National Defence Défense nationale

Canadian Forces College

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Digitalization of the Royal Canadian Air Force

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JCSP 49

Service Paper

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PCEMI n° 49

Étude militaire

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CANADIAN FORCES COLLEGE - COLLÈGE DES FORCES CANADIENNES

JCSP 49 - PCEMI n° 49
2022 - 2023

Service Paper – Étude militaire

DIGITALIZATION OF THE ROYAL CANADIAN AIR FORCE

Major Juliane Ross

DIGITALIZATION OF THE ROYAL CANADIAN AIR FORCE

AIM

1. The aim of this service paper is to assess the significance of digitalization and networking for the Royal Canadian Air Force in order to provide recommendations to help the organisation to meet the challenges of the twenty-first century.

SCOPE

2. A number of issues are involved and will be discussed below; of these the central issues for the RCAF are digitalization and networking. Topics discussed:

a. Context
   i. General world context of digitalization;
   ii. The Commitment of Canada to Digitalization; and
   iii. Activities by other agencies (Canadian Army)

b. Key concepts of digitalization and networking (which will be explained later in detail):
   i. Definitions;
   ii. Connected Fight;
   iii. Connected Technologies;
   iv. Connected Humans; and
   v. Connected Industry.

DISCUSSION

Context

3. General world context of digitalization. Digitalization and networking are two of the most significant elements in the Fourth Industrial Revolution[1] which is characterized by demographic changes, global economic shifts, resource scarcity, and a perceptible acceleration toward digitalization.[2] These developments are interdependent, affect all nations, and disrupt all fields, including defence. Global changes demonstrate the necessity of integrating digital literacy into the Canadian Armed Forces.[3]

4. The Commitment of Canada to Digitalization. It is essential to emphasize the Government of Canada's commitment to digital transformation first.[4] In 2018, a Minister of

[1] Royal Canadian Airforce, 'Future Concepts Directive Part 2: Future Air Operating Concept' (Ottawa, 15 August 2016), 8.
[2] Klaus Schwab, 'The Fourth Industrial Revolution', *Foreign Affairs*, 22 August 2022.
[3] Department of National Defence, 'STRONG.SECURE.ENGAGED. Canada's Defence Policy' (Ottawa, 2017), 14.
[4] Treasury Board of Canada, 'Digital Government Strategy', 10 June 2021, https://www.canada.ca/en/government/system/digital-government/digital-government-strategy.html.

Digital Government of Canada portfolio was created, which is solely dedicated to the issue.[5] This commitment is further demonstrated by the government's participation in the creation of a Digital Nations Charter and the subsequent release of Canada's Digital Government Strategy in 2021.

5. Activities by other components. Other components of the CAF have already successfully advanced the digitalization process. The Canadian Army has identified digitisation and improved connectivity as the first of six principles for force modernisation, which is reflected in the army's intentions, work lines, and operational initiatives.[6] Inferences and action directives are also possible for the RCAF.

6. Implications for the Royal Canadian Air Force (RCAF). According to the Future Concepts Directive Part 2: Future Air Operating Concept (2016), the operational environment is becoming increasingly complex and dynamic for the RCAF.[7] The RCAF's new strategy paper emphasises the importance of creating an RCAF that is "digital by design" in order to achieve information dominance and decision superiority.[8] To remain effective and adaptable the RCAF must be able to utilize the most recent technological advancements.

Recommendation 1. Develop a comprehensive digital strategy outlining the RCAF goals and objectives for digitalization and networking, as well as the technologies and systems that will be used to achieve these goals.

Key Concepts of Digitalization and Networking

7. The following paragraph will present key definitions and concepts of connected battle, connected technology, connected human, and connected industry in order to achieve these objectives.

8. Definitions

a. Digitalization. The process of converting analogue information into digital format is called digitalization. Digitalization allows the RCAF to store, access, and analyse large amounts of data more efficiently.[9] By enabling real-time data processing and analysis, digitalization can be used to improve the value of data provided by aircraft sensors such as radar and cameras.

b. Networking. Networking involves connecting various systems and devices in order to share data and resources. This allows the RCAF to coordinate and control its operations more effectively. For instance, networking can be used

[5] Justin Trudeau, 'ARCHIVED - Minister of Digital Government Mandate Letter', Prime Minister of Canada, 12 December 2019, https://pm.gc.ca/en/mandate-letters/2019/12/13/archived-minister-digital-government-mandate-letter.

