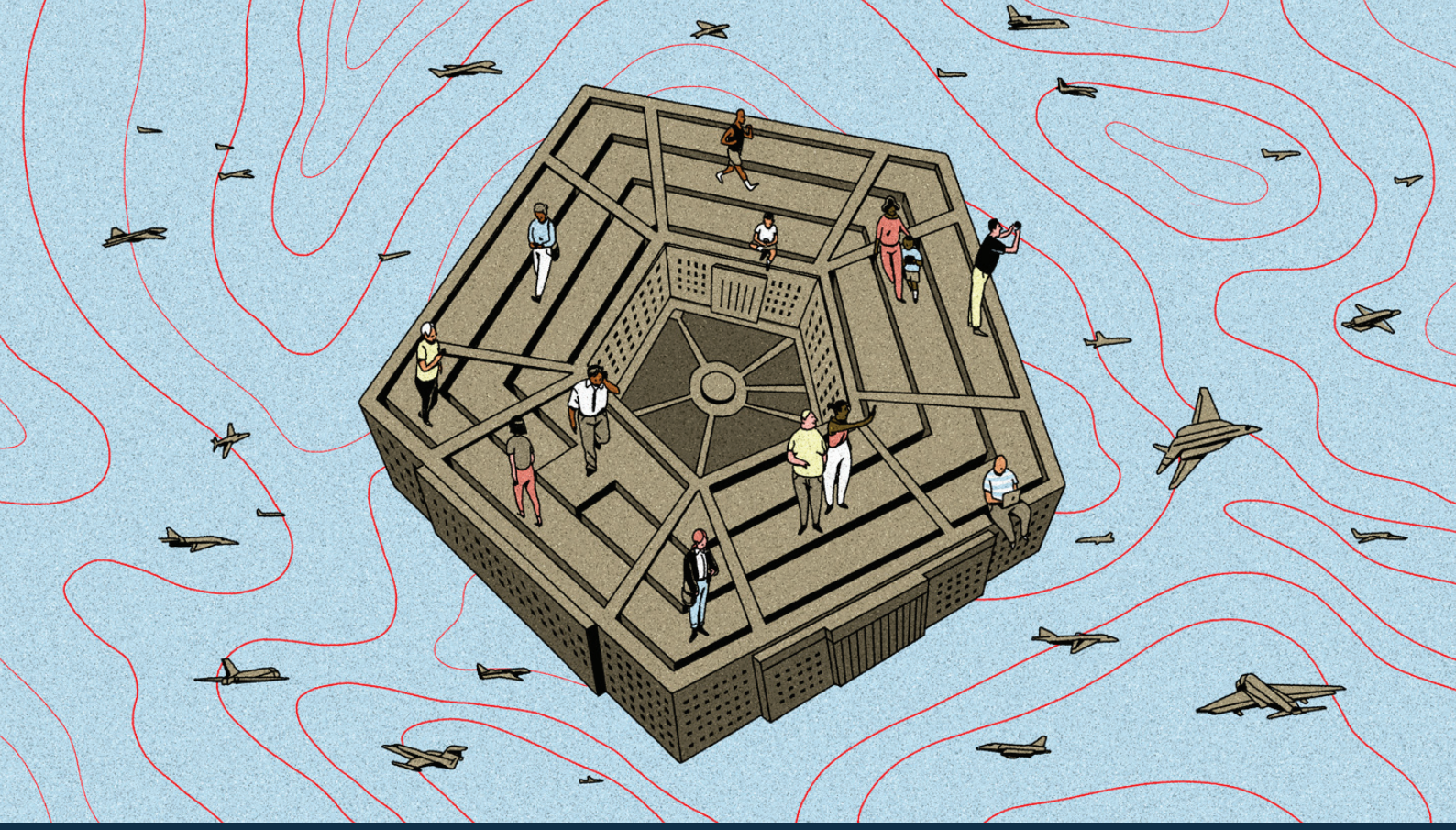

Militarising Big Tech

The rise of Silicon Valley's digital defence industry

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In September 2011, CIA and US military personnel jointly launched a drone strike authorised by President Barack Obama. The attack resulted in the assassination of Anwar al Awlaki—an ardent US-born Muslim cleric—in Yemen. Those who organised the drone strike targeted Awlaki based on geolocation data which was monitored by the National Security Agency as part of a surveillance programme.[1] Two weeks later, a CIA drone attack killed another US citizen using the same kind of data: al Awlaki's 16-year-old son, Abdulrahman al Awlaki.[2]

Although al Awlaki was deliberately assassinated by US forces, other US citizens—and thousands of civilians in Afghanistan and other parts of central Asia and the Middle East—have been inadvertently killed by drones.[3] These cases foreshadow a major flaw in the latest iteration of automated war: the imprecision of the technologies, and the great margins of error that accompany even the most sophisticated new weapon systems. In their most advanced form, the computerised tools make use of artificial intelligence and machine learning, and may soon have fully autonomous capabilities.

