6

An innovative workforce

An apparent paradox of a world where intelligent machines play a crucial economic role is not only that human beings continue to play a critical role in civilian and military organizations, but also that this role will likely become even more important – as human beings will fulfil those central tasks that are beyond the capacity of machines.[150] This means that for the Atlantic Alliance, as for any other organization, recruitment, retainment, promotion, training and continuous education are strategic components of organizational growth.[151] This is a subtle challenge – not least because, while these domains are certainly part and parcel of successfully running the organization, they are not its core business. However, NATO has a stake in the game because, without addressing these issues, it risks, like any other organization, being left behind, outcompeted and eventually forced into vulnerability or irrelevance.[152]

The digital revolution that emerged in the 1990s triggered a major change, whose consequences have started to be appreciated only recently.[153] The digital economy displays some key features that are dramatically different from the industrial era:[154] marginal costs of production tend to zero, marginal returns are increasing (rather than decreasing), and value is generated by demand-side economies of scale (network externalities) rather than supply-side economies of scale (increased efficiency due to larger production runs).[155]

150 P. R. Daugherty and H. J. Wilson, *Human + machine: reimagining work in the age of AI*, Harvard Business School Press, Cambridge, MA, 2018.

151 US Department of Defense, *AI education strategy: cultivating an AI ready force to accelerate adoption*, Joint Artificial Intelligence Center, Washington, DC, 2020.

152 Schmidt *et al.*, *NSCAI Interim Report and Second Quarter Recommendations Memo*. A. Asoni, A. Gilli, M. Gilli & T. Sanandaji, "A mercenary army of the poor? Technological change and the demographic composition of the post-9/11 US military", *Journal of Strategic Studies* (forthcoming).

153 W. Isaacson, *The innovators*. For the lag in the effects of the IT-driven revolution, see E. Brynjolfsson, D. Rock, and Chad Syverson, "Artificial intelligence and the modern productivity paradox: a clash of expectations and statistics", in A. Agrawal, J. Gans and A. Goldfarb (eds.), *The economics of artificial intelligence*. See also P. A. David, "The dynamo and the computer: an historical perspective on the modern productivity paradox", *The American Economic Review*, Vol.80, No.2, May 1990, pp.355-361.

154 Brynjolfsson and McAfee, *The second machine age: work, progress, and prosperity in a time of brilliant technologies*.

155 C. Shapiro and H. R. Varian, *Information rules: a strategic guide to the network economy*, Harvard Business School Press, Cambridge, MA, 1998.

These features, in turn, promise to reshape market structures and business strategies, with profound consequences both at the micro and at the macro level. In terms of industry and markets, for example, we observe the rapid emergence of digital titans whose reach, power and capabilities seem almost unlimited.[156] For instance, Facebook, Uber, Alibaba and AirBnB have quickly come to dominate the media, taxi, retail and hospitality industries respectively, despite their producing no content and owning no vehicle, inventory or real estate.[157] Similarly, the time for a startup to reach a market capitalization of USD 100bn has shrunk from 20 years for Fortune 500 companies to eight years for Google, and to three years or less for Uber, Snapchat and Xiami – while Snowflake took just one day to reach a USD 50bn capitalization.[158] Consistent with this trend, turnover rates in the S&P Index as well as in the Fortune 500 have been incessantly accelerating in the recent past.[159]

At the micro level, conversely, we have witnessed a dramatic increase in the deviation from the mean – a phenomenon that economist Tyler Cowen has described with "average is over". Specifically, because of technological change and the resulting trends towards market concentration that have taken place over the past decades, market dynamics rewards superstar performers, while the opportunities for those in the average part of the distribution have shrunk significantly.[160] The former head of Google's Human Resources, Laszlo Bock, well described this trend by providing a simple insight: in the high-tech industry, one top engineer equals 300 good engineers.[161] Interestingly, and related to this observation, such talent is extremely concentrated. In fact, AI expertise remains surprisingly rooted in the universities that pioneered these technologies: Stanford and the University of California-Berkeley have historically possessed the top courses in AI, thus feeding Silicon Valley with the human capital it needs;[162] Google's DeepMind is in London, because that is where the founding researchers lived; the first expansion of DeepMind outside the UK was to Edmonton in Alberta, because Richard Sutton, a key inventor of reinforcement learning, lives there; Uber opened an AI office in Toronto because it wanted to hire Raquel Urtasun,

156 M. Ford, *Rise of the robots: technology and the threat of a jobless future,* Basic Books, New York, NY, 2015; S. Zuboff, *The age of surveillance capitalism: the fight for a human future at the new frontier of power*, Public Affairs, New York, NY, 2018; and P.W. Singer and E. T. Brooking, *LikeWar: the weaponization of social media*, Houghton Mifflin Harcourt, New York, NY, 2018.

