2021 State of the VITA Technology Industry

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by: Ray Alderman, Chairman of the Board, VITA

This report provides the reader with updates on the state of the VITA Technology industry in particular and of the board and system industry in general, from the perspective of Ray Alderman, the Chairman of the Board of VITA. VITA is the trade association dedicated to fostering American National Standards Institute (ANSI) accredited, open system architectures in critical embedded system applications. The complete series of reports can be found at Market Reports. (www.VITA.com/MarketReports)

Introduction

We live in interesting times. We are moving from a petroleum-powered world to an electricity-powered world. We are moving from a labor-powered manufacturing model to a robotic-powered manufacturing model. We are moving from human-powered decision making to artificial intelligence-powered decision making. We are moving from broadcast-powered news and entertainment (push) to streaming-powered news and entertainment (pull). We are moving from classroom-powered learning to online-powered learning. We are moving from mall-powered shopping to online-powered shopping. Most of these changes are being driven by technology, but COVID-19 is the new catalyst accelerating these changes.

At the same time, we are experiencing a massive collision between economics, politics, data, technology, federal laws, and state's rights as a new administration comes into office. So, let us look at whose ox will be gored in the coming months and why!

Economic Conditions

Let us start-off with the macro-view. U.S. GDP grew 4.1% in Q4 while falling 3.6% for all of 2020. Forecasts range for 5% to 10% growth in the next two quarters in 2021, driven by pent-up demand from consumers and lower health risks from high vaccination rates.[1]

However, a recent Bank of America study shows that U.S. consumers have been putting their stimulus money and extra income into savings or paying

1 Ben Winck, "*US GDP will return to pre-pandemic highs by the end of March, Morgan Stanley says*", Business Insider, March 9, 2021, https://www.businessinsider.com/economic-outlook-us-gdp-growth-inflation-unemployment-forecasts-morgan-stanley-2021-3

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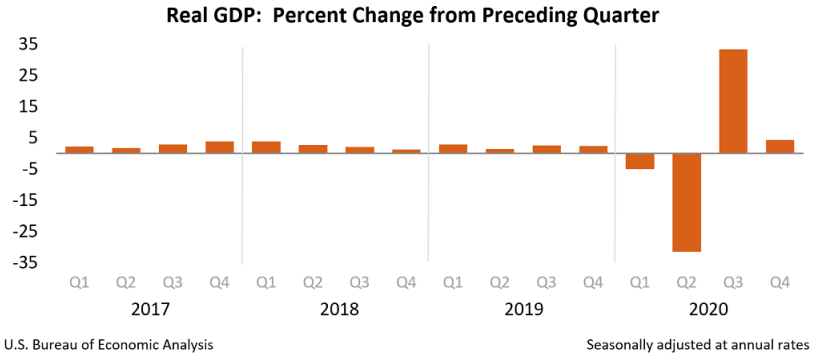
down debt. And, they have been putting some extra money into the stock market. They are not buying cars or eating in restaurants or buying new appliances.[2] That observation dampens the enthusiasm for the higher-end GDP growth forecasts considerably. The sanest economic forecasts are in the 4% to 6% growth range for U.S. GDP in the first two quarters of 2021.



Europe's GDP declined 6.9% in 2020 and is expected decline again in 1Q 2021 due to continued lockdowns, new Covid variant infections, and slow vaccination rates. UK GDP declined by 9.9%, France declined by 8.3%, Spain fell 11%, and Germany declined by 5% last year.[3] The EU entered the pandemic from a weak economic position.

China's GDP grew 2.3%, if you believe the numbers. Japan's GDP declined 4.8% in 2020. U.S. GDP is poised to recover more quickly in 2021 while Europe and Japan's growth rates will suffer from the drag of their industrial-age manufacturing base (automobiles, aircraft, trains, machinery, etc.) and their economic policies.

In my previous report, I introduced the 5-phase model of the Covid virus effects on the world, so let us use that again to see if the model was somewhat predictive and whose ox is about to be gored:

1. Medical Crisis

Since December 2020, we have seen three Covid vaccines approved in the U.S. (Pfizer, Moderna, Johnson & Johnson), and the AstraZeneca vaccine is in the wings. Some European countries suspended the use of the AstraZeneca vaccine for reactions and complications after injection but re-approved it a few weeks later. The EU got into a big flap about vaccine deliveries from factories in Belgium: vaccines made on the continent were being shipped to the UK to vaccinate their people before the people in the EU got it.[4] Since the UK left the EU, those companies could send the vaccines back to the UK, instead of the EU countries who were trying to extract economic revenge for Brexit. UK vaccination rates are significantly higher than vaccination rates in mainland EU countries.

While the EU-UK vaccine flap has now been resolved to some degree, the mainland Europeans are warming-up to the Russian Covid vaccine (called Sputnik-V) to fill the gap. Looks like Italy is about to make and deliver the Russian vaccine to their people.[5] I will pass on the Russian vaccine if it becomes available in the U.S.

Additionally, the Covid virus is mutating. We now have UK variants, South African variants, Indian variants, and Brazilian variants which are more contagious.[6] Preliminary tests say that the present vaccines are effective against them, but we really do not know for sure (small statistical samples). Covid is changing almost as fast as the Italian Government.