Handheld internet-ready digital devices have transfigured billions of people worldwide into atomised data-production machines, feeding information into hundreds, if not thousands, of algorithms each day. Although we have swiftly integrated smartphones and tablets into our lives, we very seldom reflect on how the data stored and transmitted by these gadgets can easily become militarised. For example, recent reports describe how the US Defense Intelligence Agency, affiliated with the Department of Defense (DoD), routinely uses commercially available geolocation data collected from individual cell phones—sometimes without warrants.[4] Military and intelligence agencies can use such data not only for spying, but also to reconstruct social networks and even to target individuals for lethal attacks.

Drones, geolocation software, spyware, and other such tools are emblematic of a new series of collaborations between Big Tech and Big Defence. Over the past two decades, the DoD and 17 US government agencies collectively known as the US Intelligence Community have attempted to capture technological innovation at its source: Silicon Valley. Military and spy agencies have done this by creating outposts along the West Coast; organising a high-profile advisory board that links the Pentagon to Big Tech firms; coordinating summits, forums, and private meetings with influential investors and corporate executives; and appealing directly to the hearts and minds of entrepreneurs, engineers, computer scientists, and researchers who are sometimes sceptical of government bureaucrats, especially those from the DoD.

In many ways, it is impossible to fully understand the US military today without an analysis of its deep connections to the tech industry.

The interconnections between the worlds of network technology and defence stretch back more than 50 years. For example, from the early 1960s, the DoD's Advanced Research Projects Agency (ARPA) played a crucial role in funding computer research that led to the ARPANET, the precursor to today's internet. Silicon Valley's early development was financed largely by defence and intelligence agencies, and the Pentagon was heavily invested in tech companies throughout the Cold War.[5]

What Is Virtual War?

Virtual warfare obviously means different things to different people. There is no agreed definition—which gives room to interpret the term broadly, holistically, and anthropologically. I take a wide-angle view, focusing on four different elements: robotic and autonomous weapons systems; a high-tech version of psychological operations or psyops; predictive modelling and simulation programmes, which some call 'computational counterinsurgency'; and cyberwarfare, meaning the attack and defence of critical infrastructures. These technologies and techniques are predicated on the production, availability, and analysis of massive quantities of data—often surveillance data –collected from drones, satellites, cameras, cell phones, electronic transactions, social media, email messages, and other internet sources.

We can think of this as war by algorithms. Increasingly, the technologies make use of artificial intelligence or AI to automate decision-making processes. The development of virtual weapons relies on the combined efforts of a wide range of scientists and technical experts—not only chemists, physicists, engineers, computer programmers, and data analysts, but also biotech researchers, political scientists, psychologists, and anthropologists. Much of the work is rather banal, and takes place in nondescript buildings in suburban office parks, tech campuses, or university laboratories. Silicon Valley has emerged as a major centre for this kind of defence and intelligence work.

In some ways, virtual warfare is a continuation of the so-called Revolution in Military Affairs or RMA, a doctrine that was articulated by the Pentagon's Office of Net Assessment in the 1980s and 1990s. It leaned heavily towards technology-based solutions. After 9/11, when the US waged its so-called Global War on Terror, and went to war against global networks of insurgents armed with relatively simple technologies such as improvised bombs, rifles, and grenade launchers, the RMA lost steam, and counterinsurgency became fashionable after a long hiatus. But now, in a period marked by rapid innovation, algorithmic modes of governance, and the rise to power of rival nations like China and Russia—each of which is pursuing its own virtual war-fighting technologies—computerised combat has once again taken centre stage among US military establishment elites.

The Intersection between Big Defence and Big Tech: Creating DIUx

Mountain View rests comfortably between the heavily forested Santa Cruz mountains and the southern shores of the San Francisco Bay. Through the first half of the twentieth century, it was a sleepy town with cattle farms, fruit orchards, and picturesque downtown streets. But after a team of scientists led by William Shockley invented the semiconductor there in 1956, it grew rapidly, along with the rest of Silicon Valley. Today, it's a bustling suburb with more than 80,000 residents.

