The Role of Technology in China's Arctic Engagement: A Means as Well as an End in Itself

Camilla T. N. Sørensen & Christopher Weidacher Hsiung

China wants to ensure its role as a major stakeholder in the Arctic, and improving Chinese technological capabilities play a prominent albeit complex role in this endeavour as a means both to strengthen China's attractiveness in the eyes of the Arctic states and stakeholders and to ensure that China is able to establish a presence in the region and access its resources. However, development and application of Chinese technology in the Arctic is also an end in itself. Beijing defines the polar regions, the seabed and the outer space as "new strategic frontiers" (zhanlüe xin jiangyu) understood as the most challenging – but also most rewarding – areas to operate in, which relates not narrowly to the tangible Arctic resources to be extracted, but also to the pressure Chinese entities in the region are under to advance their knowledge and improve their technological capabilities and solutions. This further links China's Arctic engagement with its national development strategy, where ensuring China a frontrunner position within new technologies is a key priority, as well as with China's broader geo-strategic visions and plans.

The article has two main contributions. Firstly, it scrutinises the role of technology in China's Arctic engagement and shows how it is best viewed as a long-term process. Secondly, the article highlights how the intensifying US-China great power rivalry in recent years has led to a pragmatic adjustment in China's approach and tactics in the region, characterised by what we call Chinese "tactical retreat". Following the "China's Arctic engagement as a long-term process" argument, the key point is that establishing Chinese presence and influence in the Arctic will continue to be a persistent Chinese priority, but Beijing is able and willing to scale down and keep a lower profile when assessed as strategically beneficial. This underscores how China's Arctic engagement has become more confident and sophisticated over the recent decade.

Introduction

This article examines the role of technology in China's Arctic engagement, which so far remains an underexplored topic in the literature on China and the Arctic (e.g. Brady, 2017; Hong, 2020; Kopra, 2020). We set out to highlight how China's determination to ensure the country a leading role in the development and application of new technologies is linked in complex ways with China's efforts to establish an Arctic presence. As we show below, Chinese technological advancement in the Arctic is to be seen as a means to help establish China as an Arctic stakeholder, which the

Christopher Weidacher Hsiung is a Researcher, Swedish Defence Research Agency (FOI). The author is solely responsible for the content of this article, which does not necessarily reflect the views of the Swedish Defence Research Agency. Camilla T.N. Sørensen is an Associate Professor, Royal Danish Defence College (RDDC).

Arctic states and other Arctic stakeholders see interests in engaging with. Chinese knowledge and technology can for example contribute to strengthen understanding and mitigation of the rapid climate change taking place in the Arctic. Chinese technological advancement is thus part of Chinese efforts to build comprehensive relationships in the region and present China as a valuable partner for dealing with the challenges facing the Arctic states and other Arctic stakeholders. This implies that technology is a means in China's Arctic strategy.

Technological advancement is, however, also an end in itself for Beijing. In China, the polar regions (i.e. the Arctic and the Antarctic), together with the deep seabed and outer space, are seen as very challenging areas to operate in, resulting in a constant urge for Chinese researchers, engineers etc. to advance their knowledge and improve their technological capabilities and solutions (e.g. Xinhua, 2015). Being able to conduct research and other activities in the Arctic is therefore valued in Beijing also for the way it contributes to promote and raise the overall level of innovation and technology in China, which constitutes a key priority in China's national development strategy for restructuring and upgrading its economic model. Such emphasis on the Arctic as a crucial frontier for increasing China's technological level implies that ensuring Chinese access to the Arctic is a means in China's national development strategy and the development and application of new technologies in the Arctic thus becomes an end in itself.

The intensifying US-China great power competition has entered the Arctic in recent years resulting in growing efforts by Washington to decrease China's manoeuvring space in the region. This includes heightened US concerns over China's development and application of new technologies in the Arctic, often viewed as having dual-use purposes with potential for military usages. Several of the other Arctic states are also becoming more hesitant in cooperating with Chinese stakeholders in the region (Olesen & Sørensen, 2019). This has led to a pragmatic adjustment in China's approach and tactics in the Arctic, where China seeks to tone down its Arctic ambitions while reemphasising cooperative policies and how engagement with Chinese stakeholders, including access to Chinese knowledge and technology, can benefit Arctic states and other Arctic stakeholders. We suggest that such pragmatic adjustment is best understood as a Chinese "tactical retreat". Following our emphasis on how technology plays a role in China's Arctic engagement as a means and as an end in itself, the key point is that establishing Chinese presence and influence in the Arctic will continue to be a persistent Chinese priority. It thus links up with key domestic objectives and plays into China's long-term visions and plans about how to ensure its role as a leading great power. However, Beijing is able and willing to scale down and keep a lower profile when assessed necessary and prudent. This underscores how China's Arctic engagement has become more confident and sophisticated over the recent decade.