And it looks like immunity from Covid after vaccination only lasts for 6 to 18 months, depending on what you read. We do not know for sure about that either. So, it is starting to look like we will all get a Covid booster shot when we get

2 Anthony Russo, "*Bank of America Says Consumers Won't Spend Stimulus Checks*", Capital Watch, March 10, 2021, https://www.capitalwatch.com/details/news/529678372750626816.html

3 "*U.K.'s Covid-hit economy slumps by record 10 percent in 2020, worst in 300 years*", NBC News/Reuters, February 12, 2021, https://www.nbcnews.com/news/world/u-k-economy-slumps-record-10-percent-2020-after-covid-n1257600

4 Francesco Guarascio, John Chalmers, "*Countdown to 'catastrophe:' Inside Europe's fight for COVID shots*", Reuters, February 5, 2021, https://www.reuters.com/article/us-health-coronavirus-vaccines-europe-in/countdown-to-catastrophe-inside-europes-fight-for-covid-shots-idUSKBN2A50I1

5 Philip Oltermann, Angela Giuffrida, "*Russia's Sputnik V Covid vaccine gaining acceptance in Europe*", The Guardian, March 10, 2021, https://www.theguardian.com/world/2021/mar/10/russias-sputnik-v-covid-vaccine-gaining-acceptance-in-europe

6 Brian Wang, "*2021 Will See a Battle Between New Vaccines and New Virus Variants*", Next Big Future, March 16, 2021, https://www.nextbigfuture.com/2021/03/2021-will-see-a-battle-between-new-vaccines-and-new-virus-variants.html

our flu shots this fall, regardless of which vaccine you got earlier.[7] If you want to explore this further, I recommend that you read this article.[8] Good Luck, especially to those who got the Russian vaccine.

2. Economic Crisis

This is macro-economic, and we have already covered GDP declines by country. Unemployment fits into this category so let us explore that area. There are about 10 million people in the U.S. collecting unemployment benefits, 6.1 million who are underemployed (working jobs below their skill levels), and another 6.9 million who have left the labor force.[9] Leaders in the new administration say we can put them all back to work immediately, in new high-paying jobs making solar panels and writing computer software. The unemployment rate in the U.S. peaked at 14.7% in early 2020. The latest stats say that we are now at 6.2% unemployment.

In the EU, unemployment peaked at 7.6% in 2020, but is forecast to rise to 11.2% in 2021 for the reasons stated earlier.[10] Europe is about 6 months behind the U.S. and other countries in some economic effects of the Covid pandemic. They took a worse GDP beating in 2020 than the U.S., and now they are about to take a delayed unemployment beating. The European Commission expects the Euro-zone to go into a deep recession this year.

But EU leadership has an answer to this predicament: put all unemployed people back to work making semiconductors.[11] They want 20% of the world's advanced semiconductors to be built in Europe by the end of this decade. That is going to set-off a firestorm of complaints from smaller EU countries that do not get the government money to build the fabs in their country. Presently, about 10% of the world's semiconductor production facilities are in Europe.[12] As a sidenote, India just announced that they would give $1 billion to any companies who build new semiconductor fabs in their country.[13]

3. Financial Crisis

This is micro-economic and more localized. In New York, about 200 hotels (out of 700) have closed and 7 of them have filed for bankruptcy.[14] About 40% of the hotels are delinquent on their mortgage payments.

But the leadership in New York have a solution: turn those empty hotels into casinos and make New York City an East Coast version of Las Vegas.[15] Three casino licenses in NYC are up for grabs, and unemployed hotel workers can get high-paying jobs dealing cards, running roulette wheels, and hustling drinks and food. Didn't Atlantic City (NJ) try that some years ago?

Another prediction in this segment was that many companies, states, counties, and cities would issue a blizzard of bonds to stay solvent. So far, we have seen over $1 trillion in new bond issues from corporations since the pandemic

7 Guy Faulconbridge, "*Regular booster vaccines are the future in battle with COVID-19 virus, top genome expert says*", Reuters, March 15, 2021, https://www.reuters.com/article/us-health-coronavirus-britain-peacock-ex/exclusive-regular-booster-vaccines-are-the-future-in-battle-with-covid-19-virus-top-genome-expert-says-idUSKBN2B70V2

8 Hilda Bastian, "*The Differences Between the Vaccines Matter*" The Atlantic, March 7, 2021, https://www.theatlantic.com/health/archive/2021/03/pfizer-moderna-and-johnson-johnson-vaccines-compared/618226/

9 John Binder, "*No Labor Shortage: 17M Americans Remain Unemployed, All Want Jobs*", Breitbart, March 9, 2021 https://www.breitbart.com/politics/2021/03/09/no-labor-shortage-17m-americans-remain-unemployed-all-want-jobs/

10 Marine Strauss, "*McKinsey predicts near doubling of unemployment in Europe*" Reuters, April 19, 2020, https://www.reuters.com/article/us-health-coronavirus-eu-jobs/mckinsey-predicts-near-doubling-of-unemployment-in-europe-idUSKBN2210UZ

11 Douglas Busvine, Mathieu Rosemain, "A*nalysis: Money no object as governments race to build chip arsenals*", Yahoo! Finance/ Reuters, March 26, 2021, https://www.yahoo.com/finance/news/analysis-money-no-object-governments-101405976.html

12 Joel Hruska, "E*U Wants 20 Percent of Semiconductor Manufacturing by 2030*", Extreme Tech, March 5, 2021, https://www.extremetech.com/computing/320563-eu-wants-20-percent-of-semiconductor-manufacturing-by-2030

13 Sankalp Phartiyal, Aditi Shah, "*A billion for every chip-maker who 'makes in India,' sources say*", Reuters, March 31, 2021, https://www.reuters.com/article/us-india-semiconductor-exclusive/exclusive-a-billion-for-every-chip-maker-who-makes-in-india-sources-say-idUSKBN2BN12J

14 Mary K. Jacob, "*NYC faces crisis of empty hotels amid COVID pandemic*", New York Post, March 9, 2021, https://nypost.com/2021/03/09/nyc-faces-crisis-of-empty-hotels-amid-covid-19-pandemic/

15 Josh Kosman , Carl Campanile, "*Vegas casinos could be coming to NYC*", Fox Business/New York Post, March 10, 2021, https://www.foxbusiness.com/lifestyle/vegas-casinos-could-be-coming-to-nyc

began. Those companies are Apple, Boeing, Oracle, Verizon, and ATT.[16] States and municipal governments are still getting money from the federal stimulus bills, so they do not need to borrow just yet. California and New York are considering wealth taxes on their well-to-do citizens. New York is considering a financial transaction tax on all securities transactions in the state to raise money. The Feds are considering a mileage tax on vehicles to fund infrastructure initiatives.[17]

Work-from-home is killing mass transit systems in major cities during Covid (very few riders). People are moving out of crowded cities and into the suburbs, leaving empty office buildings and apartments behind as they work from home. Air travel is starting to recover, but the travel industry suffered a 42% decline in revenues in 2020.[18] Even after Covid is under control, these segments will experience a slow return to previous levels.

