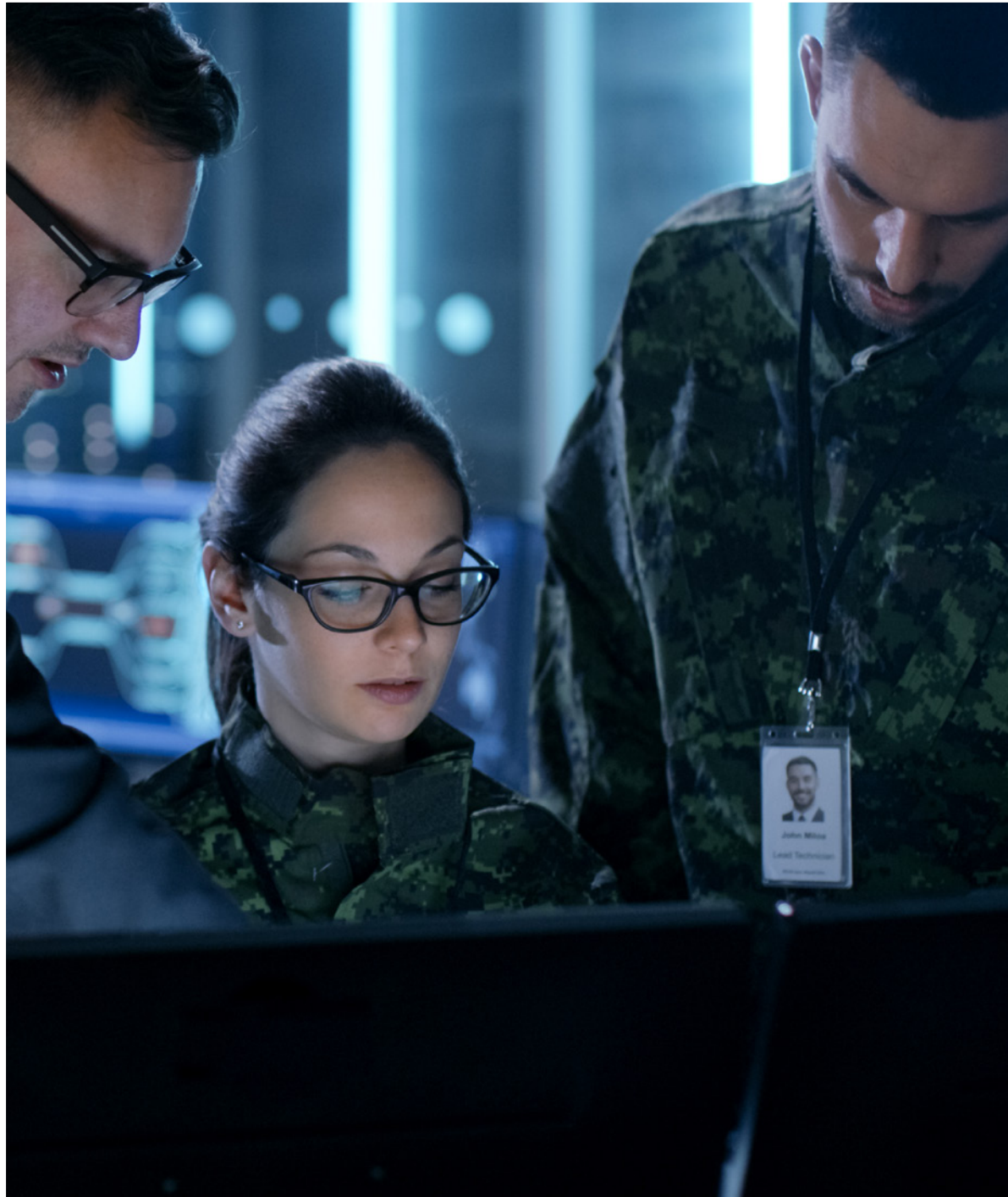


Aerospace and defence trends 2019

Defence contractors face the shadow
of technology

Part of PwC's 22nd Annual Global CEO Survey trends series





The disrupted doctrines

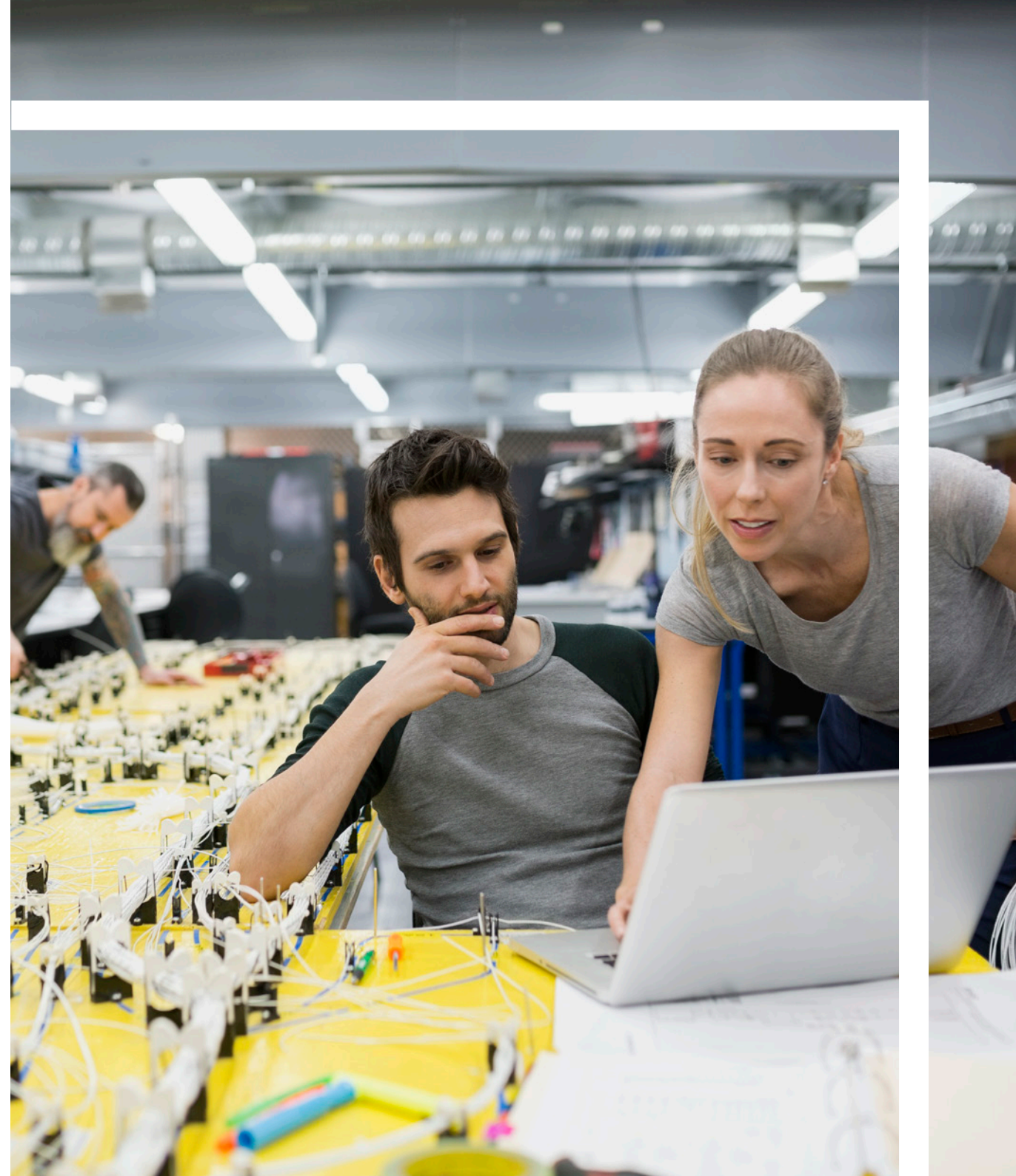
Defence companies are now facing a real crisis that they cannot afford to ignore. In every region of the world, defence ministries are revising their military capabilities and doctrines for the twenty first century — and focussing on new technologies for complex weapons platforms and cybersecurity protection. Innovation, driven by artificial intelligence, connected devices, novel power systems, autonomous platforms, virtual reality and synthetics, and robotics, is increasingly attractive to defence departments. And many of these latest breakthroughs and the most adaptable advances in these technologies are driven by and available not from aerospace and defence (A&D) companies, but from the innovation clusters that are expanding their influence in virtually every large global seat of power.