This article thus has two main contributions. First, it scrutinises China's Arctic engagement focusing on the role of technology. Here we demonstrate how technology plays a role in China's Arctic engagement as a means as well as an end in itself, which further leads us to emphasise how China's Arctic engagement is best viewed as a long-term process. China wants to ensure its position as an Arctic stakeholder and the improvement of Chinese technological capabilities plays a prominent albeit complex role in this endeavour as a means to strengthen China's attractiveness in the eyes of the Arctic states and other Arctic stakeholders. However, we suggest that for Beijing this is not narrowly a question about ensuring Chinese access to tangible Arctic resources and shipping routes. It is more broadly about ensuring Chinese access to operate in the region , expecting in the process to develop crucial knowledge and new technologies that link up with key domestic objectives and play into China's long-term visions and plans about how to ensure its role as a leading great power. Second, the article contextualises such developments in China's Arctic engagement in the intensifying US-China great power competition by discussing how Beijing has sought to adjust its approach and tactics in the Arctic in recent years.

The article therefore proceeds as follows. We first outline how technological advancement is increasingly emphasised in China's Arctic engagement, including in key strategic documents and policy statements regarding the region. We then conduct an analysis of the role of technology in China's Arctic engagement as it manifests itself in practice in three specific areas: (1) scientific research, (2) natural resource extraction and infrastructure development; and (3) digital communication and satellite navigation. These two sections enable us to show how technology plays a role in China's Arctic engagement as a means as well as an end in itself, which we do in the following section. Next, we discuss how the intensifying US-China great power competition is impacting China's manoeuvring space in the Arctic and how China is adjusting its approach and tactics. Our main point is that because the Arctic plays a key role in China's determination to ensure that the country has a leading role in the development and application of new technologies, Chinese interests in the region are persistent and long-term. Therefore, the Chinese manoeuvring in the region in recent years is best understood as a "tactical retreat". In the end, we elaborate on our main findings and address some policy implications thereof, where a main concern is how the Arctic states and other Arctic stakeholders can continue to engage China and thus ensure access to Chinese knowledge and technology beneficial in dealing with the challenges they face in a rapidly changing Arctic, without coming into conflict with the US or assisting unwanted Chinese activities in the region (Conley & Wall, 2021; Devyatkin, 2021).

The growing emphasis on technology

Over the recent decade, China has substantially increased its focus on and presence in the Arctic (e.g. Brady, 2017; Doshi, Dale-Huang & Zhang, 2021). China officially defines itself as a "near-Arctic state" (*jin beiji guojia*) and has underlined how it sees itself as having legitimate interests and rights in the region, notably in relation to conducting research, natural resource extraction and shipping alongside issues pertaining to regional governance. In its Arctic Policy White Paper published in January 2018, Beijing thus highlights how the Arctic should not be regarded as a demarcated region, referring specifically to how climate change in the region has global implications and international impacts (State Council, 2018). The Chinese position therefore is that it is not up to the Arctic states alone to establish the rules and norms for the future development of and access to the region and its resources. Beijing is, however, keenly aware that China not having any Arctic territory depends on the Arctic states and other Arctic stakeholders seeing benefits in having China present and involved in the region and in further developing their relations with Chinese stakeholders. Therefore, China focuses on establishing strong and comprehensive relationships with the Arctic states and other Arctic stakeholders and on gradually increasing China's presence and influence in Arctic institutions and mechanisms. In order to do this, China seeks to propose benefits to the Arctic states and other Arctic stakeholders. The focus thus is on knitting China into the region – on multiple levels – through offers and agreements regarding for instance research, resource extraction and infrastructure development. Chinese technological advancement plays a growing role in such efforts. It is challenging on many fronts to operate in the Arctic region – most obvious is the harsh and complex physical environment. High levels of knowledge and sophisticated technological equipment are therefore required to operate and to conduct research as well as natural resource extraction and development of needed infrastructure to facilitate improved and viable Arctic shipping routes. Improvement of knowledge and technology are therefore always in demand among Arctic states and other Arctic stakeholders, and there is a room to manoeuvre here for China in the region .

In recent years, the Chinese government has made it clear that it wants to raise the level of its Arctic knowledge and technological capabilities, evidenced in key strategic documents and policies. For instance, in China's 13th Five-Year Plan (covering the period 2016–2020), the Chinese government called for strengthening the country's activism in the polar regions. It, among other things, designed a program for expanding China's polar scientific capacity, including improving innovation and technological advancement to achieve these goals (Compilation and Translation Bureau, 2016: chapter 41). In the latest plan, the 14th Five-Year Plan (covering the period 2021-2025), the Chinese government called for even greater engagement in the Arctic Ocean region and Antarctica while also explicitly incorporating the active development of the "Polar Silk Road" as part of the Belt and Road Initiative (BRI) (Lanteigne, 2021). In the Arctic Policy White Paper, Beijing also clearly envisioned an increasingly important role of science and technology in its Arctic engagement both in order to better understand the Arctic environment and its global effects, and in order to develop the Arctic through, for example, the utilisation of resources such as oil, natural gas and fisheries (State Council, 2018). Significantly, the Chinese government defines the polar regions, the deep seabed and outer space as crucial frontiers or rather as "new strategic frontiers" (*zhanlüe xin jiangyu*) for increasing Chinese technological level (e.g. Xinhua, 2015).

