasses naturally, which many of us don't, then their use is still going to be rather limited. So let's put this one to rest and move on.

Whatever new display system we envision there are a few things we'll have to pay special attention to if they ever stand a chance of going mainstream. These include, among many other things, their availability, cost and usability, as well as their ability to be manufactured at scale, field of view, resource requirements, and, of course, the presence of competitive, viable alternatives.

### Displays In Us

For my part the most sensible form of new display to adopt during this tricky transition period would be Smart Contact Lenses that are, to all intents and purposes, and so to speak, integrated with us. So let's take a metaphorical closer look at them.

Touted as futuristic tech, alongside Smart Glasses, for the past few decades so far development in this area has been relatively slow and awkward. While, for example, we've seen the development of Smart Contact Lenses that can be used to detect and monitor an individual's blood sugar levels, as far as being able to be used as a viable display medium they've fallen short on all sorts of fronts, from the lack of a convenient power source and the lack of small enough integrated communications and display technologies, all the way through to worries that any display that's so close to the human eye could, on the one hand cook it, and on the other be so close that noone could focus on what's being displayed on it well enough for it to be useful. All these are, of course, valid points, but they're also issues that, like many others of our time, will inevitably be overcome.

One of the biggest hurdles to creating the science fiction smart contact lenses of the future was the lack of an appropriate power source, but thanks to advances in Piezoelectric energy systems, as well as our slimy distant cousins the Electric Eel researchers have now managed to potentially solve that issue by creating

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the world's first Bio-batteries, aqueous batteries that not only generate significant, but manageable amounts of power, in relation to its size, but that are also, conveniently, made from the same materials as today's contact lenses.

Meanwhile as the size of components keeps shrinking, in some cases to the nanoscale, whether it's the antenna, that are needed to keep these devices connected, the rectifiers needed to efficiently convert the energy or the Electro-illumination, LED and Quantum Dot display systems and the semiconductor substrates they need to rest on in order to function, I don't think we'll have long to wait before we see the first viable concepts emerge.

**Displays On Us**

If, for whatever reason, displays that are in us, or integrated with us, prove too much of an issue for people then the next best option will be to adopt and develop displays that are on us, whether those displays are, for example, integrated with our clothing, or whether they're physically affixed to us, and here we have several more options.

The first option that would only require a small amount of re-work would be the use of flexible E-Ink displays which several companies have already demonstrated can be easily integrated into any style of clothing, for example, into board shorts, jackets, shirts and T-shirts, trousers, and even shoes. In the future, as the technology continues to progress these types of displays, which, again, will likely be powered using Piezoelectric and Triboelectric energy, and combined with nanoscale components, could be used to create a whole array of new display types and form factors that can be turned on and off, and controlled either at will, or automatically.

One of the problems with this approach though could be, ironically, the technology's portability. After all, unless you can remove the display from your clothing, akin to a velcro strip, and re-attach it to another compatible item of clothing, then users will likely quickly abandon the idea. However, a fix to this might come in the form of new universal "wearable technology" standards that ensure compatibility and clever design.

Now let's move onto other alternatives, such as being able to affix the displays physically onto our skin, as well as elsewhere such as, again, clothing. After all, we take skin with us everywhere we go, and we never take it off so it could end up being a natural alternative to



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today's clunky smartphone screens. Today there are a number of promising emerging technologies, all of which are flexible, low cost and low power, and that over time will all be able to support high definition displays that match and eventually beat the vivid colours we see, for example, on today's modern TV screens.

Recently I've seen huge strides in the development of flexible, 3D printable Electro-illumination, LED and Quantum Dot displays that range in thickness from a couple of millimetres to just a few atoms, all of which, with the right semiconductor substrate, can be easily affixed anywhere on a persons skin, and, perhaps most importantly, easily and painlessly removed at will like a modern day plaster.

While today these types of displays are slowly finding their way into healthcare applications, for example, for continuous real time biomedical monitoring, generally in the form of Smart Tattoos, they could be easily re-worked and integrated with nanoscale components to create ultra low cost, high definition displays that can be controlled in a variety of ways, whether that's gesture, touch or voice control, or autonomously via a personal AI Assistant like the ones I described in the previous chapter.

My main concern, as with any of these new display technologies though are less to do with the technology itself but more about their adoptability and usability.