[6] HQ, Canadian Army, 'Advancing with Purpose: The Canadian Army Modernization Strategy' (Ottawa, December 2020).

[7] Royal Canadian Air Force, 'Future Con cepts Directive Part 2: Future Air Operating Concept' (Ottawa, 15 August 2016), 8.

[8] Royal Canadian Airforce, 'Royal Canadian Airforce Strategy. AGILE · INTEGRATED · INCLUSIVE' (Ottawa, February 2023).

[9] Christine Legner et al., 'Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community', *Business & Information Systems Engineering* 59 (2017): 301–8.

to improve the efficiency of air-to-air and air-to-ground communications, allowing the RCAF to respond more effectively to rapidly changing battlefield conditions.[10]

9. Digitalization, in the context of the RCAF, includes shaping mentality, processes, and capabilities.[11] In its concrete form, it provides decision-making support through highly networked data processing as the foundation for command superiority, which makes command available in a new form for the mission.[12]

10. Connected Fight. A connected fight is a military concept that refers to the capability of different military elements to share information and resources in real-time, as well as to effectively coordinate and control their operations.[13]

11. Connected Fight in the RCAF. Digitalization and networking enable the RCAF to collect, process, and analyse information from multiple sources from different components more efficiently. This can help improve the RCAF's situational awareness, enabling it to respond more effectively to changing battlefield conditions.[14] The digitalization of the RCAF, for instance, can be used to enhance aircrews' situational awareness by providing them with real-time data from advanced sensors such as radar and cameras. This can help reduce the risk of collisions and other dangers, thereby enhancing the overall safety of the RCAF's operations.[15]

12. Joint Connected Fight. The digitalization of the RCAF can also be used to improve the interoperability of its systems and devices, allowing the air force to coordinate and control its operations with other military services, such as the army and navy, more effectively. This can assist in enhancing the overall effectiveness of the Canadian military in a connected conflict.

13. Overall, the digitalization of the RCAF is essential for a connected fight. This concept can be supported by the digitalization of the RCAF, which will enable the air force to collect, process, and share large amounts of information in real time, and to connect its systems and devices in order to more effectively share information and resources.[16]

Recommendation 2. Develop a comprehensive digital strategy outlining the air force's goals and objectives for digitalization and networking, as well as the technologies and systems that will be used to achieve these goals.

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[10] Eric W Frew and Timothy X Brown, 'Networking Issues for Small Unmanned Aircraft Systems', *Journal of Intelligent and Robotic Systems* 54 (2009): 21–37.
[11] Peter C Verhoef et al., 'Digital Transformation: A Multidisciplinary Reflection and Research Agenda', *Journal of Business Research* 122 (2021): 889–901.
[12] Dennis K. Leedom, 'Thinking Inside or Outside of the Box: Impact of Digitization on Battle Command', *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 43, no. 3 (1999): 349–53.
[13] Lieutenant-Colonel Pux Barnes, 'Mission Command and the RCAF: Considerations for the Employment of Air Power in Joint Operations', 2014, 5.
[14] Louise Ebbage and Barry McGuinness, 'Assessing Human Factors in Command and Control: Workload and Situational Awareness Metric' (Bristol, May 2002),3.
[15] Yunfei Yin, Guanghong Gong, and Liang Han, 'Experimental Study on Fighters Behaviors Mining', *Expert Systems with Applications* 38, no. 5 (2011): 5737–47.
[16] Xiao Song et al., 'Military Simulation Big Data: Background, State of the Art, and Challenges', *Mathematical Problems in Engineering* 2015 (24 November 2015): 1–20.

Recommendation 3. Develop a robust networking infrastructure to connect diverse air force systems and devices, as well as those of other military services, in order to effectively share information and resources.

14. Connected Technology. Connected Technology, also known as the Internet of Things, refers to any technology that is connected to the internet or similar digital networks (IoT).[17] Networking and interoperability are essential components of the air force's high technology strategy. By connecting its systems, the air force can quickly share information and resources, allowing it to respond in real time to changing situations. This enables the air force to not only respond to threats more effectively, but also operate more efficiently, saving time and resources.