Chinese interests in the Arctic and the important role given to technology are also spelled out in the authoritative document related to China's BRI plans. After some years of uncertainty, the Arctic is now formally part of the BRI, officially labeled as the Polar Silk Road. For instance, technological advancement is highlighted as an important component in the Arctic maritime domain, notably in the "Vision for Maritime Cooperation under the Belt and Road Initiative", a jointly issued strategy document by the China National Development and Reform Commission (NDRC) and the State Ocean Administration (SOA) in 2017. The document declares the Arctic a "blue economic passage", which calls for strengthening "common maritime security for mutual benefits", including initiatives such as maritime search and rescue, maritime monitoring and management, sharing ocean navigation results, and building ocean observation and network systems (Xinhua, 2017). Moreover, the document states "China is willing to work with all parties in conducting scientific surveys of navigational routes, setting up land-based monitoring stations, carrying out research on climatic and environmental changes in the Arctic, as well as providing navigational forecasting services" (Xinhua, 2017). Again here, it is emphasized how China with its technological advancements have something to offer in the Arctic.

The emphasis on the Arctic in China's push for digital connectivity as envisioned in its "Digital Silk Road" (DSR) – an increasingly crucial component in China's overall BRI plans – is also growing (e.g. Jüris, 2020; Tillman, Yang & Nielsson, 2020). Generally, Beijing foresees that the DSR can promote Chinese technical solutions, standards and norms and facilitate Chinese efforts to influence global standards for global digital connectivity (Triolo, Allison, Brown & Broderick, 2020). According to the "Vision for Maritime Cooperation under the Belt and Road Initiative", the

Chinese plan is a harmonization of standards and improved information networks with countries participating in the BRI by "jointly building a system with broad coverage for information transmission, processing, management and application, a system for information standards and specifications, and a network security system, thus providing public platforms for information sharing" (Xinhua, 2017). As will be further demonstrated below, the Arctic plays into such Chinese planning.

In sum, according to several key strategic documents, the need to apply and develop advanced knowledge and technology to safeguard and move China's Arctic engagement forward are clearly articulated. Furthermore, it also links up with key domestic objectives focused on restructuring and upgrading the economy as well as with China's long-term visions and plans about how to ensure its role as a leading great power. That Chinese technological advancement in the Arctic has such double focus or role becomes clearer if we include analysis of how the various Chinese stakeholders include technologies in their Arctic projects and cooperation.

Use of technology in China's Arctic engagement

In this section, we turn to examine the role of technology in China's Arctic engagement as it manifests itself in practice in three specific areas. These areas are: (1) scientific research, (2) natural resource extraction and infrastructure development, and (3) digital communication and satellite navigation.

The role of technology in China's scientific research in the Arctic

Scientific research on climate change and its impact in the Arctic constitutes a core focus in China's Arctic engagement.[1] Climate change directly affects China. For instance, many of its coastal areas are at risk of experiencing rising sea levels and the country's agricultural production is also expected to be adversely affected (Jakobson, 2015; Devyatkin, 2021). It is therefore of vital importance for China to improve its scientific understanding of the Arctic, which includes enhancing its technological capacity to conduct the necessary expeditions and experiments, and acquire the necessary data. As understanding and mitigating the rapid climate change taking place in the region is a core objective of all Arctic states and other Arctic stakeholders, any Chinese progress in this area would be met with strong interest and China would be able to utilise such progress to also strengthen its relationships in the region. Looking in particular at how China seeks to strengthen its scientific research in the Arctic, specifically as it relates to technology, there are three main ways.

First, China aims to establish and run research stations in the region. Since 2004, China runs a research station, the Yellow River Station (*huanghe zhan*) in Norwegian Svalbard, that is operated by the Polar Research Institute of China (PRIC). The research station conducts research on sea ice, glacial monitoring and the atmosphere. While the focus is on climate change research, the research also helps China to develop knowledge and technological skills that can advance its overall ability to utilize any future Arctic opportunities. For instance, improved glacial monitoring can mitigate challenges for more reliable navigation for Chinese shipping companies wanting to use the Arctic waters. The China-Iceland Arctic Science Observatory established in 2018 fills similar functions. The observatory is to monitor climate and environmental changes in the Arctic and is managed by PRIC and Iceland's Institute of Research Centres (e.g. Schreiber, 2018). Moreover, China and Finland are jointly developing the China–Finland Arctic Monitoring and Research Centre between China's Institute of Remote Sensing and Digital Earth and Finland's Arctic Space Centre. The main objective is to collect, process and share satellite data to support environmental monitoring, climate change research and Arctic navigation (Chinese Academy of Sciences, 2018). This can clearly assist China's "Digital Silk Road" in the Arctic, as well as more broadly.