157 T. Goodwin, "The battle is for the customer interface", *Techcrunch*.com, 3 March 2015.

158 World Economic Forum & Accenture, "Digital transformation of industries: digital enterprise", *White Paper*, Davos, World Economic Forum, 2016, p.7.

159 A. Dafoe, "Governing the AI revolution: the research landscape", Paper presented at the Center for International Security and Cooperation, Stanford University, Stanford, CA, 2018.

160 T. Cowen, *Average is over: powering America beyond the age of the great stagnation*, Dutton, New York, NY, 2013.

161 L. Bock, *Work Rules!: insights from inside Google that will transform how you live and lead*, Twelve, New York, NY, 2015.

162 P. Stone *et al.*, "Artificial intelligence and life in 2030: one hundred year study on artificial intelligence", Report of the 2015 Panel, Stanford University Press, Stanford, CA, 2016.

a University of Toronto professor.[163]

Google, like other digital titans, has relentlessly worked to recruit that one engineer out of 300.[164] Securing top engineers entails a comparative advantage *vis-à-vis* adversaries in performance and in resources, as competitors would not only struggle to secure the remaining top engineers, but might compromise with many "good" ones.[165] Unfortunately, most schools, colleges and universities within NATO countries are not explicitly designed to identify, nurture and promote such top talent. In contrast, education in most countries is still designed for the industrial era, where average performance was an asset. Organizations, whether private companies or public institutions, are almost always equally unfit to manage the transition towards a world where top talent is crucial. It is not a coincidence that many founders of the leading digital companies forewent college education and their career did not start at established companies. Top talent in digital companies often comes in part from abroad: this is definitely a sign that some countries cannot produce it, and thus need to import it, while others cannot retain it, and thus are unable to exploit it.[166]

This discussion leads to an inevitable question: how to lead, rather than follow, in the average-is-over age, when top talent is a key ingredient for success but few organizations and countries have real strategies to identify it, nurture it and promote it? This is a fundamentally important question, as we can evince when we look at the inherent risks of inaction. If NATO Allies do not adopt the appropriate policies and solution, they risk struggling with talent in the years ahead, which will entail significant problems both for their economies and for their military power. It is, however, also important to look at some opportunities and comparative advantages: NATO Allies host some of the most important global hubs for AI, like the Bay Area, Austin, Seattle, Boston, Amsterdam, Paris, Berlin, Toronto, Montreal, London or Oxford.[167] Additionally, several NATO countries possess significant AI latent power – i.e., highly skilled human capital, working primarily in universities or research centres, which nevertheless has relatively limited involvement with private or government work.[168] Building on lessons learned, experience, and insights from

---

163 A. Goldfarb and D. Trefler, "Artificial intelligence and international trade", in Agrawal, Gans and Goldfarb, *The economics of artificial intelligence*, pp.463-92. See also J. Olander and M. Flagg, "AI hubs in the United States", *CSET Data Brief*, Center for Security and Emerging Technology, Washington, DC, May 2020.

164 E. Schmidt and J. Rosenberg, *How Google works*, Grand Central Publishing, New York, NY, 2014.

165 M. E. Porter, *Competitive advantage of nations hardcover*, Free Press, New York, NY, 1990; R. Gunther McGrath, *The end of competitive advantage: how to keep your strategy moving as fast as your business,* Harvard Business School Press, Cambridge, MA, 2013.

166 TalentSeer, *2020 AI talent report: current landscape & market trends*, TalentSeer, 2020; M. Sheehan, "Chinese AI talent in six charts", Macro Polo: Decoding China's Economic Arrival, Chicago, IL, 2020; Rasser *et al.*, *The American AI Century.*

167 D. Castro, M. McLaughlin and E. Chivot, *Who is winning the AI race: China, the EU or the United States?* , Center for Data Innovation, Washington, DC, 2019.