This however is where skin based displays may have the upper hand on some of the other display alternatives that we'll in our arsenal if for no other reason that today people are already comfortable with the concept of plasters, albeit for an entirely different application. Additionally if these new displays can serve a dual function, for example, acting as both a display and a biomedical monitoring device that can record and report an individuals health in real time, then the cultural resistance to adopting this new format could be even lower still.

Having said that though the cultural resistance to adopting them could still likely be higher than today's smartphone displays, but I have a feeling that's something that could be addressed by marketing them to the "right" demographic, such as younger people and even perhaps, if you take into account the dual role of the technology, the elderly.

**Displays Near Us**

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So I've discussed displays that are in us and on us, so now let's have a look at the different display formats that could be near us, and the different forms they could take.

The two most obvious alter display systems that manufacturers could consider would be either flexible and rollable displays, Pico Projectors, or a variation thereof.

Long muted as suitors in waiting both these display systems have suffered numerous false starts and so far neither have lived up to the hype, especially pico projectors, which despite having the advantage of being small enough to pack into many of today's and tomorrow's devices, such as smartphones and wearables, and being able to project a display onto almost any surface, from our skin to the nearest coffee bar or wall, have failed, culturally at least, to take off, and despite recent advances without significant re-designs and improvements I don't see them ever reaching their full potential.

As for flexible and rollable displays again, while the technology has advanced significantly in recent years, both in terms of quality and reliability, there's still a big question mark hanging over their final form factor and their subsequent usability. For example, being able to fold them or unfurl them is all well and good, but again, their eventual success will rely on users willingness to embrace the new form factors and unless this is addressed in a satisfactory manner their adoption will stall. That said though I do see flexible displays as being the next natural evolution of today's smartphones especially as they'll be able to be shaped and moulded to suit a variety of formats, which would let them be placed anywhere and on any thing. And as for adoption, despite any concerns, as users become more accustomed to using them they could very well end up helping break down some of today's cultural barriers and accelerating the adoption of some of the other form factors I've discussed in this chapter.

Another display technology that we'll start having access to in this horizon is holograms, but even though I saw the world's first live demonstration of the first free form 3D living hologram back in 2017 it's still likely that this technology is either going to be too expensive to manufacture and deploy at scale, or that it will lack the maturity needed to see it taken as a serious contender. That said though all these barriers will erode over time, just not quickly enough for this



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horizon.

Moving on, one of the most interesting future concepts, but also one that would be heavily reliant on already being deployed at scale into the world around us, would be the development of what I'll call a Smart Surface platform, and no it's not a hat tip to Microsoft's Surface tablet, one where the objects around us, from billboards to walls, windows to tabletops, become the display.

When combined with the inherent "Follow me" capabilities that in some cases are already starting to be embedded into our devices, and then augmented by my Ethereal computing platform described in the previous chapter, smart surfaces, which could be created using any of the technologies I've discussed in this report, would allow users to instant "anywhere" access to personalised display services wherever they are, whether they're at home, at the mall, at the office, or just walking down the street, as well as millions of other locations.

## NOW FOR THE REST

Now that I've discussed the different display systems available to us in the future it's time to move on and evolve the rest of the present day smartphone stack, namely, to name a few, the batteries, brains, communications, sensing, speakers and storage components, all of which, frankly, are simple to envision, especially given the fact that over time all these technologies will not only be significantly miniaturised, in many cases to the nanoscale, but they will also be more powerful and energy efficient to boot.

Having finally decoupled the display from the rest of the smartphone we're now almost free to do what we want with the remainder of what was once the smartphone platform, and move to the post smartphone era, where the device is now no longer "one thing" in "one form factor" but many potential things in many potential form factors.

These new form factors include the ability to embed the above nanoscale components, whether it's singly or in combination, into almost any object conceivable, from belt buckles, buttons and jewellery to fingernail polish and even make up and mascara.

However, while the number of different form factors we can embrace will increase exponentially from here on in, there will also be new opportunities to radically reinvent the technologies

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that form the foundation of all these individual components. For example, and just for starters, electronic circuits will one day be replaced by biological, chemical and photonic circuitry, and tomorrow's quantum sensors will abandon today's nanoelectro-mechanical designs and embrace the power of quantum mechanics. All of this, of course, means that technologically all of these new components will be as far removed from today's variants as bacteria are from humans, and as a result organisations would be wise to think differently, and realise that tomorrow's technologies won't just be slightly different, but magnitudes different.