Second, China conducts scientific expeditions in the Arctic with its two icebreaker vessels Snow Dragon (*Xuelong*) and Snow Dragon 2 (*Xuelong 2*) with a growing emphasis on using advanced technology. The newest icebreaker vessel, Snow Dragon 2, constructed in 2019 has been jointly designed with Finnish Aker Arctic and is China's first indigenously manufactured icebreaker vessel, marking a significant technological advancement. Snow Dragon 2 is equipped with oceanographic survey and monitoring apparatus enabling exploration of the physical oceanography, biodiversity, and atmospheric and environmental conditions in the Arctic. Furthermore, it enables conducting fishery resources surveys (Zhao, 2019). In addition, China is seemingly also building its first nuclear powered icebreaker vessel, which will be a technological leap for China's scientific and commercial aspirations in the Arctic, and in the broader polar regions (Goldstein, 2020).

Since some years back, China has notably begun to conduct increasingly sophisticated scientific experiments as part of its Arctic expeditions that include acoustic and bathymetric surveys to produce navigational charts (Martinson, 2019). During China's 9th Arctic expedition in 2018, China for the first time independently deployed unmanned observational equipment such as an unmanned ice station and climbing marine profile buoys. It also deployed a Chinese produced autonomous underwater glider (*haiyi*) used to conduct deep-sea environment observation in vast areas (Zhou, 2020). According to a research report, activities such as these have greatly enhanced China's ability to observe and monitor the Arctic environment (Wei et al, 2020). In September 2019, China successfully launched its first polar observation satellite. The satellite, called BNU-1, will monitor sea ice drift and ice shelf collapse and is expected to improve China's remote sensing capability and help expand Arctic shipping (Brady, 2019). In 2021, the satellite started its Arctic mission after first having completed its Antarctic mission, sending back more than 1000 images of the south polar region (Xinhua, 2021). During China's 11th Arctic expedition in 2020, several advanced scientific experiments and surveys were conducted, for instance obtaining record-breaking sediment core sample in the Arctic Ocean (China News Service, 2020).

Third, China aims at developing closer scientific collaboration with Arctic states and other Arctic stakeholders, both bilateral and multilateral. Since 2012, there has been a Sino-Russian bilateral dialogue, subsequently followed by similar bilateral dialogues with, for instance, Canada. A particular successful example is the China Nordic Arctic Research Center (CNARC) established in 2013, which gathers scientists, entrepreneurs and politicians from China, Norway, Kingdom of Denmark, Iceland, Sweden, Finland well as Russian and US observers (Ping & Mayer, 2018). In addition, as an observer member in the Arctic Council (obtained in 2013), China is involved in the scientific working groups in the Arctic Council (Zhang et al, 2019). China has moreover expressed interest in further developing its role in the scientific working groups in the Arctic Council (e.g. State Council, 2018).

The role of technology in China's natural resource extraction and infrastructure development in the Arctic

Aiming to ensure Chinese access to the economic potential of the Arctic, most notably natural resource extraction and usage of Arctic shipping routes, Beijing has a focus on both presenting Chinese companies and other Chinese stakeholders as attractive partners, and on influencing institutional and legal frameworks (State Council, 2018; Doshi, Dale-Huang & Zhang, 2021). However, it is also clear that when Chinese stakeholders seek cooperation with others on natural resource extraction and infrastructure development in the region, it is also aimed at gaining access to knowledge and technological capabilities. Chinese energy companies for example still lag technologically behind many of their Western peers, and therefore their participation in Arctic natural resource extraction is viewed as an opportunity to learn and improve their technological expertise (Hsiung, 2016). However, Chinese experts remain confident that China can, over time, make a valuable contribution with capital and investment, but also as an emerging leading provider of technological equipment (Yang, 2018).

Chinese stakeholders have in fact become involved in certain energy and infrastructure projects, where Chinese technology has been utilized. The most developed Arctic energy project with Chinese participation is the Yamal LNG project in Russia's Northwest Siberia, run by Russia's Novatek together with China National Petroleum Corporation (CNPC) and French Total. The Yamal project is operational and serves European and Asian customers, China included, with LNG. Broadly speaking, Chinese investments have been crucial for the project with Chinese stakeholders providing up to 60 percent of the financing (Sørensen & Klimenko, 2017). However, Chinese energy companies have also played a role in providing technical equipment such as Arctic modules for the liquefaction process of the LNG terminal, albeit most of the crucial knowhow and technology were provided by French Total. According to Chinese accounts, their participation results in learning as well as enhancement of Chinese technical skills to operate in the Arctic (Hsiung, 2016).