A federal tax hike bill will be coming to Congress soon, to pay for infrastructure and the Covid stimulus benefits. Raising the corporate tax rate, raising taxes on the wealthy, and raising the tax rate on capital gains are the top three targets.[19]

Additionally, European banks are preparing for an onslaught of loan defaults and bankruptcies as their economies tank in 2021.[20] All of Europe is desperately looking for new tax opportunities.

4. Political Crisis

We have a new president and a new administration in 2021. And both houses of Congress are now controlled by the Democrats. Looks like the governors of New York and California will be ousted because of their poor handling of the Covid health crisis and their personal behavior. Representatives, senators, state and local officials, and journalists are resigning or getting fired regularly, more than I can recount here, due to the changing political winds inspired by the Covid pandemic. We will see more of this in 2021 as this phase matures. Italy's government collapsed again (no big surprise there) over their handling of the Covid response. They have had 66 governments since 1945 (the previous one lasted 14 months). Myanmar's military (Burma) executed a coup and took over the government recently. The Covid crisis was a great time to do it

The XL pipeline was killed in the first weeks of the new administration, oil and gas leases were suspended on public lands and waters, and construction of the border wall was halted by executive orders in January. Thousands of jobs were lost as the new administration embraces climate change and new immigration policies. Lawsuits over the XL pipeline termination are being filed. Border facilities are rapidly filling-up with illegal crossers. Border state leaders are starting to file complaints with the new administration.

5. International Crisis

London is losing financial corporations to Amsterdam and Paris, cities that are vying to become the financial center of Europe after Brexit. The EU continues to fine and levy taxes on U.S.-based technology companies. Organization for Economic Cooperation and Development (OECD) has 140 countries (including the U.S. now) involved in defining a universal tax rate on internet-based tech companies. This is basically an agreed-upon tariff on all electronic services delivered across country borders.[21] Obviously, the U.S.-based tech companies will pay-out more than the U.S. takes-in from foreign internet-based companies.

16 David Canellis, "*World's top companies, including Apple, borrowed $1 trillion in just five months*", TNW, May 22, 2020, https://thenextweb.com/hardfork/2020/05/27/apple-disney-oracle-att-boeing-corporate-bonds-issued-one-trillion-dollars-five-months/

17 Thomas Franck, "*Vehicle mileage tax could be on the table in infrastructure talks, Buttigieg says*", CNBC, March 26, 2021, https://www.cnbc.com/2021/03/26/buttigieg-says-white-house-is-weighing-mileage-levy-to-fund-infrastructure.html

18 Alex Gangitano, "*Travel spending drops 42 percent in 2020, trade group says*", The Hill, March 17, 2021, https://thehill.com/business-a-lobbying/543659-travel-spending-drops-42-percent-in-2020-trade-group-says

19 "*Biden Plans First Major Federal Tax Hike Since 1993*", Newsmax, March 15, 2021, https://www.newsmax.com/politics/biden-tax-increase-major/2021/03/15/id/1013783/

20 John O'Donnell, "*Analysis: Europe braces for pandemic reality to hit banks*", Reuters, February 17, 2021, https://www.reuters.com/article/us-health-coronavirus-banks-analysis/analysis-europe-braces-for-pandemic-reality-to-hit-banks-idUSKBN2AH0GW

21 Andrea Shalal, Michael Nienaber, Leigh Thomas, "*U.S. drops 'safe harbor' demand, raising hopes for global tax deal*", Reuters, February 26, 2021, https://www.reuters.com/article/us-g20-usa-oecd/u-s-drops-safe-harbor-demand-raising-hopes-for-global-tax-deal-idUSKBN2AQ2E6

Many countries are complaining that the distribution of Covid vaccines favor the larger developed nations, creating some international tensions. Vaccine shipments are having an effect on pending trade agreements, especially between the UK and the EU. The UK is negotiating a trade agreement with the U.S. first, since any negotiations with the EU will be clouded by vaccine availability issues.[22]

6. Legal Crisis

There is a 6th phase developing that might be tangentially associated with Covid, since everyone was forced online during the lockdowns. We are seeing a wave of anti-trust litigation pile-up against Amazon, Apple, Facebook, and Google over their monopolistic behavior. Additionally, there are first amendment issues concerning Facebook and Twitter suspending certain accounts and removing certain content.[23]

Some segments of the U.S. economy will recover faster than others. Some segments will continue to decline as the phases mature. It looks like Europe will continue to decline across the board, according to the economists. While the illustrations used here are anecdotal, there are many other available examples to support the observations and conclusions. Vaccines will not stop the progression of the financial, economic, political, and international problems.

Technology

Let us explore the automotive industry, since that is a mix of economics, technology, and pending severe disruption. In 2020, the pandemic drove auto sales down 15% at a time when automakers were spending heavily on new electric vehicle (EV) designs.[24] Competition in the EV market will be fierce in the future. In addition to the traditional carmakers, there are hundreds of new companies making electric cars, pickups, and trucks. About 400 of them are in China's supply chain alone, making cars, trucks, components, and batteries.[25] BMW is already making electric motorcycles and ebikes as an extension to their line of cars.