**Energy Sources**

Batteries, which when we look at the problem they were originally designed to solve, namely providing different devices with the energy they need to operate, have long been at the top of smartphone users gripe lists, and while battery technology has improved significantly over the years the unfortunate truth is that the devices that they support, thanks to advances in other component and display technologies, have become increasingly power hungry. As a result battery life, that bane of every smartphone users existence hasn't changed much.

In this horizon though advances in a myriad of energy fields provide us with some exciting new energy alternatives to today's traditional LiON stored energy batteries. That said though how successful these alternatives will be will be down to the energy punch they can pack in and deliver, how easy they are to integrate with the other components, and how well the whole device is optimised.

Arguably one of the best things we could do would be to do away with the battery all together, and fortunately we'll be able to using, for example, wireless charging and so called battery-less technologies which allow the devices to draw and harvest their energy from new, sources.

Some of these alternative technologies include backscatter energy systems that harvest electricity directly from the radio frequencies in the air, piezoelectric generators that harvest electricity from mechanical stress, thermoelectric resonators that generate electricity from the temperature variations in the air, and triboelectric energy systems that produce electricity from the friction of movement. And those are all for starters.

Bearing in mind all these can also



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be combined with more traditional battery technologies, such as good old Lithium Ion, or even 3D printed thin film batteries, graphene hybrids, photovoltaics, polymers or even new classes of superconductor composites, all this means that in the future there will be no shortage of energy solutions to our future energy problems.

**The Brains of the Operation**

Just like today's devices tomorrow's devices will be heavily reliant on their ability to process information, their so called brains, but unlike today where most of that analysis is tactical and reactionary tomorrow it will be intelligent and proactive as more AI workloads are processed at the edge, whether that's in the device, or the within the sensors and sensor networks themselves.

As the way we design, develop and manufacture processors continues to evolve it is clear we are nearing a junction point where future processors won't be confined to a narrow range of architectures or technology types, as they are today, but will be able to draw on billions of different designs and variations that allow them to be highly customised and optimised for the workloads of the future.

During this horizon I envisage that, on the one hand more manufacturers will become more vertically integrated and take responsibility for designing and fabricating more of their own chips, but it's also likely that we'll see the progressive rise of the Chinese semiconductor industry which itself will help fuel a new global innovation arms race which, in turn, will help dramatically accelerate the overall rate of semiconductor innovation.

Over time though, as mentioned previously, today's conventional electronics circuitry will give way to new biological, chemical and photonic inspired ones, and we're already seeing examples of these emerge. Examples such as next generation Biological computing platforms, which are increasingly being referred to as Living computers, as well as DNA, Liquid, and Neuromorphic computing platforms. However, while all of these platforms architectures are radically different from today's the differences don't stop there.

DNA and living computers are already showing us that they have the potential to pack all of the computing power of all the computers in the world today into a package no larger than a grain of rice, and, meanwhile, the first generation of

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neuromorphic computers, which will be self-learning and revolutionise AI, will be able to pack the power of today's largest supercomputers into a package the size of than a human fingernail.

As processors though, whatever their form or architecture, continue to get smaller and more powerful, they'll also become dramatically more energy efficient, and the combination of all of these new developments will allow us to create new computing and device form factors that were previously unimaginable.

In the near term though, during our transition from silicon to new exotic forms of computing tomorrow's chips will be imbued with hardware level encryption capabilities, and be designed differently from today's, increasingly adopting new 2.5D, Multi Module Chip and System in a Package (SIP) designs, that allow them to be customised in an almost infinite number of ways. And transistor sizes will be much smaller too, comfortably approaching 0.5nm and even the atomic scale, meaning we can pack tens and hundreds of billions of transistors into a even more miniscule package. But just as we start getting used to the idea of a resurgent Moore's Law it's also likely that transistors themselves will be revolutionised, whether it's using new nanotechnologies such as nanotubes, or liquid transistors, and eventually replaced, by the new biological, DNA and neurmorphic "artificial synapse" technologies I discussed earlier.