The Chinese energy companies CNPC and China National Offshore Oil Company (CNOOC) are also involved in the initial phase of developing a new LNG project – the Arctic LNG 2 at the Gydan Peninsula just across from the Yamal Peninsula, which could provide another opportunity for Chinese companies to learn and acquire advanced technology for complex and challenging energy operations. CNPN and CNOOC have each acquired a 10 percent share respectively alongside the main shareholder Novatek with 60 percent, Total ¨with 10 percent, Mitsui Group with 5 percent and Jogmec with the remaining 5 percent. The Arctic LNG 2 project is expected to begin LNG production in 2023 (Nilsen, 2021). Beyond this, Chinese energy companies have also been engaged in oil exploration surveys, most often in cooperation with Russian partners. In addition, COCSO's engineering subsidiary China Offshore Oil Engineering Co. through its oilfield service subsidiary China Oilfield Services Limited (COSL) has conducted geophysical surveys and provided marine support in the Arctic (Hsiung & Røseth, 2019). While this suggests still modest Chinese activities, it indicates how there is a growing level of Chinese technological involvement and performance in Arctic natural resource extraction. In other words, Chinese companies and other Chinese stakeholders are applying their own knowledge and technology, but are also developing this and are learning from companies and partners that have longer experience operating in the Arctic, and hence have acquired more Arctic-specific knowledge and technology.

The same 'pattern' is seen in relation to China's contribution to the development of shipping infrastructure in the Arctic. The proclaimed benefits of using Arctic shipping routes for trade and commerce between China and Europe via the NSR often tend to be overly optimistic, and indeed actual transits remain quite low (Moe & Stokke, 2019). Nonetheless, China's long-term strategic calculus indicates a growing interest. As mentioned, China wants to involve Arctic shipping routes as part of its BRI, defined as the Polar Silk Road. China is working especially close with Russia to improve the NSR. More specifically, China has shown interest in the construction of two sea ports, the Zarubino port and the Arkhangelsk deep-water port. The Zarubino port is located close to Vladivostok near the Chinese border and is to aid transportation links in China's northeast regions and assist in the development of the Russian Far East. China's Jilin province and China Merchants Group have provided support and capital to the project. Regarding the Arkhangelsk deep-water port, reports note how China Poly Group in 2016 signed an agreement of intent to invest about five billion USD, and also China's large state-owned shipping company China Ocean Shipping Company (COSCO) has declared interest in the project (Nilsen, 2017). That said, the project seems currently to have come to a halt and future involvement of Chinese stakeholders remain unclear (Moe, 2021).

Related to this, China also aims to compete within construction for Arctic-water going vessels. While still lagging behind more advanced nations such as South Korea and Japan, China is learning quick and investing in research and development. China has already gained certain experience in building large ice-vessels, for instance constructing a fleet of seven ice-class 1A container vessels with Maersk, a Danish shipping company, and the Arc7 condensate gas carrier Boris Sokolov for the Yamal LNG project (The Arctic Institute, 2020). In 2019, China's COSCO and the Silk Road Fund together with Sovcomflot, the Russian state-owned shipbuilding company, and Novatek established a joint venture, the Maritime Arctic Transport, with the goal to manage an ice-breaking tanker fleet of Arctic ice-class vessels to transport LNG from existing and projected LNG projects (Sovcomflot, 2019). Chinese shipbuilders have also put in a bid to build a 220-meter-long floating dock catered to Russia's new nuclear icebreaker fleet (Staalesen, 2021a). As with natural resource extraction projects, China uses the technology and equipment that have already been developed – often not specifically for polar conditions – but also learns and further improves the technology and equipment in the process.

The role of technology in China's digital communication and satellite navigation in the Arctic

The third area relates to digital communication and satellite navigation. The Chinese expect that improved satellite navigation technology in the Arctic can make the country's commercial shipping activities in the region more predictable and safe, and thus also commercially more viable. China already issued its first Arctic navigation manual in 2014, and in 2016, together with Russia, signed an agreement on cooperation regarding the NSR, which has subsequently been further advanced through the two sides' formal agreement to jointly develop the NSR as part of China's BRI (Hsiung & Røseth, 2019). Moreover, in 2022, China plans to launch an imaging satellite to monitor Arctic shipping routes, using Synthetic Aperture Radar (SAR) technology, the first Chinese satellite to use such technology (Zhou, 2020).

More broadly, China has long aimed at developing its own global navigation system, the so-called Beidou-system, to limit any dependency and vulnerabilities connected with relying on the US GPS-system. China has conducted several experimental probes in the Arctic to test its communication capabilities. For instance, in a 2019 evaluation, China assessed a number of technologies, including Very High Frequency (VHF) radio connectivity, medium-frequency Navtex systems, and the DSC system part of the Global Maritime Distress Safety System (Humpert, 2019; Chan, 2019). In 2020 China completed its full navigation satellite system with a total of 35 satellites on three different orbit heights making the system operational (Jones, 2020). China and Russia are also working on increasing the compatibility and interoperability of their national navigation systems (Russia with its GLONASS) (Hsiung, 2021).

As noted above, Beijing has incorporated the Arctic in the Digital Silk Road, and Chinese stakeholders seem to express especial interest in the so-called Arctic Connect, which is a project run by an international consortium involving mainly the Finnish state-owned company Cinia Oy in partnership with Russian telecommunications provider Megafon, as well as Norwegian and Japanese partners. The aim is to connect Europe and Asia through a 13,800 km long submarine communication cable along the NSR, but also to develop a system to serve local communities in the Russian Arctic. Chinese stakeholders, notably China's Telecom, has announced interest in the project (Shagina & Buchanan, 2021). Moreover, HMN Technologies (formerly Huawei Marine and responsible for undersea telecom cable communication) has been selected to provide technical platforms in the construction of the Arctic Connect (Jüris, 2020). Participation in the build-up of Arctic information technology solutions is aimed at benefitting Chinese companies commercially and making them more globally competitive, but it is also to try out and improve Chinese technology under the harsh and challenging conditions in the Arctic. Presently, however, it seems that Megafon has decided to temporarily put a halt to the project in order to reassess the structure and economy of the project (Staalesen, 2021a).