Western democratic nations may not have the luxury of imposing defence ministry relationships with technology sectors, but they have not been shy about expanding their ties to national centres of innovation in their Silicon Valleys. The US Department of Defense (DoD) launched the Defense Innovation Unit (DIU), which supports experimentation and equipment development in artificial intelligence (AI), autonomous systems, biological warfare and protection, and information technology through venture capital-like investments in startup tech firms. Included in DIU's portfolio is a joint venture between the US Marine Corps and Local Motors (a company based in Arizona's emerging 'Silicon Desert') to deploy portable 3D printer microfactories in spartan wartime environments. Also, a special operations forces programme uses headsets made by Halo Neuroscience (a San Francisco-based maker of cognitive stimulation devices) to assess improvements in tactical motor skills, such as marksmanship, close-quarters combat and overall strength training. Similar technology investment funds have been earmarked through the US Special Operations Command's Sofwerx — a public-private technology incubator meant to attract civilian

innovation — and other programmes being rolled out by the Army, the Defense Advanced Research Projects Agency (DARPA) and the Air Force.

In addition to these initiatives, brand-name US technology companies such as Microsoft and Amazon have had numerous contracts with the military in recent decades. Currently, they are competing for a massive US\$10bn, ten-year enterprise cloud project with the DoD known as the Joint Enterprise Defense Infrastructure (JEDI) to give the US a competitive edge in the intelligence world. Amazon's cloud unit is also a prime contractor to US intelligence agencies. Tellingly, none of the providers of cloud-based services to the DoD or the UK Ministry of Defence, for example, are part of the legacy defence contractor base. Considering that the Pentagon has cited its shift to the encrypted and private cloud as part of its ongoing commitment to strengthen its use of emerging technologies such as AI, machine learning and the Internet of Things, this could have long-term implications for the industry.

As they watch these digital weaponry deals take off, A&D companies have limited R&D firepower to prosecute this prospective tech race. To illustrate, in PwC's 2018