At first glance, it seems like an odd place for military and intelligence agencies to set up shop. Mountain View is nearly 2,500 miles (4,024 km) away from the Pentagon. Direct flights from San Francisco to Honolulu take less time than flights to Washington, DC.

The Pentagon and Silicon Valley are not only geographically distant, but there are other differences too. The Defense Department is often considered a notoriously bloated, stuffy, wasteful bureaucracy,

with rigidly hierarchical organisational structures and inflexible workplace norms. By contrast, Mountain View's biggest employer is Alphabet, Google's parent company, one of the world's most valuable corporations. Its 26-acre campus, known as the Googleplex, includes more than 30 cafés, free food and drink for its employees, on-site fitness centres, and swimming pools. A life-size iron *Tyrannosaurus rex* skeleton, lovingly called Stan by Google employees, is prominently displayed outside a main building.

Despite these differences—indeed, *because* of them—Defense Secretary Ash Carter very publicly established a Pentagon outpost less than two miles (3 km) away from the Googleplex. The Defense Innovation Unit Experimental, or DIUx, was created in August 2015 to quickly identify and invest in companies developing cutting-edge technologies that might be useful to the military.[6] With DIUx, the Pentagon built its own start-up accelerator dedicated to funding firms specialising in AI, robotic systems, big data analysis, cybersecurity, and biotechnology.

DIUx's new home wasn't so out of place. Its headquarters was located in a building once occupied by the Army National Guard, on the grounds of the Ames Research Center, the largest of NASA's ten field sites, and Moffett Field, once home to the California Air National Guard's 130th Rescue Squadron. Defence giants Lockheed Martin and Northrop Grumman have offices less than 3 km away. In 2008, Google itself was encroaching on government territory: it entered into a 40-year lease agreement with NASA Ames for a new research campus. Then it signed a sixty-year deal with NASA to lease 1,000-acre Moffett Field, including three massive dirigible hangars.[7] Today, Google uses the hangars to build stratospheric balloons which might one day provide internet services to people living in rural areas[8]—or perhaps conduct high-altitude military surveillance missions.

DIUx's office was in close proximity to other tech firms: Amazon's Lab126 (where the Kindle reader, Amazon Echo, and other digital devices were hatched); LinkedIn's corporate headquarters; and Microsoft's Silicon Valley campus. Apple's corporate offices were located 8 km away, in nearby Cupertino. The Pentagon's newest digs were literally at the intersection of Big Tech and Big Defence. DIUx's office, housed in a squat brick building, embraced the contradictions of Pentagon West: 'The corridors are old-school drab, the doors secured with combination locks. But inside, the newcomers have revamped the spaces with blackboards, whiteboards, and desks arrayed in random diagonals, to match the nonhierarchical vibe of a Valley startup', reported an observer.[9]

Ash Carter's plan was ambitious: to harness the best and brightest minds from the tech industry for Pentagon use. The native Pennsylvanian had spent several years at Stanford University prior to his appointment as Defense Secretary, and was impressed with the Bay Area's innovative spirit and millionaire magnates: 'They're inventing new technology, creating prosperity, connectivity, and freedom', said Carter.[10] 'They feel they too are public servants, and they'd like to have somebody in Washington they can connect to.' Astonishingly, Carter was the first sitting Defense Secretary to visit Silicon Valley in more than 20 years.

The Pentagon has its own research and development (R&D) agency, DARPA, but it pursues projects that are decades, not months, away. Carter wanted a nimble, streamlined office that could serve as a kind of broker, channelling tens or hundreds of millions of dollars from the DoD's massive budget towards up-and-coming firms developing technologies on the verge of completion. Ideally, DIUx would serve as a liaison, negotiating the needs of grizzled four-star generals, the Pentagon's

civilian leaders, and hoodie-clad engineers and entrepreneurs. Soon, DIUx opened branch offices in two other cities with burgeoning tech sectors: Boston and Austin.