To summarize, the above examination shows how Chinese researchers, companies and other Chinese stakeholders are increasingly applying and developing their knowledge and new technological equipment and solutions in their Arctic engagement. They aim to take advantage of the new opportunities opening up in the region, but it should not be only narrowly understood as getting access to Arctic resources and shipping routes. It is also a broader focus on taking advantage of the opportunities that the harsh and challenging conditions give for testing and improving Chinese knowledge and technology. This also partly comes with the opportunity for cooperation with researchers and companies from other countries that are more experienced in the Arctic, such as, for example, the cooperation with Finnish counterparts on the design and building of the Chinese icebreaker, the Snow Dragon 2. This way, China gains access to advanced knowledge and new technologies that are also highly valuable for China in other non-Arctic areas or sectors. This underlines how technology plays a role in China's Arctic engagement as a means as well as an end in itself, as we further elaborate on in the next section.

Linking up with key domestic objectives and long-term visions and plans

As we have shown in the two previous sections, technological advancement takes up a growing role in China's Arctic engagement. The Chinese themselves often present their contribution to developing Arctic science and technological solutions in the region as a means to establish China as an Arctic stakeholder (e.g. Zhang et al, 2019). In addition, the Chinese highlight how sharing their knowledge and technological capacity and strengthening their cooperation with Arctic states and other Arctic stakeholders, can help increase the attraction and legitimacy of China as an Arctic stakeholder (e.g. Sun, 2018). However, in addition to this more widely shared view of technology as a means for China's Arctic engagement, China's technological involvement in the Arctic links up with key domestic objectives and plays into China's long-term visions and plans about how to ensure its role as a leading great power.

Technology is a key component in China's national development policies and more broadly core features of Chinese president Xi Jinping's strategy for the "great rejuvenation of the Chinese nation" (*Zhonghua minzu weida fuxing*), which aims to elevate the country to great power status on par with the US (Xinhua, 2018). While innovation and technology have long been key focal points in Beijing's efforts to reform and develop the Chinese economic structure – for example as pillars in Deng Xiaoping's "four modernisations"[2] – the importance of technology has been elevated even further since Xi Jinping came to power in 2012. Especially in the context of developments in the international system in recent years, where Beijing perceives the trend moving towards more uncertainty and increased hostility, particularly between China and the US, the need to build China's own independent and resilient economy and technological prowess has been amplified (Pei, 2020).

Indeed, recent key strategic plans, such as China's latest Five-Year Plan, or the so-called "Made in China 2025"[3], strategy have formulated clear priorities for China to become a leading technological power in a wide range of technological sectors, and to ensure self-sufficiency in order to reduce dependency on foreign technologies and markets. China is particularly keen on advancements in emerging technologies such as artificial intelligence (AI), digitalisation, and intelligent manufacturing (Gill, 2021).

The domestic incentives play a crucial role – Chinese leaders are keenly aware that raising the ability to innovate and develop cutting-edge technologies are critical to restructure, upgrade and diversify its economic structure away from the previous export-manufacturing based model to a more sophisticated knowledge and service-based structure. One of the greatest tasks facing China is how to overcome the so-called "middle-income gap" (Glawe & Wagner, 2017). Broadly speaking, China will need to implement several crucial economic reforms to switch the prior heavy focus on capital-intense and low labour cost strategies to improved efficiency and higher productivity. A special focus is on innovation and advanced technology as the driver for China's future economic structure.

Ultimately, sustaining economic growth and prosperity constitutes a core priority for Beijing, because it is a fundamental requirement in order to ensure continued domestic stability, and thus the domestic legitimacy of the Chinese Communist Party (CCP) in China (Dickson, 2016). The Chinese focus on ensuring access for its researchers, companies and other Chinese stakeholders to the Arctic, and the emphasis on Chinese technological advancement in the region, have to be viewed in this broader context. Technology thus plays a role in China's Arctic engagement as an end in itself – or put in another way, the Arctic as a crucial frontier for increasing Chinese technological level implies that ensuring Chinese access to the Arctic is a means within China's national development strategy.

The emphasis on technological advancement in China also has implications for the modernisation of the Chinese military and links up with Beijing's ambition to develop a world-class Chinese military by 2049 (e.g. Fravel, 2020). This dual-use approach to technological developments is encapsulated in the so-called "military-civil fusion" (MCF) strategy (Kania, 2019). Ensuring Chinese access to the Arctic is also in this context seen as important – again, various Chinese activities in the region can help China acquire important knowledge and experience and push for development of Chinese technology that also have potential military applications. Generally, technology plays an important role for states that aim to enhance their military presence and improving military operational capacity in the Arctic. For instance, the Russian Navy has relied heavily on research on oceanography and meteorology, and the US has made significant research investments and efforts in similar fields, which have resulted in improved operational and tactical awareness for the US Navy (Pedersen, 2019).