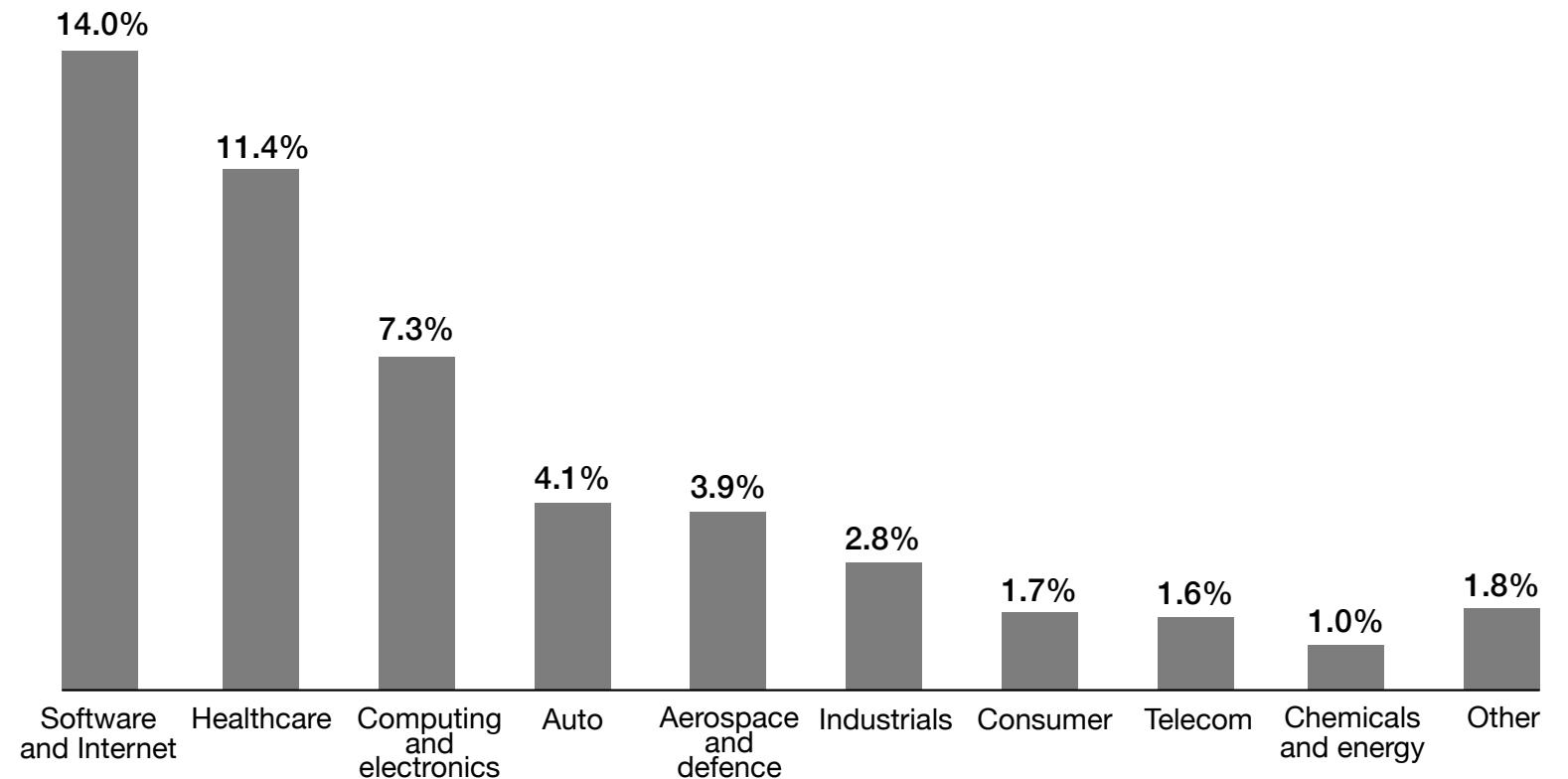
Global Innovation 1000 study, the 32 publicly listed A&D companies decreased their R&D expenditures by 0.5% (US\$22.1bn in 2017 to US\$22.0bn in 2018), and lagged behind their peers in other industries overall. Indeed, even when the US\$100bn of US Department of Defense R&D investments, most of which are allocated to defence companies, is added into the mix, the A&D sector falls well behind other industries (see exhibit).

It's just the beginning

Over the foreseeable future, defence companies will continue to face increased competition from nontraditional commercial entrants, particularly in instances involving dual-use technologies. This has already begun in the field of space launches with Elon Musk's SpaceX and Jeff Bezos's Blue Origin, which have disrupted the Boeing–Lockheed Martin joint venture United Launch Alliance. In the UK, Reaction Engines Limited, founded by three propulsion engineers who had been at Rolls-Royce, has produced a series of engine breakthroughs aimed at improving the efficacy of private space travel. This pattern of newcomers slicing off pieces of business normally monopolised by defence contractors is not likely to abate anytime soon. New rivalries are emerging in space, led by San Francisco-based satellite imaging company Planet Labs; in augmented reality, in which the Swedish software company XMRReality is staking a big

EXHIBIT

R&D intensity (total R&D expenditure/total revenue) by industry



Source: 2018 Global Innovation 1000 Study, Bloomberg data, Capital IQ data, Thomson Reuters Eikon data



The time for urgent response within the A&D sector is now.



claim; and in defence electronics and communications, an area targeted by high-tech firm Mercury Systems, located near Boston.