15. There are numerous digitalization applications, ranging from the automated processing of unmanageable data clusters (big data) to systems with complex decision-making aids (artificial intelligence). Numerous examples are particularly useful for the RCAF, both now and in the future. For instance, pilots are aided in the operation of their aircraft by assistive systems that employ comprehensive algorithms to connect a wide variety of operating parameters. Analyses of big data will allow more effective mission planning and preparation of operational weapon systems. The use of virtual reality will elevate realistic training to an entirely new level.[18]

16. Unmanned aerial vehicles (UAVs), are one example of the air force's high-tech approach. These systems have become an integral part of the air force's arsenal, providing ground troops and decision-makers with intelligence and surveillance capabilities in real time. The air force has embraced the use of UAVs by developing complex systems and integrating them into its existing network, allowing it to respond rapidly to new situations and provide vital intelligence to those in need.

17. Without digital support, it is difficult to disseminate the avalanche of information that people must now manage.[19] The RCAF should improve and ensure mission execution with connected technologies while keeping humans in the loop. Digital technologies can enhance the safety of RCAF personnel by increasing their situational awareness and providing them with more accurate data. Using advanced sensors and data analytics, for example, can assist pilots in avoiding collisions and other dangers more effectively. Through the application of digital technologies, air force operations can also be made more efficient. For example, automation systems can reduce the workload of pilots and other personnel, allowing them to focus on more crucial duties.

18. Networking technologies can assist in enhancing collaboration and coordination among RCAF personnel. By connecting various systems and devices, for instance, personnel can share

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[17] Keyur K Patel, Sunil M Patel, and P Scholar, 'Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges', *International Journal of Engineering Science and Computing* 6, no. 5 (2016).
[18] Ovidiu-Dumitru Rusu PhD candidate and Sorin Topor PhD, 'Digitallization of the Modern Fighting Field under Cyber Security', *International Scientific Conference 'Strategies XXI'*, 2021, 298–302.
[19] Steffen Hoßfeld, 'Optimization on Decision Making Driven by Digitalization', *Economics World* 5, no. 2 (1 March 2017).

information and resources more efficiently, thereby enhancing the overall effectiveness of their operations.

19. All in all, digitalization and networking are essential technologies that can enhance the effectiveness and efficiency of the RCAF by utilising Connected Technologies. As a result, the RCAF is able to respond better to the operational environment's complexity and dynamism. It is essential to invest in these technologies and cultivate a workforce capable of operating and maintaining them.

Recommendation 4. Invest in the development and implementation of networking and digital technologies, including advanced sensors, data analytics, and automation systems, in order to increase the effectiveness and efficiency of the Royal Canadian Air Force.

20. Connected Humans. As the role of technology continues to grow in how the air force operates, it has become increasingly important to connect individuals. Networking and digitization have become key change agents in the air force, allowing for enhanced inter-personal communication, collaboration, and information sharing.

21. The growing complexity of technological systems places ever-increasing demands on humans, and these demands must be appropriately accounted for.[20] By automating certain processes and tasks, for instance, the RCAF can reduce the number of personnel required to complete them, which addresses staff shortages but at the same time requires highly skilled personnel and a willingness to learn.

22. From a personnel standpoint, the digitalization of the RCAF may pose some obstacles like the need for personnel to acquire new skills and adapt to new technologies and systems; these may necessitate additional education and training.[21] Additionally there is a need to operate and maintain the most advanced digital technologies and networking systems and these may necessitate specialised knowledge and skills in digital literacy.

23. Digital literacy is the ability to use and interact with information and communications technologies and digital information ecosystems.[22] As a discipline, it uses the essential 21st-century skills of critical thinking, collaboration, creativity, and communication.[23] A digitally literate employee may not be intimately familiar with every technical aspect of the available technologies, but they understand them well enough to employ them appropriately, coordinate their use by subordinates, communicate their potential, and incorporate them into the organization's vision.[24] Digital literacy cannot be taken for granted, and because digital literacy involves interactions, the requirements for competencies change in tandem with ecosystems and