At the same time, traditional contract electronic manufacturers (CEMs) like Foxconn are putting things in place to make EVs for any new start-up car company. They have designed a common EV chassis and drive train. All a new start-up company needs to do is select interior colors, fender styles, and paint colors. Foxconn will build the vehicle, put the new company's logo on it, and ship it.[26] A start-up electric car company does not need engineering, manufacturing, purchasing, or operations people to get into the business.

Amazon has partnered with Rivian to build their own custom EV delivery trucks. Apple has been working on an electric car since 2014 (Project Titan). ZTE and Huawei (both Chinese telecom companies) are getting into the electric vehicle business. ATT, Ikea, Amazon, and other companies have joined an alliance for electric vehicles.[27]

Volvo plans to eliminate all gas and diesel cars and trucks in their line-up by 2030 and sell only electric vehicles. And they plan to sell them online.[28] That raises another interesting disruption: Volvo dealers will just supply the delivery and maintenance for the vehicles. Most states have passed laws that automakers cannot sell directly to consumers but must go through franchised dealerships in each state. Automotive dealerships are in for some interesting changes

22 David Milliken, "*Irish foreign minister says UK guilty of 'perverse nationalism' over U.S. trade*", Reuters, March 13, 2021, https://www.reuters.com/article/us-britain-eu-ireland/irish-foreign-minister-says-uk-guilty-of-perverse-nationalism-over-u-s-trade-idUSKBN2B507C

23 Prasad Krishnamurthy, "*How Congress can prevent Big Tech from becoming the speech police*", The Hill, February 18, 2021, https://thehill.com/opinion/judiciary/539341-how-congress-can-prevent-big-tech-from-becoming-the-speech-police

24 Paul A. Eisenstein, "*For the auto industry, 2020 was a horrible year — but it ended better than expected*", NBC News, January 5, 2021, https://www.nbcnews.com/business/autos/auto-industry-2020-was-horrible-year-it-ended-better-expected-n1252892

25 Danny Vincent, "*The uncertain future for China's electric car makers*", BBC News, March 27, 2020 https://www.bbc.com/news/business-51711019

26 Ann Steffora Mutschler, "*Auto OEMs Face New Competitive Threats*", Semiconductor Engineering, March 4, 2021, https://semiengineering.com/automotive-oems-face-new-competitive-threats/

27 "*Amazon, AT&T, IKEA, others join electric vehicle alliance*", Smart Energy Decisions, January 23, 2020, https://www.smartenergydecisions.com/energy-management/2020/01/23/amazon-atandt-ikea-others-join-electric-vehicle-alliance

28 "*Volvo to Go Electric-Only and Shift Sales Online From 2030*", Newsmax Finance, March 2, 2021, https://www.newsmax.com/finance/streettalk/volvo-electric-vehicles-ev-online/2021/03/02/id/1012158/

in the near future. Other EV makers will follow suit, selling direct to consumers online and just using dealerships for support, delivery, and maintenance. Expect some big court cases as this new business model expands.

Internal combustion engine (ICE) vehicles contain about 2000 moving parts. Electric vehicles contain only about 20 moving parts in the drive train. There will be much lower needs for repairs, oil changes, antifreeze changes, and maintenance from dealerships and repair shops in the future. Dealerships make lots of money selling repair parts. With fewer parts in an EV to wear-out, a dealership's parts business will shrink dramatically. EV maker Rivian sees little need for dealerships or repair shops. They will diagnose your vehicle's problem remotely and send a repair van to fix it, wherever you are.[29]

EVs still have a long way to go. First, they have limited range, so they need to be charged regularly. That takes time. There's Level-1 (120V, slow-charging), Level-2 (220V, medium-time charging), and Level-3 (440V, fast charging), depending on the options purchased with the vehicle. Homes, apartment buildings, office buildings, and shopping centers will all need to install charging stations in the future. The cost to charge a vehicle with each of the charger levels is based on the time it takes, not the amount of electricity used. Fast charging costs more than slow charging (a convenience-based pricing model). A 20-minute fast charge might get you 50 extra miles of range, and you must find something productive to do while you wait.[30] The city of Petaluma, CA just passed a law banning the construction of any new gas stations, inspiring the installation of electric charging stations. That leaves 16 gas stations to serve 60,000 residents in Petaluma, if they can stay in business.[31]

Charging is annoying on a road trip. Is there a better way? Yes, a company called Ample will pull-out your drained batteries and install freshly charged batteries in your EV in 10 minutes and send you on your way.[32] They are doing this now in San Francisco for Uber drivers. This concept destroys any company's marketing efforts to differentiate their EVs by claiming longer battery life or better range. It may also destroy the warranty on your vehicle too.

How much does a battery swap cost? The article does not say, but you are going to pay a convenience premium again. It sure beats waiting around for your EV to charge-up in a parking lot somewhere. Look at this like buying propane for your barbecue grill from Blue Rhino at the grocery store. You buy a full tank and take it home. When it is empty, you bring back the tank, turn it in, and pick-up another full tank. You do not own the tank. If this battery-swap idea works, you do not need to own the batteries in your EV either. You just swap them out when you need more electricity.

Look at the previous information and count the number of oxen being gored by EVs and the new business models being introduced in the automotive market. While electric vehicles are cleaner than ICE-powered vehicles, many jobs will be lost, and many traditional businesses will go away. How fast all this happens depends on how quickly consumers replace their ICE vehicles, and how rapidly the EV makers can slide down the price-learning curve.