168 *Ibid.*

the relevant academic literature, we can identify several possible courses of action.

Nurturing creativity. In his legendary *Fleet Tactics*, Capt. Wayne P. Hughes noted that he grew passionate about naval warfare when, as a teenager during World War II, he bought a copy of Jane's *All the World's Fighting Ships*.[169] This is an interesting insight, because the (fairly) expensive Jane's publication was still reasonably affordable to a motivated kid interested in exploring the world of defence. Somewhat similarly, Bill Gates was able to unleash his passion for computing because, the high school he attended in the late 1960s was among the few in the world that had a computer that he and his pals could use to experiment.[170] From Hughes to Gates, the barriers to entry had grown significantly and from the 1960s, when Gates was in school, to our time, they have continued to increase exponentially: as a result, many children and teenagers are deprived of the opportunity to discover their "true calling". Nowadays, children or teenagers interested in AI, ML and BD in fact face major barriers, the so-called "AI divide": some may not have access to fast and reliable internet connections (geography), others may not have access to laptops or desktops (inequality), all teenagers are excluded from large datasets – whether owned by governments or multinational corporations – and from sufficient computing power.[171] NATO Allies might consider implementing policies aimed at democratizing access to AI capabilities, as there are good reasons to think this will help the Alliance maintain its technological primacy in the long-term. How? Making government datasets available could be a first step.[172] Promoting digitalization in schools is a second step. Although this is not the role of NATO or of Allies' Ministries of Defence, several opportunities exist: while striking deals with major cloud computing providers, Ministries of Defence could negotiate that some remote computing resources be allocated to schools, including their military academies. NATO Allied governments could equally increase funding to these initiatives, as well as organize grand challenges in cooperation with major tech companies in which participants are granted access to remote computing power.[173] Alternatively, the US National Security Commission on Artificial Intelligence recommends creating a USD 25m 5-year AI infrastructure to provide researchers and students with computing power, government datasets as well as educational tools and user support, so as to democratize AI. A similar initiative, potentially launched in cooperation with the European Union, would

169 W. P. Hughes, *Fleet tactics and coastal combat*, Naval Institute Press, Annapolis, MD, 2014.

170 P. E. Ceruzzi, *A history of modern computing*, The MIT Press, Cambridge, MA, 2003, 2nd edition.

171 N. Ahmed and M. Wahed, "The de-democratization of AI: deep learning and the compute divide in artificial", *arXiv*, 2010.15581v, 2020. For a discussion on national strategies, see Rasser *et al., The American AI Century.*

172 Schmidt *et al.*, *NSCAI Interim Report and First Quarter Recommendations Memo*, p.11.

173 Rasser *et al.*, *The American AI Century.*

cost less than USD 1m per NATO/EU member.[174]

Changing education. NATO countries also face a related challenge with education. Besides the oft-repeated claim that more Science, Technology, Engineering and Maths (STEM) students are needed, the student population in NATO countries often lacks familiarity with modern technologies and relevant problem-solving and team-working skills – i.e., the very skills which will acquire importance in an age where intelligent machines become more central.[175] This assessment has very serious implications that trickle down to the world of defence, where organizations struggle to find suitable candidates and their difficulties will grow more acute in the years ahead. NATO Allies could actively contribute to addressing this problem, at least partially, by sponsoring more proactive university classes to endow students with the skills of the future. *Hacking for Defense*, the Stanford University-born innovation class, is an interesting model that could be adopted or applied – at very limited cost.[176] The simple idea would be to identify a set number of annual problems that defence organizations both at the national and multinational level cannot solve, and ask universities to provide solutions. Potentially, this model could be turned into a competition among universities from NATO countries in order to identify the best programmes when it comes to delivering effective solutions. Some universities would probably oppose such an initiative, and not participate. Others, more interested in the success of their students, would probably join in, which might generate positive cascade effects on the entire university ecosystem: universities would prioritize students' learning and growth; students would acquire appropriate skills such as working in groups and pragmatic problem-solving as well familiarity with the world of technology and defence and a more multidisciplinary training; NATO and its Allies could have access to ingenious solutions, as well as to a more qualified workforce.[177]

Promoting relevant academic research. Academic research in several fields seems to have entered a perverse spiral, according to prominent scholars.[178] Originally, higher education institutions

174 Schmidt *et al.*, *NSCAI Interim Report and Second Quarter Recommendations Memo*, p.12.

175 C. M. Christensen, Curtis W. Johnson, and Michael B. Horn, *Disrupting class: how disruptive innovation will change the way the world learns*, McGraw-Hill, Boston, 2008.