In the short term, Carter hoped that DIUx would build relationships with local start-ups, recruit top talent, involve military reservists in projects, and streamline the Pentagon's notoriously cumbersome procurement processes. His long-term goals were even more ambitious: to take career military officers and assign them to work on futuristic projects in Silicon Valley for months at a time, to 'expose them to new cultures and ideas they can take back to the Pentagon… [and] invite techies to spend time at Defense'.[11]

In March 2016, Carter organised the Defense Innovation Board (DIB), an elite civilian brain trust tasked with providing advice and recommendations to the Pentagon's leadership.[12] He appointed former Google CEO and Alphabet board member Eric Schmidt to chair DIB, which included current and former executives from Facebook, Google, and Instagram, among others.

Three years after Carter launched DIUx, it was renamed the Defense Innovation Unit (DIU), indicating that it was no longer experimental. Despite early challenges, DIUx was described as 'a proven, valuable asset' by Deputy Defense Secretary Patrick Shanahan. 'The organization itself is no longer an experiment', he said in 2018.[13] 'DIU remains vital to fostering innovation across the Department and transforming the way DoD builds a more lethal force.' In early 2018, the Trump administration requested a steep increase in DIU's budget for fiscal year 2019, from $30 million to $71 million.[14] For 2020, the administration requested $164 million, more than *doubling* the previous year's request.[15]

The CIA's Own Venture Capital Fund

Although Pentagon officials portrayed DIUx as a ground-breaking organisation, it was actually modelled on another firm established to serve the US intelligence community in a similar way. In the late 1990s, the CIA established a non-profit entity called Peleus to capitalise on innovations being developed in the private sector, with a special focus on Silicon Valley.[16] Soon after, the organisation was renamed In-Q-Tel.

The first CEO, Gilman Louie described how the organization was created to solve 'the big data problem':

> [CIA leaders] were really afraid of what they called at that time the prospect of a 'digital Pearl Harbor'… Pearl Harbor happened with every different part of the government having a piece of information but they couldn't stitch it together to say, 'Look, the attack at Pearl Harbor is imminent'… [In] 1998, they began to realize that information was siloed across all these different intelligence agencies of which they could never stitch it together… they were trying to solve the big data problem. How do you stitch that together to get intelligence?[17]

By channelling funds from the CIA to nascent firms building surveillance, intelligence gathering, data analysis, and cyber-warfare technologies, the agency hoped to get an edge over global rivals by co-opting creative engineers, hackers, scientists, and programmers. In 2005, the CIA pumped approximately $37 million into In-Q-Tel. By 2014, the organisation's annual funding ballooned to

nearly $94 million, and it had made 325 investments in an astonishing range of technology firms.[18]

If In-Q-Tel sounds like something out of a James Bond movie, that's because the organisation was partly inspired by—and named after—Q Branch, the British secret service's fictional R&D office, popularised in Ian Fleming's spy novels and Hollywood blockbusters. In-Q-Tel and DIUx were ostensibly created to transfer emergent private-sector technologies into US intelligence and military agencies, respectively. A somewhat different interpretation these organisations were launched 'to capture technological innovations… [and] to capture new ideas'.[19] Critics point to In-Q-Tel as a prime example of the militarisation of the tech industry.