During the pandemic, many auto plants closed to reduce Covid infections among their employees. The carmakers called-up the computer chip factories and delayed shipments of their orders. Production started-up in mid-2020, but a shortage of semiconductor chips shuttered those factories yet again in early 2021. With everyone staying home and working from home, the demand for new cellphones, new TVs, computers, and game boxes soared. The semiconductor industry shifted their fabs over to make more complex and more profitable chips for those markets. When the carmakers called-up the chip companies and requested their parts, there was no production capacity left to make them. Besides that, chips in cars are low-technology microcontrollers and are less profitable for the semiconductor makers. The chips

29 J. Fingas, "*Rivian's EV service plans include remote diagnosis and on-site repairs*", Engadget, April 2, 2021, https://www.engadget.com/rivian-ev-service-plan-143206646.html

30 Nick Kurczewski, "*How Much Does It Cost to Charge an Electric Car?*", Kelley Blue Book, March 5, 2021, https://www.kbb.com/car-news/how-much-does-it-cost-to-charge-an-ev/

31 Tim Levin, "*A California city just voted to ban new gas stations as the state eyes an all-electric future*", Yahoo!News, March 2, 2021, https://www.yahoo.com/news/california-city-just-voted-ban-195834548.html

32 Lora Koloday, "*Ample is trying to make battery swapping for EVs a reality, starting with Uber drivers in the Bay Area*", CNBC, March 3, 2021, https://www.cnbc.com/2021/03/03/ample-opens-5-ev-battery-swapping-stations-for-bay-area-uber-drivers.html

going into consumer products are higher-level technologies and are much more profitable.[33] The automakers were pushed to the end of the production queue. That will cost the global auto industry about $60 billion in lost car and truck sales this year. It will take the chipmakers six months to catch-up on deliveries to automakers, if not longer.

While U.S.-based companies have 47% of the worldwide semiconductor market, only 12% of those devices are made in the U.S. The top two semiconductor makers are TSMC (Taiwan) and Samsung (South Korea). Taiwan is experiencing water shortages (lots of water used to make chips), and Samsung's factories in Seoul are within artillery range of North Korea's cannons.[34]

TSMC and Samsung are the only two semiconductor companies to push transistor geometries down to the 7nm level, and both are moving toward 5nm processes now. Intel has tried and failed to get past 10nm for years. All the advanced processor chips today are being made by TSMC and Samsung, presenting a potential supply chain problem for many segments of the U.S. economy if something goes wrong. TSMC has announced plans to build a new fab in Phoenix.[35] In late March, Intel announced two new fabs for the Phoenix area.[36] Phoenix is becoming a southwest version of "Silicon Valley", ironically, a water distressed region itself.

Samsung was planning to build a new fab in Austin, TX, but the winter storm that cut power to that region for days in February has inspired them to look at other locations like Phoenix.[37] Also in February, President Biden issued an executive order to study the semiconductor supply chain and will ask for $37 billion in funding for new semiconductor manufacturing facilities.[38] The TSMC fab planned for Phoenix will cost about $12 billion when fully equipped and operational.

On a technical note, Moore's Law is breathing its last breaths, so computer architects are scrambling to increase computing power in ways other than shrinking transistor geometries. One of those ideas is "domain-specific memory", a hierarchy of different memory types with different speeds and in-memory computing capabilities.[39] A recent study showed that 91% of the energy used in a neural network was consumed by data movement. The rest of the energy was used for processing. And when data is moved, it creates latency in the processing flow. To use domain-specific memory, programmers must change how they write their code, and be very aware of where their data is stored, and in what order. Except for caches, most software treats memory as a general resource with no unique characteristics.

It was interesting to see Micron announce in March, that they would sell their Utah fab. That factory was building 3D Xpoint memory in a deal with Intel. Xpoint memory looks like a primitive version of domain-specific memory to me. One of the reasons given for closing the factory was that programmers were not willing to change their programming structure to take advantage of Xpoint. Sales volume for the chips was too low to keep that fab running. Maybe Xpoint memory did not bring enough performance benefits to the table, to justify all the memory-management bit-fiddling programmers had to write to use it. Micron says they will concentrate on using CXL-based (Compute Express Link) domain-specific memory concepts. We did this back in my mainframe days: we used independent paths to cache, main memory, and disk storage. All the programmer needed to remember was which port to use, to read or write data

33 Douglas Busvine, Christoph Steitz, "*Analysis: Carmakers wake up to new pecking order as chip crunch intensifies*", Reuters, February 19, 2021, https://www.reuters.com/article/us-autos-chips-analysis/analysis-carmakers-wake-up-to-new-pecking-order-as-chip-crunch-intensifies-idUSKBN2AJ0LD

34 Jonathan Shieber, "*Taiwanese reassurances that water shortages won't hit chipmaking show climate change's direct threat to tech*", Tech Crunch, March 11, 2021, https://techcrunch.com/2021/03/11/taiwanese-reassurances-that-water-shortages-wont-hit-chipmaking-show-climate-changes-direct-threat-to-tech/

35 Debby Wu, Ian King, "*TSMC Wins Approval From Phoenix for $12 Billion Chip Plant*", Bloomberg, November 18, 2020, https://www.bloomberg.com/news/articles/2020-11-19/tsmc-wins-approval-from-phoenix-for-12-billion-chip-plant

36 Kifi Leswing, "*Intel is spending $20 billion to build two new chip plants in Arizona*", CNBC, March 24, 2021, https://www.cnbc.com/2021/03/23/intel-is-spending-20-billion-to-build-two-new-chip-plants-in-arizona.html

37 Noah Manskar, "*Samsung eyes four US locations for $17 billion chip factory*", New York Post, March 3, 2021, https://nypost.com/2021/03/03/samsung-eyes-four-locations-for-17-billion-chip-factory/

38 Trevor Hunnicutt, Nandita Bose, "*Biden to press for $37 billion to boost chip manufacturing amid shortfall*", Reuters, February 24, 2021, https://www.reuters.com/article/us-usa-biden-supply-chains/biden-to-press-for-37-billion-to-boost-chip-manufacturing-amid-shortfall-idUSKBN2AO13D

39 Brian Bailey, "*Domain-Specific Memory*", Semiconductor Engineering, March 11, 2021, https://semiengineering.com/domain-specific-memory/

to each memory domain. That makes more sense than programmers keeping track of the address ranges of certain memory types, in a messy memory map that looks like a checkerboard.