[20] W Patrick Neumann et al., 'Industry 4.0 and the Human Factor–A Systems Framework and Analysis Methodology for Successful Development', *International Journal of Production Economics* 233 (2021): 107992.
[21] Royal Canadian Air force, 'Future Concepts Directive Part 2: Future Air Operating Concept', 23.
[22] Juan D. Machin-Mastromatteo, 'Information and Digital Literacy Initiatives', *Information Development* 37, no. 3 (1 September 2021): 329–33.
[23] Elizabeth Barrett-Zahn, 'Digital Literacy', ed. EDITOR Elizabeth Barrett-Zahn, *Science and Children* 58, no. 5 (2021): 6.
[24] Jo Fu, 'Complexity of ICT in Education: A Critical Literature Review and Its Implications', *International Journal of Education and Development Using ICT* 9, no. 1 (2013): 112–25.

the technologies that shape them; thus, digital literacy is ephemeral.[25] In sum, digital literacy necessitates skills, knowledge, and attitudes to interact in the present, while a broader set of intellectual skills is required for future evolution. Developing these skills is the exact purpose of training and education.

24. Young junior staff already both live this digital mindset and the associated demand for comprehensive information, and use this networking. [26] This means that a new leadership culture must emerge in the RCAF; networking creates a digital leadership that requires a new understanding of trust and a more distributed sharing of responsibility. This includes that an appropriate means of communication - also with the necessary data security - is available to everyone, regardless of location. Digitalization thus creates attractiveness in many respects.[27]

25. Overall, the digitalization of the RCAF can provide numerous benefits for air force personnel, but it also necessitates adaptability and a willingness to acquire new skills.

Recommendation 5. Invest in education and training programs to ensure that Royal Canadian Air Force personnel can operate and maintain the most advanced digital technologies and networking systems.

26. Connected Industry. Industry 4.0 is a German initiative that outlines a strategic approach to digitalization in manufacturing. It has grown in popularity in recent years and focuses on developing more system digitisation and network integration via smart systems. In order to establish a link between the two, this approach could be adopted by the RCAF in partnership with Canadian industries moving in the same direction.[28]

27. Thus, 'connected industry' can be seen as crucial for the digitalization of the RCAF as it enables the air force to leverage the most recent technological innovations and capabilities from industry partners.[29]

28. Recognizing, that formal collaborating requires a high level of approval, working with industry partners and academia, the RCAF can gain access to the most cutting-edge digital technologies. Technologies, such as advanced sensors, data analytics, and automation systems can be integrated into the air force's systems and equipment to enhance its capabilities. Industry partners can also offer the air force access to specialised expertise and resources, such as

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[25] Ibrar Ul-Haq Bhatt, ''Curation'as a New Direction in Digital Literacy Theory', 2015, 2.
[26] Gugup Kismono and Utilithia Banguningsih Hanggarawati, 'Gender and Generation Gaps in Government Organization: Does It Affect Work Engagement?', *Jurnal Siasat Bisnis*, 2022, 3. See also: Tobias Kollmann, 'Das Digital Leadership', in *Digital Leadership*, by Tobias Kollmann (Wiesbaden: Springer Fachmedien Wiesbaden, 2022), 1–42.
[27] Hesse, 'Digitalization and Leadership-How Experienced Leaders Interpret Daily Realities in a Digital World', 1858.
[28] Gizem Erboz, 'How to Define Industry 4.0: Main Pillars of Industry 4.0', *Managerial Trends in the Development of Enterprises in Globalization Era* 761 (2017): 767.
[29] David L Norquist, 'DoD Digital Modernization Strategy: DoD Information Resources Management Strategic Plan FY19-23' (OSD Washington United States, 2019), 11.

engineering and manufacturing capabilities, which can accelerate the development and implementation of new technologies.[30]

29. Connection to industry and academia can also assist the RCAF in identifying new opportunities for innovation and staying abreast of the latest digital technology trends and advancements. This can help ensure that the air force remains at the forefront of digitalization and is able to respond to emerging threats.

30. Overall, connected industry is important for the digitalization of the RCAF because it provides access to the latest technologies and expertise, which can help to improve the air force's capabilities and ensure it remains competitive in an operational environment that is becoming increasingly complex and dynamic.

Recommendation 6. Establish partnerships and collaborations with industry and academia to gain access to cutting-edge digital technologies and advance research and development in this field.