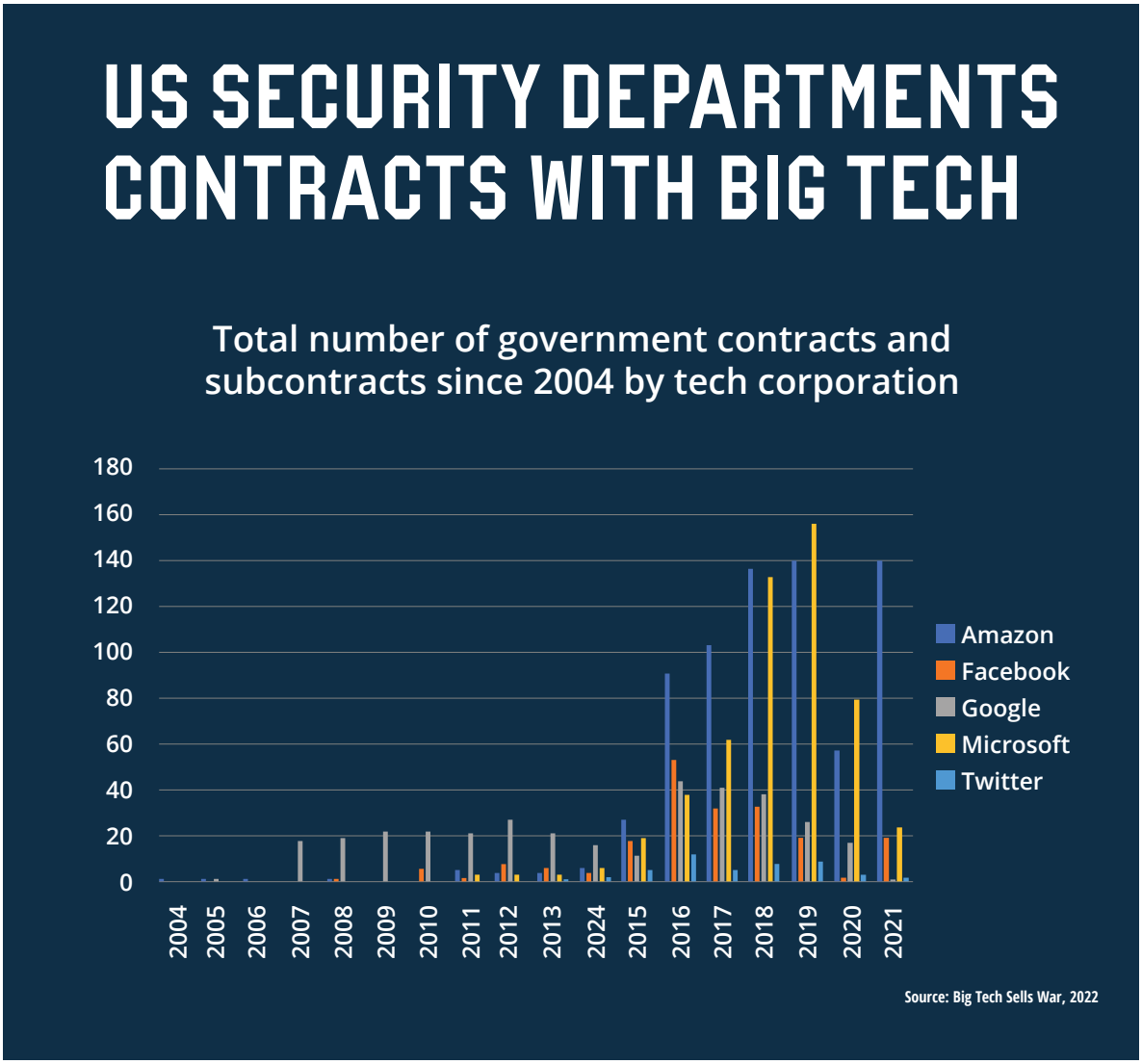
In monetary and technological terms, it's likely that the most profitable In-Q-Tel investment was Keyhole, a San Francisco-based company that developed software for weaving together satellite images and aerial photos to create three-dimensional models of the earth's surface. The programme could essentially create a high-resolution map of the entire planet. In-Q-Tel provided funding in 2003, and within months, the US military was using Keyhole to support US troops in Iraq.[20]

Official sources never revealed how much In-Q-Tel invested in Keyhole, but in 2004, Google purchased the start-up. It was renamed Google Earth. The acquisition was significant: Yasha Levine writes that the Keyhole-Google deal 'marked the moment the company stopped being a purely consumer-facing internet company and began integrating with the US government'.[21] By 2007, Google was actively seeking government contracts evenly spread among military, intelligence, and civilian agencies.[22]

Apart from Google, In-Q-Tel's portfolio includes firms with futuristic projects such as Cyphy, which manufactures tethered drones that can fly reconnaissance missions for extended periods thanks to a continuous power source; Atlas Wearables, which produces fitness trackers that closely monitor body movements and vital signs; Fuel3d, which sells a handheld device that produces detailed three-dimensional scans of structures or objects; and Sonitus, which has developed a wireless communications system, part of which fits inside the user's mouth.[23] If DIUx has placed its bets with robotics and AI companies, In-Q-Tel has pursued those creating surveillance technologies—geospatial satellite firms, advanced sensors, biometrics equipment, DNA analysts, language-translation devices, and cyber-defence systems.

More recently, In-Q-Tel has shifted towards firms specializing in data-mining social media and other internet platforms. These include Dataminr, which streams Twitter data to spot trends and potential threats; Geofeedia, which collects geographically indexed social media messages related to breaking news events such as protests; and TransVoyant, a firm that collates data from satellites, radar, drones, and other sensors.[24]

Some might applaud US military and intelligence agencies' successful recruitment of tech firms. Given the rapid development and deployment of high-tech weapons systems and surveillance programmes by rival nations such as China—which has deployed comparable technologies against its own citizens in Xinjiang province[25]—proponents often claim that the US military cannot afford to fall behind in an AI arms race. But such arguments fail to consider how merging Big Defence with yet another major industry will bind the US economy ever more tightly to endless wars abroad and militarised policing at home.