While China's military presence in the Arctic so far is limited, it is clear that China's technological advancement in the Arctic such as its Beidou system can benefit the Chinese military as it gains a domestic Chinese system for guidance and weapon targeting, and for increasing situational awareness. As we will discuss in the conclusion below, such a dual-use approach presents challenges for Arctic states and other Arctic stakeholders in their cooperation with China in the Arctic. First, however, we turn to examine the Chinese response to the growing constraints and challenges – their reduced manoeuvring space – in the Arctic.

Access to the Arctic as a persistent priority – 'tactical retreat'

In the context of intensifying US-China great power competition, the US as well as several of the US allies, including the ones in the Arctic such as Kingdom of Denmark, Canada and Norway, are increasingly sceptical regarding China's Arctic engagement. Fundamentally, the US views China as its main great power competitor (The White House, 2017). In his speech at the Arctic Council in 2019, former US Secretary of State Michael Pompeo warned of Chinese revisionist behaviour in the Arctic and made it clear that the US now also views the Arctic as a venue for US-China great power competition (Pompeo, 2019; Sørensen, 2019a). While the Biden administration has taken a more traditional diplomatic approach, the basic contours of the US-China great power competition persist, and it will likely only further increase in the years, if not decades, to come. In the Arctic region, this US-China great power competition has manifested itself with an increasingly active US trying to decrease China's presence and influence in the region. For instance, Washington has tried to halt Chinese involvement in Greenland, including attempts by China to buy an old naval base and to construct new airports in Greenland (Sørensen, 2018). Beyond this, the US is also boosting its own Arctic capabilities such as, for example, its plans to acquire new icebreakers (Humpert, 2020).

Technology constitutes a core issue in the US-China great power competition. A case in point is how the US has embarked on a full-scale effort to limit China's ambitions to take the lead in the next generation of telecommunication technologies, exemplified by the heated controversy over Chinese telecommunication company Huawei and its global 5G network ambitions. The US has implemented stricter export controls, investment restrictions and is urging US companies and US allies and partners, including in the Arctic, to restrict their business engagement with China (Segal, 2019). Often the US highlights the above-mentioned dual-use application of Chinese knowledge and technologies, including the Chinese knowledge and technologies applied and developed in the Arctic. For instance, in its annual report to Congress, the US Department of Defense stated that China's "civilian research could support a strengthened Chinese military presence in the Arctic Ocean, which could include deploying submarines to the region as a deterrent against nuclear attacks" (US Department of Defense, 2019: 5).

The Chinese response to the US offensive toward China in the Arctic has so far been rather measured and cautious. There are indications of a kind of Chinese "tactical retreat" with reduced Chinese activities in the Arctic states that are allied to the US and are NATO members such as Greenland (Kingdom of Denmark), Iceland and Norway, while China has increased the priority given to Russia (Sørensen, 2019a). The "knitting China into the region" approach mentioned above is increasingly difficult in the context of the intensifying security tension and heightened mutual strategic mistrust between China and the US. The Chinese are therefore seemingly adjusting their approach and tactics.

However, establishing presence and influence in the Arctic is – as elaborated above – a persistent Chinese priority that links up with China's ability to succeed in the ongoing restructuring and upgrading of the Chinese economy, and plays into China's long-term visions and plans about how to ensure its role as a leading great power. Despite toning down its ambitions and reducing its activities, the Chinese therefore continue to follow developments in the region closely and seek to identify opportunities for China to engage without huge disproportionate risks of backlash and costs. A case in point is the two recent Chinese Arctic expeditions – the 11th and the 12th in the autumn of 2020 and 2021 respectively – which seem to have operated exclusively in international waters likely in order to decrease the risk of rejection and negative coverage if China had to apply for permissions to conduct activities in the exclusive economic zones of the Arctic coastal states (Feng, 2020; Staalesen, 2021b).

In many ways, such careful and calculated Chinese reaction is a continuation of the more confident and sophisticated Chinese engagement in the Arctic that has developed over the recent decade (Sørensen, 2019b). In addition, it is further probable that the growing US opposition to China's presence and activities in the Arctic, including US efforts to mobilize the other Arctic states, causes Chinese companies and businesses to reassess their options in the region. In Greenland, there have been incidents pointing to such broader Chinese reassessment and restraint, for example when the Chinese state-owned construction company, China Communication Construction Company Ltd. (CCCC), chose to withdraw its bid for the construction of airports in Greenland in June 2019 referring to political and practical barriers and challenges (Gustafson, 2019).[4]