CONCLUSION

31. The ability of RCAF of the 21st century to comprehend, predict, adapt, and exploit digitalization on future battlefields is crucial for maintaining and expanding its competitive advantage.

32. Future military operations will almost certainly rely on connected fight, technology, industry and humans to achieve superior defensive capabilities. Digitalization and networking will connect humans with intelligent technologies to provide troops with 'extrasensory' perception, superior situational understanding, predictive capabilities, improved risk assessment, and the development of shared insights.

33. Digitalization and networking are essential to allow the RCAF to remain effective and responsive in an operational environment that is becoming increasingly complex and dynamic. By leveraging digital technologies, the RCAF can improve situational awareness, efficiency, and interoperability with other military services. To obtain these advantages, it is necessary to invest in digitalization, including the development and implementation of digital technologies, as well as the training and education of RCAF personnel and cooperate with industry.

34. Based on these conclusions the recommendations presented throughout the paper are restated in Annex A.

[30] Vasile Florin Popescu, 'From Human Body Digitization to Internet of Bodies toward a New Dimension of Military Operations', *Land Forces Academy Review* 24, no. 3 (2019): 242–49.

ANNEX A

CONSOLIDATED LIST OF RECOMMENDATIONS

Recommendation 1. Develop a comprehensive digital strategy outlining the Air force's goals and objectives for digitalization and networking, as well as the technologies and systems that will be used to achieve these goals.

Recommendation 2. Develop a comprehensive digital strategy outlining the Air force's goals and objectives for digitalization and networking, as well as the technologies and systems that will be used to achieve these goals.

Recommendation 3. Develop a robust networking infrastructure to connect diverse Air force systems and devices, as well as those of other military services, in order to effectively share information and resources.

Recommendation 4. Invest in the development and implementation of digital technologies, including advanced sensors, data analytics, and automation systems, in order to increase the effectiveness and efficiency of the Royal Canadian Air force.

Recommendation 5. Invest in education and training programs to ensure that Canadian Air force personnel can operate and maintain the most advanced digital technologies and networking systems.

Recommendation 6. Establish partnerships and collaborations with industry and academia to gain access to cutting-edge digital technologies and advance research and development in this field.

BIBLIOGRAPHY

Airforce Technology. 'F-16 Fighting Falcon Multirole Fighter'. Accessed 10 January 2023. https://www.airforce-technology.com/projects/f-16-fighting-falcon-multirole-fighter/.

Allen, Wing Commander Jon. 'Promoting Innovation in the Canadian Armed Forces'. Toronto,2022.

Barnes, Lieutenant-Colonel Pux. 'Mission Command and the RCAF: Considerations for the Employment of Air Power in Joint Operations'. Trenton, 2014.

Barrett-Zahn, Elizabeth. 'Digital Literacy'. Washington, DC: National Science Teachers Association, 2021 publisher-place: Washington.

Bhatt, Ibrar Ul-Haq. ''Curation'as a New Direction in Digital Literacy Theory', 2015.

Department of National Defence. 'STRONG.SECURE.ENGAGED. Canada's Defence Policy'. Ottawa, 2017.

Ebbage, Louise, and Barry McGuinness. 'Assessing Human Factors in Command and Control: Workload and Situational Awareness Metric'. Bristol, May 2002.

Frew, Eric W, and Timothy X Brown. 'Networking Issues for Small Unmanned Aircraft Systems'. *Journal of Intelligent and Robotic Systems* 54 (2009): 21–37.

Fu, Jo. 'Complexity of ICT in Education: A Critical Literature Review and Its Implications'. *International Journal of Education and Development Using ICT* 9, no. 1 (2013): 112–25.

Gimpel, Henner, and Fabian Schmied. *Risks and Side Effects of Digitalization: A Multi-Level Taxonomy of the Adverse Effects of Using Digital Technologies and Media*, 2019.

Hesse, Andreas. 'Digitalization and Leadership-How Experienced Leaders Interpret Daily Realities in a Digital World', 2018.

Hoßfeld, Steffen. 'Optimization on Decision Making Driven by Digitalization'. *Economics World* 5, no. 2 (1 March 2017).

HQ, Canadian Army. 'Advancing with Purpose: The Canadian Army Modernization Strategy'. Ottawa, December 2020.