Project Maven

Many companies funded by In-Q-Tel and DIUx have been small start-ups in dire need of cash. But the Pentagon's interest in Silicon Valley also extends to the biggest internet-based companies.

Consider the case of Project Maven—known formally as the Algorithmic Warfare Cross-Functional Team. Deputy Defense Secretary Robert Work established the programme in April 2017, describing it as an effort 'to accelerate DoD's integration of big data and machine learning… [and] to turn the enormous volume of data available to DoD into actionable intelligence and insights at speed…'.[26] *The Bulletin of the Atomic Scientists* states the problem succinctly:

> US spy planes and satellites collect more raw data than the Defense Department could analyze even if its whole workforce spent their entire lives on it. Unfortunately, most of the imagery analysis involves tedious work—people look at screens to count cars, individuals, or activities… most of the sensor data just disappears—it's never looked at—even though the department has been hiring analysts as fast as it can for years.[27]

The Pentagon had spent tens of billions of dollars on sensors. Creating algorithms to sort and analyse the images made good economic sense, and at a projected cost of $70 million,

Project Maven must have seemed like a bargain. The scope of the work was staggering. In their current state, AI systems require massive data sets for 'deep learning', which essentially means learning by example. During the latter half of 2017, people working on Project Maven reportedly labelled more than 150,000 visual images to create the first datasets for training the algorithms. The images—photos of vehicles, individuals, objects, events—had to account for hundreds, if not thousands, of variable conditions—different altitudes, photo angles, image resolution, lighting conditions, and more.

What organisation could possibly take up such a task? Pentagon officials were quiet about which companies were involved, but some insiders provided oblique hints that significant Big Tech players were involved.[28] Marine Corps Colonel Drew Cukor, who headed Project Maven, noted that 'We are in an AI arms race… It's happening in industry [and] the big five Internet companies are pursuing this heavily. Many of you will have noted that Eric Schmidt [then CEO of Alphabet Inc., Google's parent company] is calling Google an AI company now, not a data company'.[29]

Just eight months after the Defense Department launched Project Maven, the military was using the programme's algorithms to support drone missions against ISIS in Iraq and Syria.

In March 2018, Gizmodo published a series of blistering exposés revealing that the Pentagon had quietly contracted Google for Project Maven work in September 2017.[30] According to internal emails from Google executives, the deal was worth at least $15 million, and was expected to increase to as much as $250 million.[31]

Some emails detailed meetings between Google executives and Deputy Defense Secretary Jack Shanahan.[32] More than ten Google employees were assigned to the project, and the company had partnered with several other firms including DigitalGlobe, a geospatial imaging company, and CrowdFlower, a crowdsourcing company. CrowdFlower (which has since changed its name to Figure Eight) paid so-called 'crowd workers'—people who complete repetitive tasks online, such as identifying photos—to label thousands of images for algorithmic 'deep learning'. Apparently, the crowd workers didn't know what they were building, or who would benefit as a result.[33]

Some of Google's internal emails implied that the company had ambitious plans going beyond what was initially suggested in the Pentagon's initial announcements. One suggested creating a 'Google-earth-like' spy system giving users the ability to 'click on a building and see everything associated with it' including people and vehicles.

Google officials privately worried about a potential public relations problem if the Project Maven project was leaked: 'I think we should do a good PR on the story of DoD collaborating with GCP from a vanilla cloud technology angle (storage, network, security, etc.)', wrote Fei-Fei Li, Google Cloud chief AI scientist, 'but avoid at ALL COSTS any mention or implication of AI'.[34]

But eventually, word got out.

