



Research article

Arctic design: revisiting traditional fur clothing within the daily routine of reindeer nomads

Svetlana Usenyuk-Kravchuk^{*,a}, Nikolai Garin^a, Alexandra Trofimenko^a, Denis Kukanov^b^a Arctic Design School, Ural State University of Architecture and Art, 23 K. Liebknecht St., Ekaterinburg, 620075, Russia^b Peter the Great Museum of Anthropology and Ethnography (Kunstkamera) RAS, 3 University emb., Saint Petersburg, 199034, Russia

ARTICLE INFO

Keywords:

Arctic
Reindeer
Fur clothing
Nenets people
Adaptation
Biomimesis
Cultural mimesis
Arctic design
Human geography
Ethnography
Anthropology
Culture heritage

ABSTRACT

This research investigates the domain of indigenous fur clothing for the extreme conditions of the Arctic. The main goal is to reveal the principles of personal wellbeing through observing and analyzing traditional Nenets fur coat and footwear together with the actual experiences of making and using clothing items. For that, we draw from the existing pool of research on functional parameters tested and evaluated in a lab and our empirical data (interviews and participant observations 2013–2016), to eventually come up with two interwoven concepts of clothing based on bio- and cultural mimesis. On the one hand, traditional fur clothing is the result of the biomimetic appropriation of natural abilities of reindeer to withstand severe climates. On the other, it is the embodiment of knowledge on the environment and skills acquired through the dynamic relationship between tools, materials, and personal identities of makers and wearers. This conceptualization, we argue, provides insights into how to both support the very existence in the extreme/severe environment and contribute to personal wellbeing. We conclude by proposing directions for further research towards developing design standards for the emerging multicultural community of Arctic newcomers.

1. Introduction

To most of the global populace the Arctic still represents one of the most desolate and sparsely populated areas in the world (Harriss, 2012), while for Russia that possesses almost two-thirds of the world's Arctic "The Far North" is declared one of the main strategic priorities (Laruelle, 2015). However, the conditions of the Russian Arctic – a hostile climate, long distances, limited infrastructure, etc. – pose significant obstacles to year-round activity in this area. Moreover, on a human scale, the wellbeing, safety and performance of people coming to work and live in the Arctic become some of the key challenges for planners at all levels and localities.

Historically, in the Arctic, the challenges of nature have encouraged a firm reliance on technology: adequate clothing, housing, and transportation have aided people living in extreme climatic conditions. However, among various objects involved in northern ventures throughout the history of human presence, only a few have managed to pass a long-term "Arctic test," namely to facilitate human living and working for several centuries continuously, without significant changes

in materials, forms, and functions. This research investigates the domain of so-called "traditional" Arctic clothing. The main goal is to reveal the principles of personal wellbeing through observing and analyzing clothing items *in situ* along with activities of making and wearing embedded into a daily routine of reindeer nomads. For that, we link together the existing pool of research on functional parameters tested and evaluated in a lab and our field observations (firsthand data), to eventually consider so-called "superpowers" one can gain by making and wearing these clothes.

The article is structured as follows: First, we set up the research context by introducing the community under study. Second, we review the relevant literature and identify the existing knowledge gap in the field of research on traditional clothing. Third, we describe the methodology and data, clarifying the concepts of bio- and cultural mimesis as an instrumental combination for the exploration by designers. Then we describe the application of the proposed concepts on two items of traditional fur clothing as a single-case study and outline the main findings. Next, we discuss the results as connected back to the provided

* Corresponding author.

E-mail address: svetlana.usenyuk@gmail.com (S. Usenyuk-Kravchuk).

theoretical foundation. We conclude by outlining potential directions for further research.

1.1. Research context

This work began with field observations of production and producers of clothes that are still made and worn by local communities of Western Siberia and Yamal Peninsula, Russia. Our case study is centered on the geographically and culturally balanced community of the Nenets/Nentsy (Samoyedic group) of the northern part of the Ural Federal District (Figure 1).

Historically, their traditional economy was based primarily on large-scale fully nomadic reindeer herding. At a practical level, such a way of living is a result of centuries-long evolution that implies not only the adaptive response of human body and mind but also the acquisition of necessary skills, and the creation of the entire (context-sensitive) material world. The fully-fledged representation of physical, social and spiritual aspects of the Nenets centuries-long existence can be found in studies by A. Golovnev and colleagues (Golovnev and Osherenko, 1999; Golovnev et al., 2014), Stammler (2005), Liarskaya (2010), Hasnulin et al. (2014), Arzyutov (2019).