Some computing platforms though will be noticeably absent from the future lineup, for example, tomorrow's powerful Quantum computer chips likely won't be mature enough, or have the right price points to be integrated into tomorrow's smart devices, and even then they'll have to have overcome a significant hurdle, namely the fact that in order for them to be accurate enough they need to be kept at near Absolute Zero temperatures.

Throughout all of this though, one thing is certain, tomorrow's computing devices will be as powerful as they are alien and bizarre.

**Bring the Crowd**

As for the remainder of the pieces of our smartphone jigsaw puzzle they'll also have evolved significantly by the time we reach this horizon.

Communications technologies will have adopted 5G long ago and will now be looking to embrace 6G, a ultra fast communications technology based



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on quantum mechanics, and it's also likely that we'll have seen interesting growth of new decentralised blockchain communications networks that could eliminate our reliance on traditional carrier networks.

Furthermore tomorrow's receivers and antenna will be nanoscale in size which will make them easy to invisibly integrate them into anything and everything you could desire, from dermal display systems and smart contact lenses, to everyday objects and everything in between.

As mentioned previously, sensors will also have embraced the weirdness of quantum mechanics, creating a vast new range of quantum sensors that are millions of times more sensitive than today's which will open up a vast range of new applications, whether it's the ability to do away with traditional GPS technologies, or by helping create new ultra sensitive sensing systems that can help us gain ever deeper insights into the quantified self.

Audio systems too will have evolved and speakers that can focus sound only to the place where its needed will be commonplace, letting multiple users, for example, simultaneously stream and listen to different things all at the same time while being in the same space,

and as for information storage, well, arguably, given our improved levels of connectivity it should all be stored in the cloud, but what if it wasn't?

Well while exotic atomic scale and DNA based storage systems would still likely be some way from being mature enough, or commercially viable enough for use in this horizon, that means that for now atleast we'll still likely be stuck with more advanced and storage dense versions of today's flash storage platforms.

**PUTTING IT ALL TOGETHER**

Once society is comfortable with the concept of de-coupling the display from today's traditional smartphone format there is no doubt that we will see the emergence of a new innovation arms race as manufacturers around the globe race to ideate new concepts and new formats for consumers to embrace. As a result, the future is wide open, and the creative opportunities have never been greater.

**SUMMARY**

It goes without saying that while all of these new technologies, when combined together in new ways, will fundamentally

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change our relationship with technology, but the most revolutionary aspect of all of this will be the capabilities we can build on top of these new form factors and computing platforms, and the new use cases they'll open up which will be unlimited.



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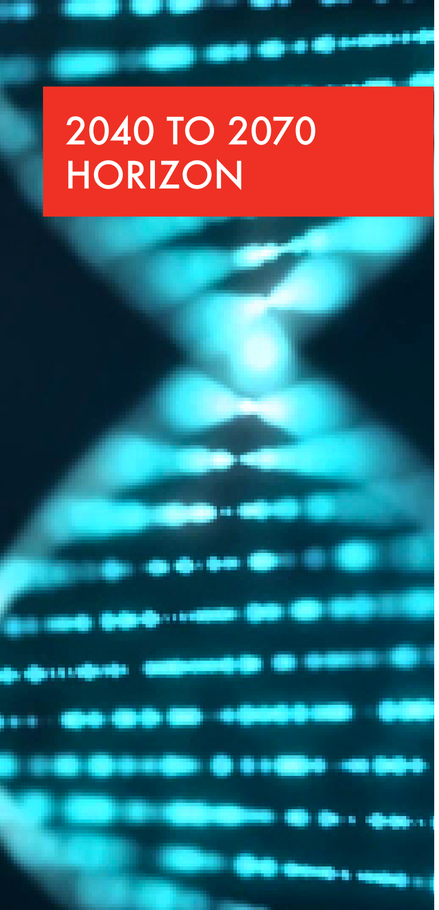

# 2040 TO 2070 HORIZON

AS WE extend our horizon out to 2040 and beyond, to 2070, things start to become increasingly interesting, as well as increasingly alien and bizarre.

During the early 2040's it's highly likely that the "smartphone" formats we saw emerge in the previous chapter, if we can still call them smartphones after the metamorphosis they'll be able to go through, which I'd argue we can't and shouldn't, will still be heavily influencing the designs and formats are the start of this horizon.