176 For further information see https://www.h4d.us/: *HACKING for DEFENSE® The Nation's Brightest Minds Tackling Your Toughest Problems*.

177 Geoffrey Parker, Marshall Van Alstyne and Sangeet Paul Choudary note how education is prone to disruption, but it has not been disrupted yet. See G. G. Parker, M. W. Van Alstyne and S. P. Choudary, *Platform revolution: how networked markets are transforming the economy and how to make them work for you*, W. W. Norton & Co., New York, NY, 2016.

178 To our own delight, the US National Security Commission on Artificial Intelligence's Third Quarter Recommendations, which were recently published, advance suggestions which go in the same indirection, including innovation awards, emphasis on multidisciplinary research and incentives for high-risk research: Schmidt *et al.*, *NSCAI Interim Report and Third Quarter Recommendations Memo*, pp.30-33.

started rewarding publications in order to identify the best scholars, and thus contribute to a vibrant intellectual life within universities.[179] However, as warned by anthropologist Marilyn Strathern, "when a measure becomes a target, it ceases to be a good measure".[180] This is what has happened within many academic disciplines: over time, the practice of rewarding publications has lost its initial intent (it is important to recognize, however, that there are significant differences from one discipline or country to others).[181] As a result, prominent scholars complain that the growth in academic publications has generated less and less knowledge: publications no longer aim at generating new knowledge, but have progressively become a means for career progression.[182] The skewing of the reward system in academic research towards large numbers of publications (the so-called "publish-or-perish" imperative) has in fact created perverse incentives for young scholars to pursue less risky projects that can deliver several publications in a short time-span.[183] While rational from an individual perspective, this strategy risks having severe negative side effects at the societal level. One obvious danger is that, by the age most researchers have job stability (tenure) and hence the possibility to pursue knowledge, they are likely going to be well past the "creative age" (which is generally below 35).[184] In addition, for a field like AI that is subject to increasing returns of scale and where "300 good engineers equal one top engineer", academic incentives that reward quick and safe publications might come with huge long-term costs. The obvious downside here is that NATO Allies risk carrying out less and less real research, and hence producing less and less useful knowledge, even though they publish more and more articles. Some academic disciplines have already atrophied and the corollary to this is a steady decrease in innovation and innovators.[185]

179 J. Mokyr, "The contribution of economic history to the study of innovation and technical change, 1750-1914", in B. H. Hall and N. Rosenberg, eds., *Handbook of the Economics of Innovation*, Vol.1, New York, Elsevier, 2010, pp.11-51.

180 M. Strathern, "'Improving ratings': audit in the British University system", *European Review*, Vol.5, No.3, 1997, pp.305-321.

181 As the authors of a quite controversial book put it, "never before in the history of humanity have so many written so much while saying so little". See M. Alvesson, Y. Gabriel, and R. Paulsen, *Return to meaning, a social science with something to say*, Oxford University Press, Oxford, UK, 2017.

182 "J. Scott, "Agriculture as politics, the dangers of standardization and not being governed", *Theory Talk blog*, 15 May 2010, http://www.theory-talks.org/2010/05/theory-talk-38.html; D. Colquhoun, "Publish-or-perish: peer review and the corruption of science", *The Guardian*, 5 September 2011.

183 W. de Freitas, "Publish or perish culture encourages scientists to cut corners", *The Conversation*, 22 September 2015; G. Gazda, "Publish or perish dilemma", *Behavioural and Social Sciences at Nature Research*, 11 October 2019.

184 D. K. Simonton answers, "Does creativity decline with age?", *Scientific American*, 1 March 2016; K. H. Kim and R. A. Pierce, "Creativity and age", in E.G Carayannis (eds), *Encyclopedia of creativity, invention, innovation and entrepreneurship*, Springer, New York, NY.