As I have mentioned in previous reports, the von Neumann computer architecture concept is falling apart. General purpose CPUs are not ideal for many tasks, and that is motivating a lot of research into "domain-specific architectures". This idea started with the development of DSPs and GPUs in the past, to handle certain types of computing problems better than CPUs. Most automotive and industrial control applications will still use general purpose CPUs (microcontrollers) since they are just pushing sequential code through a decision-tree. But generic CPUs are inefficient for AI and many new data-driven applications.[40]

These observations suggest specialization and fragmentation in the computer industry, much like we have seen in medicine over the years. We have radiologists, dermatologists, internal medicine, neurologists, orthopedics, oncologists, ear/nose/throat, allergists, pediatricians, cardiologists, gerontologists, proctologists, and many more specialties in medicine today. Looks like the same thing might happen with board and systems designers in the near future, when domain-specific architecture chips start showing up. Young engineers might be forced to choose a domain-specific branch of the computer architecture tree for their careers.

"Young engineers might be forced to choose a domain-specific branch of the computer architecture tree for their careers."

Military

The 2022 defense budget, to be requested from Congress in May, is expected to be flat with 2021: about $696 billion. How that money gets distributed across the services is going to create some resentment. Despite the failures with the Littoral Combat Ship (LCS), the Zumwalt Destroyer (DDG-1000), banging their big ships into other big ships in the Pacific Ocean, and the problems with the new Ford-class carrier catapults and elevators, the Navy should get the most money in 2022.[41] They will get more surface ships, fighter planes, and submarines in the new budget. The Air Force will get more F-35's and B-21 bombers. But the Army's tank, missile, artillery, and ground combat vehicle programs will suffer. Congress has already cut the budgets for the Army and Air Force "Project Convergence" experiments. And this shift could have some prime contractors looking at additional acquisitions.[42] There are seven shipyards in the U.S. that can build warships: Huntington-Ingalls (MS), Bath Iron Works (ME), Electric Boat (CT), Newport News Shipbuilding (VA), Austal (AL), Marinette (WI), and NASSCO (CA). The 2022 defense budget could be a huge government stimulus program for all of them.

These new priorities revolve around the Pentagon's "Asian Pivot" strategy: competing with China's naval build-up in the Pacific. In a war with China, the U.S. Navy will be the primary fighting force with carrier-based fighter planes and ship-based missiles. They will be followed by Guam-based stealthy Air Force long-range bombers. The Army is unlikely to be landing large ground forces or tanks in Taiwan or China until late in any conflict. If the budget shift to the Navy happens, that would suggest that present Army weapons platforms are more than adequate for a ground war in Europe, against Russia's declining military capabilities. Those old Army platforms and capabilities are also adequate for a ground war against North Korea too. Same goes for Iran.

40 Brian Bailey, "*Von Neumann Is Struggling*", Semiconductor Engineering, January 18, 2021, https://semiengineering.com/von-neumann-is-struggling/

41 Paul McLeary, "*Top Lawmaker: Army Budget Needs 'Not Even Close' to Navy, Air Force*", Breaking Defense, March 18, 2021, https://breakingdefense.com/2021/03/top-lawmaker-army-budget-needs-not-even-close-to-navy-air-force/

42 Doug Berenson, Chris Higgins, Jim Tinsley, "*The U.S. Defense Industry in a New Era*", War On the Rocks, January 13, 2021, https://warontherocks.com/2021/01/the-u-s-defense-industry-in-a-new-era/

The bigger issue is what the Navy will build with all the new money. There are plans for a 500-ship Navy and a 1000-ship Navy. Both plans expect a large percentage of new ships to be unmanned. But Congress has rejected the Navy's robotic ship concepts as operationally unclear and technically unstudied.[43]

The Navy dropped the carrier-based Northrop-Grumman X-47B attack drone years ago. Then, they removed the teeth and claws from the Boeing MQ-25 fighter/bomber drone and turned it into a carrier-based tanker drone.[44] The only armed unmanned drone that the Navy flies off ships today is the MQ-8 Fire Scout helicopter. It carries a few 70mm rocket tubes onboard, barely enough firepower to irritate an enemy ship. But they did sail their 132-foot unarmed unmanned sub-hunter surface ship (Sea Hunter) from San Diego to Hawaii and back in 2019, without crashing into another ship. And they are making progress connecting their ISR and weapons systems together under Project Overmatch.

There are some Navy leaders who think that converting the MQ-25 and the X-47 drones into unmanned fighter planes is the way to go. They see 40% to 60% of carrier-based fighter planes being unmanned in the future.[45] As a sidenote, one of the problems with the X-47 drone involved landing on the carrier: the tail hook would hit in exactly the same spot each time it landed. That resulted in damage to the carrier's flight deck, so the software guys had to modify their code so the drone would land in a slightly different place each time (*see page 15 of Christian Brose's new book, "The Kill Chain").

Some leaders are suggesting that we get rid of old legacy platforms, like aircraft carriers and the B-52 bombers, because they require a huge portion of the budget to maintain, upgrade, and operate. Those platforms are not considered survivable in future wars. Retiring those old platforms would free-up money to build more F-35's and Aegis destroyers.[46]

In early 2021, the Marines began deactivating their tank divisions. Tank-on-tank battles, like we saw in the Iraq war, are becoming a thing of the past.[47] The Marines will mount rocket-artillery missile tubes (long-range precision fires) on their light combat ground vehicles and kill tanks from many miles away. The Army will keep their tanks and armored divisions for now but are designing a cannon that fires projectiles 1,000 miles.[48] Army tanks might be relegated to a fire support role for ground troops.