That said though, as we start to accelerate through the 2040's and into 2050 and beyond, the pace of technological transformation will be unlike anything we've ever seen before. Also, lest we forget, this era is when we finally expect to realise the Singularity, where Man and Machine merge, and witness the emergence of Artificial Super Intelligence (ASI), both of which will be revolutionary, and bring about a new technological epoch.

## HUMANS BECOME THE PLATFORM

The next platform I'm going to discuss is one that I'm going to call "Synth," which is short for Synthetic, and you'll see why shortly.

During this horizon the individual technological components, and the devices and systems they'll be able to give rise to, will alter radically, in architecture, form and size.

Nanoscale components which will increasingly become the norm will start to be challenged by even smaller components that are atomic or quantum in scale, and during this horizon it is likely that we will start to see a much faster shift away from traditional electronic based systems to new biological, chemical and photonic alternatives.

Similarly the world of Synthetic Biology will now be much more of a driving force in technology development than it was back in the 2020's, and it's this latest advance, more than any other, as organisations find new ways to merge man and machine, that could usher in the much lauded next stage of human evolution. The result of which, of course, will mean that eventually humanity will become the technology platform of the future.

In the interim period though, between the previous horizon and this final outcome, final in terms of this report that is, people will be able to augment and enhance themselves with different technologies that will provide them with a wealth of new abilities and attributes.

Imagine, for example, being able to ingest an off the shelf, or prescribed, smart pill that contains doses of different nanomachines, whether those nanomachines are purely inorganic, or even perhaps bio-hybrid machines that combine the best of inorganic and organic elements together.

Some nanomachines attach to your optic nerves to provide a real time Brain to Machine visual interface capable of transmitting content, that originates from outside your body or directly via a network of connected hive minds, directly into your brain's visual cortex, while others latch onto other junctions in your brain to, on the one hand augment your intelligence and provide you with a direct neural network communications interface that gives you the ability to communicate telepathically with other people on the hive network. In this vision the smartphone has now become so small, and so advanced, that its individual components are now mechanically integrated with you.

Moving further down into the rabbit hole and pushing the horizon out more, beyond 2050, over time there will nothing, other than the ethical and moral arguments of course, from stopping us replacing these tiny artificial nanomachines with more "natural," albeit synthetic, biological machinery. Thanks to synthetic biology and the continued development of powerful in vivo gene editing tools in this horizon we'll be able to splice new synthetic or semi-synthetic DNA sequences into our genomes to give ourselves new abilities and attributes on demand.

Attributes that help us turn our own bodies into the next generation of advanced living communications, computing, sensing and storage platforms, where each cell within our bodies has more processing power than all of today's computers combined, can act as a living communications beacon capable of receiving and transmitting the entire electromagnetic spectrum, and where just a single cell's worth of DNA can hold Zetabytes of data. And I'm not just talking about our ability to genetically engineer four base DNA solutions, thanks to the breakthrough in 2017 we'll be able to genetically engineer new DNA strands that have six base pairs, the potential of which is, well, it almost goes without saying, Earth shattering. And much more.

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And as for that much more bit, well that's something for another report, after all I'm just talking about the future of smartphones here, but not one to leave you hanging I'll give you a clue anyway. In this horizon forget everything you think you know about healthcare because what's coming will make today's most advanced procedures look like blunt instruments of mass destruction, and that's just one of the billions of possibilities open to us.



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# CONCLUSION

TODAY IT'S tempting to think that the pace of technological development is rather sedentary, but don't be fooled. When you look under the hood, to understand and assess the hundreds of emerging technologies that are either already here, or coming down the line, and then start to envision the myriad of ways they can all be combined together to create tomorrow's awe inspiring products and services, all of a sudden you'll realise that technology is racing ahead much faster than you expect, or anticipate.

The result of all this, of course, is that manufacturers who are unprepared for the future, and particularly the speed with which it will arrive could quite easily, and suddenly, find themselves being outflanked and outpaced by a competitor, or even a new market entrant in what seems like a blink of the eye.

The future belongs to the brave and the bold, not the meek and the mild, and I hope you've enjoyed reading this report as much as I've enjoyed writing it.

All the best in your endeavours, and if you ever need a helping mind then feel free to reach out to me,

Sincerely,

Matthew Griffin.




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