This isn't to say that all is rosy between defence ministries and technology companies. In the US, some Silicon Valley tech workers are opposed on ethical grounds to the concept of their employers securing military contracts. For instance, because of internal grumbling about Google technologies serving as instruments of war, the company bowed out of Project Maven, a Pentagon programme to develop image-recognition AI. In addition, a generational divide—one in which many of the defence funding decision makers are older and often don't understand the breadth or impact of advanced technologies—has to a degree slowed the movement of funds away from defence contractors to technology firms.

Moreover, the established A&D industry has another advantage that should not be overlooked: its unparalleled ability to build big and complex platforms, such as nuclear weapons systems, hypersonic missiles, nuclear aircraft carriers and fighter aircraft. Those areas will remain the

purview of defence companies for the foreseeable future.

But even with that, current funding and development trends are moving away from the A&D orbit. The need for large military systems is to a degree obviated by technology advancements that can do the job just as well with smaller and more agile equipment. Indeed, the combination of advanced technologies and accelerated acquisition and development programmes that are available from nontraditional suppliers is an increasingly attractive blend for defence departments. It also challenges defence's preoccupation with high-cost 'exquisite' systems and will potentially force a move towards a better and more affordable balance of 'exquisite' and 'expendable' platforms.

A plan of action

In its pattern of development, the crisis facing defence companies is much like the disruption that many other industries are experiencing. Startups emerge on the periphery and then, with increasing speed, redefine the nature of an industry's businesses and commercial relationships. The time for urgent response within the



A&D sector is now. There are still a number of steps that defence contractors could take to regain the upper hand in their industry.

1) Become a partner of choice with technology startups

To access technology advances, A&D companies should explore strategic partnership agreements or venture investments with startup technology firms. Lockheed Martin Ventures, Boeing HorizonX Ventures, Honeywell Ventures and Airbus BizLab are all examples of recent venture funds designed for this purpose. Since 2016, Lockheed has invested US\$40m in eight companies, with plans to funnel another US\$200m in

taxes saved into that fund. One of its most successful investments is Terran Orbital, based in Irvine, Calif., which focusses on nanosatellite design and manufacturing. Lockheed is now partnering with Terran Orbital on various DoD and National Aeronautics and Space Administration (NASA) contracts. In taking this step, defence contractors must overcome their resistance to long-term investment cycles and taking risks on projects that may never pay off.

One possible partnering approach was recently offered by Israel's Sensor Open Systems Architecture (SOSA) consortium, which launched an online platform-based homeland security innovation hub to match defence industry companies with

cutting-edge startups. Israeli defence contractors ELTA Systems and Rafael Advanced Defense Systems have been amongst the first to join this initiative. Such pairing opportunities are particularly apt because although defence companies tend to lack the innovation culture and R&D budgets to pursue every possible avenue of opportunity, defence tech startups don't have the resources needed to navigate and withstand the long-winded procurement cycles of global militaries.

2) Pursue M&A opportunities

Mergers and acquisitions can be an efficient approach to building technology scale and scope for a defence contractor. Deal activity in the global aerospace and

defence sector was strong in 2018, with more than 400 transactions, as the year experienced the third-highest cumulative deal value in history, a continuation of a longer-term trend in which three of the last four years have been the highest. The average deal size was 73% higher than the ten-year average, with the electronics sector accounting for 41% of deal share, followed by an 18% contribution from software and security systems—signifying a growing emphasis on the digital transformation of warfare capabilities.