Kratos XQ-58A Valkyrie Successfully Completes Sixth Flight, Including First Payload Release from Internal Weapons Bay

The Kratos XQ-58 Valkyrie unmanned fighter plane has been flying around Arizona for over a year now. Boeing's "Loyal Wingman" autonomous fighter plane flew for the first time in early March, in Australia. The Australian Air Force and Boeing

43 David B. Larter, "*Unclear on unmanned: The US Navy's plans for robot ships are on the rocks*", Defense News, January 10, 2021, https://www.defensenews.com/digital-show-dailies/surface-navy-association/2021/01/10/unclear-on-unmanned-the-us-navys-plans-for-robot-ships-are-on-the-rocks/

44 Kris Osborn, "*Navy Should Bring Back a Stealthy Carrier-Launched Maritime Attack Drone*", Warrior Maven, March 19, 2021,https://defensemaven.io/warriormaven/sea/navy-should-bring-back-a-stealthy-carrier-launched-maritime-attack-drone-1BgBXdXwoEWAUZR9JXSXVA

45 Paul McLeary, "*Navy's Plans Call For New Drones To Shoot, Spy, Jam*", Breaking Defense, March 30, 2021, https://breakingdefense.com/2021/03/navys-emerging-plans-call-for-new-drones-to-shoot-spy-jam/

46 Scott Cooper, "*Bye-Bye, B-52s & Carriers; Hello, More Destroyers & F-35s*", Breaking Defense, March 22, 2021, https://breakingdefense.com/2021/03/bye-bye-b-52s-hello-more-destroyers-f-35s/

47 Gina Harkins, "*The Marines are starting to say goodbye to their tanks*", Business Insider, July 21, 2021, https://www.businessinsider.com/marine-corps-begins-to-get-rid-of-all-tank-battalions-2020-7

48 David Axe, "*The Army's New 1000-Mile Cannon Will Match The Navy And Air Force's Ranged Strike Capabilities*", The National Interest, February 6, 2021, https://nationalinterest.org/blog/reboot/army's-new-1000-mile-cannon-will-match-navy-and-air-forces-ranged-strike-capabilities

worked together to design and build the aircraft.[49] Back in February, DARPA announced their new armed UAV platform idea: the Longshot. It will be launched from fighter planes and bombers in flight. It will carry existing air-to-air missiles to shoot-down enemy fighter planes, so fighter pilots do not need to get into aerial dogfights with enemy planes. The Longshot has no ground support missions.[50]

These are the kinds of non-line-of-sight (NLOS) weapons we will need in a future war. Against China and Russia's anti-access/area-denial (A2/AD) strategies, it makes no sense to risk the loss of troops and expensive platforms in a close-up fight when we can attack them with impunity from a distance. This is strategic thinking: turning the "tyranny of distance" into the "advantage of distance".

I could go on and on here, about new military platform ideas and technologies being suggested, but that is just brain candy for us in the MIL segment. Brose says, in his book, that we are looking at the problem all wrong. Military leaders must look at weapons of war as a service, not as specific platforms. In a fight, it does not matter where the firepower comes from in multi-domain operations. What matters is that the battlefield commander asks for weapons to hit a specific target, and he does not care if those weapons come from fighter planes, bombers, ships, artillery, or helicopters as long as those explosives hit the target within a few minutes of his request.

Think about that idea: explosive weapons as a service, delivered on any target anywhere on the planet in minutes. DARPA has a name for this concept. It is called the "Kill Web". If you read Brose's book, you will have a much better understanding of where MIL systems are going in the future, and how we will get there. The Kill Web looks like a kinder gentler version of Skynet from the "Terminator" movie series.

"The Kill Web looks like a kinder gentler version of Skynet from the "Terminator" movie series."

From my reading, I think I have it figured-out. Platform-based thinking is purely tactical. That is why the Navy is tangled-up in knots about unmanned planes and ships. Kill Web thinking is strategic, and that is why the Army and the Air Force have been playing with "Project Convergence" experiments without much Navy involvement. The Army and the Air Force will get smaller DoD budget allocations in 2022, so the Navy can catch-up and start thinking strategically.

Arguably, the most exciting development coming from the Pentagon and the intelligence services is their pending UFO report. In December 2020, President Trump signed the law that requires them to reveal what they know about UFOs within 180 days.[51] That says we could see their report by June, unless they ask for an extension for some reason. I suspect the report will just reveal more UFO sightings than have been publicly reported over the years, but they will not disclose anything as exciting as what we saw in the "Men in Black" movies.

Mergers and Acquisitions

In December, Hyundai Motor Group bought Boston Dynamics, the company that has been working on robotic military dogs and robotic super-soldiers.[52] In December, UAV-maker Aerovironment bought robotic ground vehicle maker Telerob (Germany).[53] Then in January, Aerovironment went out and bought small UAV maker Arcturus.[54]

49 "*Boeing's Loyal Wingman UAV completes first flight*", Intelligent Aerospace, March 3, 2021, https://www.intelligent-aerospace.com/military/article/14198573/boeing-loyal-wingman-first-flight

50 Valerie Insinna, "*These three companies won contracts for DARPA's new LongShot drone*", Defense News, February 9, 2021, https://www.defensenews.com/air/2021/02/09/these-three-companies-got-contracts-for-darpas-new-longshot-drone/

51 Chris Enloe, "*Former DNI John Ratcliffe previews UFO report, reveals many sightings 'difficult to explain'*", Blaze Media, March 20, 2021, https://www.theblaze.com/news/john-ratcliffe-previews-ufo-report

52 M. Moon, "*Hyundai confirms its $1.1 billion acquisition of Boston Dynamics*", Engadget, December 11, 2020, https://www.engadget.com/hyundai-acquires-boston-dynamics-1-1-billion-110901223.html

53 Lisa Daigle, "*UAS maker Aerovironment acquires ground-robot company Telerob*", Military Embedded Systems, December 11, 2020, https://militaryembedded.com/unmanned/rugged-computing/uas-maker-aerovironment-acquires-ground-robot-company-telerob

54 "*Qualcomm Eyes Challenge to Apple, Intel With $1.4B Deal for Chip Startup*", Newsmax Finance, January 13, 2021, https://www.newsmax.com/finance/streettalk/qualcomm-apple-intel-chip/2021/01/13/id/1005400/

Teledyne bought FLIR, a maker of thermal imaging and night-vision technologies, in January.[55] Huntington Ingalls (a big ship builder) bought the unmanned technology division of Spatial Integrated Systems in January.[56] This could be an indicator of more technology acquisitions by shipbuilders if the Navy gets the most money in the 2022 defense budget, if they build more autonomous boats.