Revolt of the Engineers

By February 2018, internal emails about Project Maven circulated widely among Google employees, many of whom were shocked and dismayed by what the company's senior executives had done. Within months, more than 4,000 Google researchers had signed a letter to CEO Sundar Pichai, demanding cancellation of the Maven contract. The letter, which was signed by several senior engineers, began with the statement: 'We believe that Google should not be in the business of war'. It also demanded that Google develop 'a clear policy stating that neither Google nor its contractors will ever build warfare technology'. By the end of the year, nearly a dozen employees resigned in protest of the company's military contracts and executives' lack of transparency.[35]

Astonishingly, the employees succeeded, at least momentarily. In early June, Google announced that the company would terminate its Project Maven work when the contract expired. Days later, Google released a set of ethical guidelines or 'AI principles', stating that the company 'will not design or deploy AI' for weapons systems, for 'surveillance violating internationally accepted norms', or for technologies used to contravene international law and human rights.[36]

Google's commitment to cancelling its Project Maven work was too good to be true. In March 2019, *The Intercept* obtained an internal Google email indicating that a third-party company would continue working on Project Maven using 'off-the-shelf Google Cloud Platform (basic compute service, rather than Cloud AI or other Cloud Services) to support some workloads'. Walker added that Google was working with 'DoD to make the transition in a way that is consistent with our AI principles and contractual commitments'.[37]

Other reports revealed that the Defense Department had awarded the Project Maven contract to Anduril Industries, best known for creating the Oculus Rift virtual reality headset. The previous year, Anduril had piloted a surveillance system developed for US Customs and Border Protection agents. The system uses AI to detect the presence of people attempting to cross the US border.

Although media reports implied that Google (and later Anduril) were the only firms that played a role in Project Maven, the reality is far more complex and troubling. A careful analysis by the non-profit research organisation Tech Inquiry documents the deeper involvement of numerous other contractors and subcontractors.[38] The Pentagon granted 'prime awards' to ECS Federal and Booz Allen Hamilton, and 'subawards' to a range of firms including Microsoft, Clarifai, Rebellion Defense, Cubic Corporation, GATR Technologies, Technical Intelligence Solutions, and SAP National Security Services, among others. These contracts were never widely publicised.

Although those Google employees who resisted Project Maven represented only a modest portion of the company's 70,000 employees, they succeeded in sparking discussion about tech industry military contracts, and a broader debate about the ethics of AI.

The Google revolt resonated throughout Big Tech and inspired others to follow. For example, in February 2019, more than 200 Microsoft employees demanded that the firm cancel a $480 million US Army contract to supply troops with more than 100,000 augmented-reality HoloLens headsets. The Pentagon's request for proposals outlined a need for a head-mounted display capable of giving soldiers night vision, stealthy weapons targeting, and the ability to automatically recognise threats. It would ideally give soldiers 'increased lethality, mobility, and situational awareness', according to the announcement.[39]

In an open letter to Microsoft CEO Satya Nadella, the workers expressed concern that in the hands of the military, HoloLens could be 'designed to help people kill' by 'turning warfare into a simulated video game'. The employees added, 'we did not sign up to develop weapons, and we demand a say in how our work is used'.[40] Microsoft executives refused to cancel the contract. Nadella said, 'we're not going to withhold technology from institutions that we have elected in democracies to protect the freedoms we enjoy'.[41]

During the summer of 2018, approximately 450 employees from tech giant Amazon signed a letter demanding that the company stop selling Rekognition—a facial-recognition software programme—to law enforcement agencies.[42] The employees' letter also asked that Amazon's Web Services division stop hosting Palantir, a tech company that provided data analysis software to US Immigration and Customs Enforcement, as the agency was targeting unaccompanied children and their families for deportation. Amazon CEO Jeff Bezos shrugged off the employees' letter. 'One of the jobs of the senior leadership team is to make the right decision even when it's not popular', he said in October 2018. 'If big tech companies are going to turn their back on the US Department of Defense, this country is going to be in trouble.'[43]

As tech workers expressed reticence about involvement in military projects, executives peddled their companies' wares to Pentagon officials. Microsoft announced Azure Government Secret, a cloud service for Defense Department and intelligence community clients requiring 'US Secret classified workloads'.[44] Oracle's websites boasted about how its products 'help military organizations improve efficiency, mission preparation, and execution'.[45] And Amazon created a slick, ninety-second promotional video in August 2018, titled simply 'Amazon Web Services for the Warfighter'.[46]

Fighting Back against the Merger of Big Tech and Big Defence

Silicon Valley's technologies illustrate the unpredictable consequences of unleashing new hardware or software. The idea that an invention can be used for either peaceful or military purposes—that is, the notion of dual-use technology—became widely accepted in US society over the past century.[47] Historian Margaret O'Mara reminds us that throughout the Cold War, 'the Valley built small: microwaves and radar for high-frequency communication, transistors and integrated circuits… Silicon Valley built elegant miniaturised machines that could power missiles and rockets, but that also held possibilities for peaceful use—in watches, calculators, appliances, and computers'.[48]