3) Play to your strengths

Focus R&D and capital expenditure investments in areas in which your company can best differentiate itself. This

should include dual-use technology, which only several major defence companies pursue. To illustrate this, Boeing has continued to invest heavily in autonomous systems applications, anticipating increased Air Force and commercial demand for these technologies. The company had already made great strides in this area as a means of improving productivity for its non-defence operations.

Of course, doing this requires a more dynamic approach to making investment choices, even in the face of uncertainty about future demand. However, there is evidence that such risk taking will be rewarded. This was demonstrated by Boeing and the Swedish aerospace firm Saab Group, which jointly developed a two-seat jet trainer plane for the US Air Force's T-X programme. The two companies have had a long record of success in tactical aircraft development, and as some of the most iconic planes wind down in the next decade (including Boeing's F-15 and F/A-18), the T-X programme offers a way to continue to generate revenue in the tactical arena.

In similar fashion, Lockheed Martin's acquisition of Sikorsky (the Stratford,

Conn.-based aircraft subsidiary of UTC) built on the company's strategic thrust as a defence platform provider. Adding Sikorsky to its existing aeronautics (F-35) and tactical strike platforms gives Lockheed an opening to benefit from growth in so-called vertical lift technology, particularly the unmanned military, urban and commercial helicopters of the future. That market faces years of R&D before it will deliver a real revenue stream, but it represents yet another large family of potential products that Lockheed hopes to offer with various features and designs.

4) Reexamine make/buy decisions

Companies can make the supply chain a channel for creativity by determining when to outsource more of the product development to suppliers with unique technology capabilities, or by establishing who could produce and design parts and components more affordably. For example, Lockheed Martin selected the Fort Worth-based technology producer Harris Corporation to provide the F-35's next-generation open system architecture-based central data processor, providing a 75% unit cost reduction and a 25-fold increase in computing power to support

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planned aircraft capability enhancements and lower sustainment costs. Depending on a single supplier can be a problematic approach, however, as it is possible that these partners may be acquired by a competitor.

5) Recruit the right talent

As always, innovation springs from talent. PwC's 22nd Annual Global CEO Survey highlights the war for talent, which for the A&D sector poses a growing talent crunch to attract and retain critical skills. With the increasing technology focus of today's business environment, skills traditionally associated with sectors such as A&D are in demand by other industries. And even though A&D companies are emphasising workforce training in areas such as data science, automation, cyber and advanced manufacturing, evidence suggests that other industries are way ahead in the race to hire and retain talent. For example, the AI gap is widening between A&D and other industries, as some tech companies have grown their AI capabilities more than the A&D industry has as a whole over the past several years. This of course will pose

major challenges as countries such as China spend billions of dollars to fulfil their ambitions of becoming a global leader in AI.

Clearly, defence contractors have their work cut out for them, much of it the result of the shadow cast by new technologies and new rivals. And in many cases, they seem a bit caught off guard and not sufficiently proactive in dealing with the disruption occurring in their industry. But A&D companies have a long history of innovation and strong R&D teams, even if they haven't funded them to the same levels as those of other industries, such as technology, that are now entering the defence market. Moreover, the strategies that A&D companies can choose from to thrive in this period of renewed competition run the gamut from internal improvements to external partnerships.

This all means that A&D companies are actually just a good strategic move or two away from fending off new competition and controlling the future of their own industry. At this point, their critical challenge is to not be afraid to make the right decisions.

Strategy made real

How should governments and the defence industry address the friction points that are hindering innovation?

An ideal operational relationship between global militaries and defence industry manufacturers would support risk taking to drive private-sector technological advances, whilst simultaneously guarding against budgetary excesses. But no country with a major military has been able to put these pieces together satisfactorily.