Two years ago, Northrop-Grumman bought rocket-maker Orbital ATK. In December, Lockheed-Martin announced they would buy rocket-maker Rocketdyne. These acquisitions are starting to make the Pentagon nervous about another massive consolidation phase in the defense supply chain.[57] Again, it is clear that the Navy must sit far offshore and fire long-range missiles in a war with China. Their big guns and carrier-based aircraft cannot reach that far.

When Nvidia bought UK-based ARM back in September, that rattled a lot of cages in the cellphone, laptop, and automotive CPU business. So, Qualcomm bought CPU start-up Nuvia in April. In February, Renesas (Japan) bought UK semi-maker Dialog.[58] While many countries are subsidizing and supporting their indigenous semiconductor companies, the UK seems to be selling theirs off (ARM and Dialog so far).

On our side of the fence, Mercury bought Physical Optics back in December.[59] They make avionics systems for military and commercial aircraft.

In March, Ametek bought Abaco Systems (VMIC, which later became the GE Fanuc embedded systems group) from Veritas.[60] The bigger surprise here was that the purchase price was four times sales. From the M&A history collected about this industry since the 1980's, the highest price paid for an embedded board and system company until now was about 3.5 times sales.

This M&A activity simply reflects, to some degree, the financial, economic, and political shifts caused by Covid. How deeply those shifts could permeate into M&A activity in our industry is hard to predict.

Summary

Things are getting better in the health and economic segments. But the financial, political, and international segments will continue to deteriorate before they stabilize. The U.S. economy will bounce back faster than other nations and Europe is predicted to be the slowest to recover. The same thing happened after the 2008 financial crisis. Consumer spending in the U.S. is about 70% of GDP so consumers will lead the U.S. in the recovery. In the EU, consumer spending is about 52% of GDP. They are more dependent on tax collections to get money for the government to spend, to boost their economies. Obviously, that is why the EU is maniacally pursuing every possible avenue to tax U.S.-based internet and technology companies.

The predicted 2022 defense budget of $696 billion (excluding allocations for Overseas Contingency Operations or OCO) will require the services to prioritize their projects and programs. If the Navy gets more money for ships and aircraft, that will force the Air Force and the Army to make some hard decisions when their budgets get cut. I have been tough on the Navy here, but they are trying to redefine their missions as we transition from fighting terrorism to fighting near-peer adversaries like China. The Army and Air Force's command and control structure is much flatter than

55 Kim Lyons, "*Teledyne is buying FLIR to create a super-sized sensor shop with thermal and laser vision*", The Verge, January 4, 2021, https://www.theverge.com/2021/1/4/22213966/lidar-flir-teledyne-thermal-sensor-drones-nasa

56 Joe Gould, "*Huntington Ingalls acquires unmanned business from Spatial Integrated Systems*", C4ISR Net, January 4, 2021, https://www.c4isrnet.com/2021/01/04/huntington-ingalls-acquires-unmanned-business-from-spatial-integrated-systems/

57 Marcus Weisgerber, "*Hicks Warns Against 'Extreme Consolidation' in Defense Industry*", Defense One, February 2, 2021, https://www.defenseone.com/business/2021/02/hicks-warns-against-extreme-consolidation-defense-industry/171811/

58 "R*enesas agrees to buy Apple supplier Dialog Semi for $5.9 billion in cash*", CNBC/Reuters, February 8, 2021, https://www.cnbc.com/2021/02/08/renesas-agrees-to-buy-dialog-semi-for-5point9-billion-in-cash.html

59 Lisa Daigle, "*Mercury Systems announces it will acquire Physical Optics Corp.*", Military Embedded Systems, December 7, 2020, https://militaryembedded.com/avionics/software/mercury-systems-announces-it-will-acquire-physical-optics-corp

60 John McHale, "*Abaco Systems to be bought by Ametek*", Military Embedded Systems, March 22, 2021, https://militaryembedded.com/avionics/computers/abaco-systems-to-be-bought-by-ametek

the Navy's hierarchal command and control structure, and that's part of the problem. The Navy has a lot of people in the tactical decision-making process, and that complicates their analysis and slows-down their response time. That is why the Navy is far behind the Army and Air Force in developing the multi-domain "Kill Web" concept.

Watching the worldwide auto industry transition to electric vehicles (EVs) will be like watching a slow-motion train wreck. Every developed country will subsidize their national auto industry somehow (protectionism), to preserve jobs and the tax base. As hundreds of companies build EVs, they will become undifferentiated commodities. All EVs look the same to me: they look like washing machines with headlights and larger wheels (Tesla being the exception here). When you consider that EVs contain far fewer parts than an ICE vehicle, and with the added efficiencies of robotic assembly, employment in the auto industry worldwide must decline significantly even with national government protection. The mess that the automakers and dealerships are in right now is much better than the mess that is coming.

The semiconductor industry is about to fragment into different "domain-specific" processors and "hierarchy-specific" memory architectures. Moore's Law is dead, and the von Neumann architecture model is even deader. We already have CPUs, MCUs, DSPs, GPUs, TPUs, and DPUs. Get ready for a bunch of new acronyms like APU (automotive processing unit), RPU (radar processing unit), SPU (server processing unit), or some other letters followed by a "U". Same thing is happening with memory, but without the "U" in the name.

So, sit back, relax, watch these transitions, and see if you can determine whose ox is being gored. Depending on how you make your living, it might be yours.