These technologies continue to have dual-use applications. Google Earth can be employed for mapping and geographic research, but it can also be used by Special Forces teams for targeting electrical power grids, bridges, or other infrastructures.[49] Microsoft first marketed HoloLens as an augmented-reality device for gamers, artists, and architects, but the most profitable consumers are likely to be infantry. Amazon's facial-recognition programme might be used for secure bank or ATM transactions, but they can also be used as surveillance technologies by military, intelligence, or law enforcement agencies such as US Immigration and Customs Enforcement. Cloud platforms offered by Amazon, Oracle, Microsoft, and Google can potentially store data for scientific researchers, public health officials, or commercial firms. But they can also increase the lethality of military forces.

Some might chide Google's dissident engineers and scientists as naïve Pollyannas. After all, didn't they know what they were getting into? If scientists generally understand that fact that once they produce knowledge, they will probably have no control over how it is used, then they must have surely understood that the devices and apps they were creating might at some point be weaponised. Or did they?

It is possible that many scientists and engineers now objecting to Silicon Valley's military work might have never imagined that they would be drawn into the military-industrial-technological complex. Perhaps they even decided to work for tech companies because they thought those firms were not in the weapons business. After all, the letter written by Microsoft's protesters states: 'We did not sign up to develop weapons'.

The researchers may also have placed inordinate faith in their company's executives. At Google, employees felt betrayed by secretive decisions that led to the Project Maven contract. The business press regularly recognises the firm as having the best 'corporate culture' in the US, not only because employees can bring pets to work and have access to organic meals prepared by professional chefs, but also because the organisation has a reputation for valuing employee collaboration.

Once Project Maven came to light, tech workers' false consciousness began to evaporate. Earning a six-figure income as an engineer or a programmer straight out of college makes it difficult to think of yourself as a proletarian, especially when you're enjoying the perks offered by the industry—free gourmet lunches, on-site gyms, and complimentary childcare, for example. For thousands of employees, being shut out of discussions about whether the company should collaborate in AI weapons development woke up a latent sense of class consciousness.

There was also another problem: Silicon Valley's long-standing entanglements with the Pentagon. As this essay accounts and as noted by Margaret O'Mara, 'Whether their employees realize it or not, today's tech giants all contain some defense industry DNA… This involves a much fuller reckoning with the long and complicated history of Silicon Valley and the business of war'.[50]

The divide between the Pentagon and Silicon Valley is mostly a myth—it's never really existed, at least not in any significant way. The differences are superficial and stylistic. For the better part of a century, the regional economy and culture have been shaped by what might be called the military-industrial-university complex. During the Cold War, the Pentagon helped build the computer industry by awarding military contracts in fields like microwave electronics, missile and satellite production, and semiconductor research.

Historian Thomas Heinrich reminds us that popular portrayals of 'ingenious inventor-businessmen and venture capitalists [who] forged a dynamic, high-tech economy unencumbered by government's heavy hand' draw attention away from the crucial role of 'Pentagon funding for research and development [that] helped lay the technological groundwork for a new generation of startups' in the twenty-first century.[51] From the 1950s until the late 1990s, Silicon Valley's biggest private-sector employer wasn't Hewlett Packard, Apple, Ampex, or Atari. It was defence giant Lockheed. Today the region faces a familiar pattern, albeit that the gargantuan size and influence of today's tech firms dwarf the computer companies of yesteryear.

This is likely to have major implications in the near future. Jack Poulson, a former Google senior research scientist and co-founder of Tech Inquiry, put it to me this way: 'I believe we're witnessing the transition of major US tech companies into defense contracts and would go so far as to predict them purchasing defense contractors in the coming years—something like Amazon buying Raytheon'.[52]

The real fault line isn't between the Pentagon and Silicon Valley. It's *within* Silicon Valley, where a modest contingent of politically awakened engineers and scientists have pushed back against the weaponisation of their work. When they face a full attack from PR messaging, hearts and minds campaigns, 'collaborative' discussion, more compensation and perquisites—and perhaps the tacit threat of losing their jobs or having them outsourced—will they capitulate?

At this point it's too early to know the outcome, but the future of virtual warfare and digital battlefields may well rest in their hands.

BIOGRAPHY

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