Kismono, Gugup, and Utilithia Banguningsih Hanggarawati. 'Gender and Generation Gaps in Government Organization: Does It Affect Work Engagement?' *Jurnal Siasat Bisnis*, 2022, 1–22.

Kollmann, Tobias. 'Das Digital Leadership'. In *Digital Leadership*, by Tobias Kollmann, 1–42. Wiesbaden: Springer Fachmedien Wiesbaden, 2022.

Leedom, Dennis K. 'Thinking Inside or Outside of the Box: Impact of Digitization on Battle Command'. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 43, no. 3 (1999): 349–53.

Legner, Christine, Torsten Eymann, Thomas Hess, Christian Matt, Tilo Böhmann, Paul Drews, Alexander Mädche, Nils Urbach, and Frederik Ahlemann. 'Digitalization: Opportunity and

Challenge for the Business and Information Systems Engineering Community'. *Business & Information Systems Engineering* 59 (2017): 301–8.

Machin-Mastromatteo, Juan D. 'Information and Digital Literacy Initiatives'. *Information Development* 37, no. 3 (1 September 2021): 329–33.

Neumann, W Patrick, Sven Winkelhaus, Eric H Grosse, and Christoph H Glock. 'Industry 4.0 and the Human Factor–A Systems Framework and Analysis Methodology for Successful Development'. *International Journal of Production Economics* 233 (2021): 107992.

Norquist, David L. 'DoD Digital Modernization Strategy: DoD Information Resources Management Strategic Plan FY19-23'. OSD Washington United States, 2019.

Patel, Keyur K, Sunil M Patel, and P Scholar. 'Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges'. *International Journal of Engineering Science and Computing* 6, no. 5 (2016).

Popescu, Vasile Florin. 'From Human Body Digitization to Internet of Bodies toward a New Dimension of Military Operations'. *Land Forces Academy Review* 24, no. 3 (2019): 242–49.

Royal Canadian Airforce. 'Future Concepts Directive Part 2: Future Air Operating Concept'. Ottawa, 15 August 2016.

———. 'Royal Canadian Airforce Strategy. AGILE · INTEGRATED · INCLUSIVE'. Ottawa, February 2023.

Rusu, Ovidiu-Dumitru, PhD candidate, and Sorin Topor PhD. 'Digitallization of the Modern Fighting Field under Cyber Security'. *International Scientific Conference 'Strategies XXI'*, 2021, 298–302.

Schwab, Klaus. 'The Fourth Industrial Revolution'. *Foreign Affairs*, 22 August 2022.

Secretariat, Treasury Board of Canada. 'Digital Nations Charter', 19 October 2020. https://www.canada.ca/en/government/system/digital-government/improving-digital-services/digital-nations-charter.html, Last Modified: 2021-11-18.

Song, Xiao, Yulin Wu, Yaofei Ma, Yong Cui, and Guanghong Gong. 'Military Simulation Big Data: Background, State of the Art, and Challenges'. *Mathematical Problems in Engineering* 2015 (24 November 2015): 1–20.

Treasury Board of Canada. 'Digital Government Strategy', 10 June 2021. https://www.canada.ca/en/government/system/digital-government/digital-government-strategy.html, Last Modified: 2022-04-20.

Trudeau, Justin. 'ARCHIVED - Minister of Digital Government Mandate Letter'. Prime Minister of Canada, 12 December 2019. https://pm.gc.ca/en/mandate-letters/2019/12/13/archived-minister-digital-government-mandate-letter.

Verhoef, Peter C, Thijs Broekhuizen, Yakov Bart, Abhi Bhattacharya, John Qi Dong, Nicolai Fabian, and Michael Haenlein. 'Digital Transformation: A Multidisciplinary Reflection and Research Agenda'. *Journal of Business Research* 122 (2021): 889–901.

Xu, Min, Jeanne M David, and Suk Hi Kim. 'The Fourth Industrial Revolution: Opportunities and Challenges'. *International Journal of Financial Research* 9, no. 2 (2018): 90–95.

Yin, Yunfei, Guanghong Gong, and Liang Han. 'Experimental Study on Fighters Behaviors Mining'. *Expert Systems with Applications* 38, no. 5 (2011): 5737–47.