Conclusion

In this article, we have set out to highlight how China's determination to ensure the country a leading role in the development and application of new technologies is linked in complex ways with China's efforts to establish an Arctic presence. We demonstrate how technology plays a role in China's Arctic engagement as a means as well as an end in itself. It thus goes beyond the question of ensuring access for Chinese researchers and companies to tangible Arctic resources. It is also a question of ensuring access for them to operate in the Arctic, where they then in the process expect to apply and develop knowledge and technology crucial both for the domestic efforts to restructure and upgrade the Chinese economy and for realising China's long-term visions and plans about how to ensure its role as a leading great power, including developing a world-class Chinese military. As such, technological engagement in the Arctic is part of China's effort to ensure the country is in a leading position in the domains of innovation, science and technology. We use this to underline how the Chinese priority of the Arctic is persistent and long-term. Therefore, we suggest that the adjustment in China's approach and tactics in the Arctic in recent years is best understood as a "tactical retreat". China has toned down its Arctic ambitions but continues to closely follow developments in the region and will engage when it is assessed as viable, such as when it does not bring China in direct opposition to the US and involves huge disproportionate risks of a backlash and costs. In other words, the focus and intensity of China's Arctic engagement is turned up and down depending on cost-benefit assessments in Beijing that are especially influenced by US policy towards China's role in the region. Beijing, however, continues to discretely engage with Arctic states and other Arctic stakeholders emphasising how cooperation with Chinese stakeholders, including access to Chinese knowledge and technology, are to their benefit.

What are the implications of our findings for Arctic states and other Arctic stakeholders? China is investing heavily and are developing knowledge and technology that Arctic states and other Arctic stakeholders have interests in as they have to deal with the challenges they face in a rapidly changing Arctic. The challenge for them, however, is how to engage with the various Chinese stakeholders without coming into conflict with the US or assisting unwanted Chinese activities in the region. It is difficult, and it will be increasingly difficult going forward. We suggest that the focus for Arctic states and other Arctic stakeholders engaging in cooperation and projects with Chinese stakeholders has to be on identifying and managing – or mitigating – vulnerabilities and risks. It requires building knowledge and intelligence on China within the Arctic states and other Arctic stakeholders, such as on Chinese politics and economic statecraft, in order to be able to carefully analyze the stakeholders and methods involved in each Chinese activity, and to assess the potential vulnerabilities and risks engendered. Such a thorough analysis is also a good starting point for designing useful legal and institutional mechanisms or frameworks, for example in relation to investment screening. As pointed out above, it is a particularly complex challenge to deal with the dual-use purpose – the potential parallel civilian and military use – of Chinese knowledge and technology in the region, including as it relates to Chinese research expeditions and stations, satellite stations, resource extraction and infrastructure projects (e.g. Humpert, 2019). China continues to have a Leninist one-party state, where the party is ever-present and involved – but to different degrees – in all matters of Chinese politics, economics and society. There are thus always complex relations and overlaps between the party-state, the military, universities, state-owned national and provincial companies, private companies and other Chinese entities, which amplifies the challenge of categorizing Chinese activities and assessing the potential vulnerabilities and risks they bring (Sørensen, 2021). Hence, it is difficult to pinpoint exactly whom you are dealing with and what the driving motives are. Ideally, one has to look into each of the Chinese activities in the Arctic, such as concrete projects and agreements, in order to assess the level of party involvement and control, as well as to gauge the potential military use and value. Besides being able to identify the Chinese stakeholders involved, it is a question of analyzing the methods used. The danger is that all Chinese activities in the Arctic are characterized as dual-use or as entailing too high vulnerabilities and risks preventing any scientific and technological cooperation with China on Arctic-related issues. This is not helpful for dealing with the challenges materialising in a rapidly changing Arctic. One way to go about this is also to put more efforts into identifying key topics and sectors, and proactively formulate rules and regulations for engagement with Chinese stakeholders. Another way is to seek to integrate Chinese research activities, including research stations, into a broader international collaborative setting (Conley, 2018: 11). So far, Arctic states and other Arctic stakeholders have tended to deal with Chinese activities in the region in a reactive and ad hoc manner, often also resulting in growing tension within the Arctic states between stakeholders with different interests. There is no easy way around this – China is emerging as a leading knowledge and technology provider and in order to deal with the challenges in the Arctic, in particular climate change, all knowledge and technology need to be mobilised and combined (e.g. Devyatkin, 2021). The overview and assessment of the role that technological advancement plays in China's Arctic engagement, which we have provided in this article, linking it also with China's national development strategy, is hopefully of value in such efforts.

Note

1. It is worth noting that China's Antarctic scientific research activities remain more comprehensive. For instance, China has five permanent research stations in Antarctic and has conducted 37 Antarctic research exhibitions compared to 12 Arctic research exhibitions as of September 2021.
2. The other three were agriculture, industry and defense.
3. The strategy was announced in 2015 by China's premier Li Keqiang – the "Made in China" strategy identifies nine priority tasks and ten core industries where China aims to lead innovation and development and created globally competitive businesses.
4. CCCC in particular referred to difficulties obtaining visas for their employees, so they could travel to Greenland and do the initial onsite surveys. The issuing of visas also to Greenland is administered in Copenhagen.

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