In the US and much of the West, the disconnect between the public and private sector is chronic, in part because military spending is cyclical and does not grow materially over the long term. Consequently, identifying and funding projects that bring tangible returns in a relatively short period is usually a priority for defence departments. But to prove out new technology so that it can be utilised in next-generation military equipment requires a substantial commitment of up-front R&D and engineering resources, at least some of which falls on the private sector. In many cases these companies are loath to make these investments without an assurance that they will be adequately covered.

As a starting point, the government and the defence industry should address these immediate issues in order to create a more welcoming environment for innovation:

- 1) To overcome the fear of risk taking, defence suppliers should focus R&D and capital expenditure investments in areas in which they have already demonstrated expertise and can take advantage of accumulated knowledge to produce new advances.
- 2) Defence departments should widen their orbit to include procuring more cutting-edge technology from companies that are not traditional private-sector suppliers. This would accomplish twin goals. First, it would give the military access to the latest digital breakthroughs. Second, it would drive incumbent defence contractors into partnerships and acquisitions of newly competing startups, which in turn would improve the innovation engines and product development agility at these established companies. Many of the technologies that would be acquired under this approach initially began as products for non-defence applications. In November 2018, for instance, the US Army awarded Microsoft a US\$480m contract to supply more than 100,000 HoloLens mixed-reality headsets for use on combat missions and in training. Microsoft won out over 25 companies that were interested in participating, including contractors such as Booz Allen Hamilton, Lockheed Martin and Raytheon.

The Pentagon is reorganising itself to accelerate these acquisitions. It announced a competition, Army Expeditionary Technology Search (xTechSearch), to look for startups ('non-traditional defence partners') to help the Army develop new weapons tech. The DoD also launched the Defense Innovation Board and a dedicated research and engineering organisation focussed on maintaining a technological edge, whilst doubling down on innovative groups such as the Defense Innovation Unit (DIU), a rapid prototyping and experimentation office meant to promote more engagement with the private sector. The US Army has also established a Futures Command to address how innovative technology plays a role in maintaining its future fighting capabilities.

3) Defence departments and the private sector must break through the cultural divide that hinders cooperation between commercial technology companies and the military. The US provides a good illustration of this. Less than half a percent of the US population serves on active duty. A senior executive from a major Silicon Valley firm recently told us that none of the company's engineers had ever worked with anyone from the military. As a result, many in tech companies harbour deep ethical concerns about helping soldiers

kill people and win wars, whilst many in the defence community are aghast at what they view as the erosion of patriotism and national service in the tech industry.

There is also a knowledge gap between leaders in Washington, who are mostly lawyers struggling to understand recent technological advances, and executives in Silicon Valley, who are mostly engineers struggling to understand the age-old dynamics of international power politics. In the past, it wasn't difficult for policymakers to understand the essence of breakthrough technologies such as the telegraph, the automobile and nuclear fission. Technology moved faster than policy, but the lag was more manageable. Digital technologies are different, spreading quickly and widely, with societal effects that are hard to imagine.

These issues and others that separate military agencies from the private sector are hurting the prospects for growth for traditional defence suppliers and the increasing number of startups involved in the industry. In the end, in developing nations or the West, a concerted effort by governments and the defence industry to identify key issues and strategies for resolving them will be necessary to overcome their negative impact.



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About PwC's 22nd Annual Global CEO Survey

PwC conducted 3,200 interviews with CEOs in more than 90 territories.

Notes:

- Not all figures add up to 100%, as a result of rounding percentages and exclusion of 'neither/nor' and 'don't know' responses.
- We also conducted face-to-face, in-depth interviews with CEOs and thought leaders from five continents over the second half of 2018. The interviews can be found at ceosurvey.pwc.
- Our global report (which includes responses from 1,378 CEOs) is weighted by national GDP to ensure that CEOs' views are fairly represented across all major regions.
- The research was undertaken by PwC Research, our global centre of excellence for primary research and evidence-based consulting services: www.pwc.co.uk/pwcresearch.

You can find other CEO Survey reports here:

ceosurvey.pwc



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