185 A major scandal erupted a few years ago in the field of social psychology, where the push to publish led to a replication crisis. It proved impossible to replicate the results of more than 50% of academic studies. See for example E. Yong, "Replication studies: bad copy", *Nature* 485, May 2012, pp.298-300; E. Yong, "Psychology's replication crisis is running out of excuses", *The Atlantic,* 19 November 2018. This problem does not affect only this field, see for instance A. Ortmann, "The

By the same token, truly talented and motivated individuals may be discouraged from entering the field of research, or they may be pushed out if they do.[186] If machines do the heavy computations, the added value from human beings must come from their core strength: policy-makers must hence start from the acknowledgment that any solution needs to reward, first and foremost, creativity and ingenious ideas (and hence the individuals/teams producing top research). One obvious rationale is that, as intelligent machines will take over many tasks from human beings, multidisciplinary research in several fields (e.g., ethics, cognitive sciences, organizational studies) will be necessary to better understand human-machine interactions. For instance, Pedro Domingos notes how machine learning's insights in counter-terrorism can be easily neutralized by an effective terrorist group: "the solution is to marry machine learning with game theory […] don't just learn to defeat what your opponent is doing now; learn to parry what he might do against your learner".[187] Otherwise, it will be even more challenging to learn, to adapt and adopt appropriate solutions. This is why, while not strictly speaking a responsibility of Ministries of Defence and Foreign Affairs, growing awareness of this problem is important for its potential long-term consequences. A proactive response is necessary, two possibilities being:

- the adoption of major rewards for those conducting top research, or weighting the adjudication of research grants in favour of (groups of) scholars conducting top research;[188]
- the creation of NATO fellowships, similar to the European Commission's Jean Monnet Chairs, restricted to young emerging scholars conducting top research.[189]

The key challenge is ensuring that such funding truly reaches top emerging scholars, i.e. commissions cannot be populated by individuals who have systematically rewarded quantity over quality of publications.

Access to talent and recruitment. As "NATO-mation" accelerates, and NATO Allies integrate enterprise-level AI into their armed forces, recruitment challenges will grow more acute: the faster the pace, the more acute the challenge. The essence of strategy, however, is to dictate the pace of change so as not to have it determined by material constraints. Intra-

---

replication crisis has engulfed economics", *The Conversation*, 13 November 2015; J. Bohannon, "About 40% of economics experiments fail replication survey", *Science*, 3 March 2016; A.Wuttke, "Why too many political science findings cannot be trusted and what we can do about it: a review of meta-scientific research and a call for institutional reform", *Politische Vierteljahresschrift / German Political Science Quarterly*, Vol.1, No.60, 2019, pp.1-22.

186 J. Scott, "Agriculture as politics, the dangers of standardization and not being governed", *Theory Talk blog*.

187 Domingos, *The Master Algorithm*, p.20.

188 Also in this case, the US National Security Commission on Artificial Intelligence advances similar proposals. See Schmidt *et al.*, *NSCAI Interim Report and Third Quarter Recommendations Memo*.

189 A number of countries already offer similar fellowships, though some observers may wonder why Ministries of Defence and Foreign Affairs should worry about research in general.

Alliance coordination, as discussed above, can prove an important enabler in this respect. On the one hand, the Alliance can design pooling or scaling mechanisms for some types of AI tasks or missions: for instance, 80 to 90 percent of data science will entail manual vetting of data, including labelling and structuring. There is enormous potential for plugging in different contributions to the overall effort from different corners of the Alliance, and thus reducing individual Allies' manpower needs. Similarly, by coordinating and cooperating on the development of common solutions, Allies can share their talent pool and thus more easily achieve their end goals. The economics of software affords an advantage in this respect. In terms of human capital, the entry barriers for software development are high: it takes time, resources and institution to develop a talented software workforce. However once developed, software can be reproduced at basically no cost. NATO Allies thus have an incentive to work together with joint teams for the development of solutions. Finally, through an organization like a potential A3IC, NATO could provide an important source of support for individual Allies: for instance, it could assist the creation of digital corps or digital reserves as well as in revisiting recruitment procedures for machine learning exerts.[190]

190 Schmidt *et al.*, *NSCAI Interim Report and Third Quarter Recommendations Memo.*