In the 20th century, the Nenets, along with other northern peoples of the vast area of former Russian Empire, had to pass through several waves of dramatic changes in their economy, culture and living environment. The advent of the Soviet power in the 1920s accompanied by great promises and expectations turned out to be devastating for indigenous communities: sedentarization and collectivization policies, attacks on traditional beliefs and languages, encroachment of industry on ancestral lands, habitat depletion and pollution (Sokolova, 2009). In 1960–70s, a massive influx of non-native people and technology arrived in the North-Western Siberia. Since then and to date, there has been a period of mutual estrangement between indigenous people of the North and Soviet/Russian newcomers, expressed in the almost total lack of direct exchange of knowledge and practices. Particularly in the Yamal Peninsula, there are two distinct communities – indigenous, small in number, and the numerous Russian-speaking – that coexist in parallel, consider themselves self-sufficient and keep a certain distance to each other (Kvashnin, 2010, p. 104)¹.

Despite (or maybe thanks to) such estrangement, today, the economic and social conditions of living of the Yamal Nenets signify the period of flourishing as a nation: they managed to adapt to a new economy successfully, their population size demonstrates positive trends (from 13,454 in 1939 to 29,772 in 2010), with stably high number of young people speaking native language and involved in traditional activities, namely herding (authors' field observations and literature: Stammler, 2005; Golovnev et al., 2014; Volzhanina, 2017). Also, they can afford using (and easily engage with) modern mobile technology ranging from snowmobiles and boat engines to mobile phones, tablets, and laptops (Stammler, 2009; Golovnev et al., 2014). While these aspects are not a matter of this work, they constitute a vital context for presenting our research.

¹ Such an estrangement occurs mainly at the level of personal contacts and does not mean that the Nenets are separated from Russian society in general. Instead, their involvement deepens with the time course, varying from children being born at state hospitals and studying at state (Russian-speaking) boarding schools, to adults doing army service in the state army, and families living on social security. Still, today, under the spur of Arctic-centered economy, the intercultural communication is based on the inner colonial vision: there is almost no practical interest in traditional knowledge and practices of adaptation and wellbeing. When the state's obsession with the vast Arctic/Far North territories collides with little desire of ordinary people to live there, there are virtually no exchange and dissemination of best local practices and know-how.

2. Literature review

The Arctic has long been a place of comfortable existence and successful adaptation by indigenous peoples: they have flourished in the extreme climatic settings for millennia. In terms of human adaptation to environmental conditions – particularly to Arctic zones – the majority of mechanisms are merely *social* and *cultural* rather than acclimatory, physiological or genetic (Ricklefs, 1973; Richerson and Boyd, 2005). Among significant cultural artifacts and practices that facilitate such adaptation Moran lists clothing, shelters, diet, etc. (Moran, 2007). In our study, we focus on the specific domain of so-called “traditional” clothing acknowledged as the supreme achievement of Arctic indigenous inhabitants (Hatt, 1969; King et al., 2005).

Indeed, the mastery of indigenous garment-makers in designing and producing clothes to withstand the extreme climate of the Arctic has long been a subject of ardent praise among Polar explorers and researchers. Numerous ethnographic/anthropological accounts from 19-20th centuries to these days have been gradually building up the solid foundation for studies on traditional clothing (just to mention a few: (Nansen, 1890; Boas, 1964; Jackson and Brice, 2012; Castren, 2012).

Relevant to the geographical context of this article, the traditional clothing of indigenous peoples of the Russian Far North – and among those the Nenets – constituted the substantial body of research conducted at the Peter the Great Museum of Ethnography (Kunstkamera) and the Institute of Ethnography named after N.N. Miklouho-Maclay, USSR Academy of Sciences. Most of this literature – available primarily in Russian – represents rich description of existing museum collections (see, e.g., Ivanov, 1970).

We complement anthropological and ethnographic representation with research findings on the subjects such as: insulation properties of fur of arctic mammals² (Scholander et al., 1950; Hammel, 1955; Irving and Krog, 1955; Moote, 1955; Irving, 1968; Cena and Clark, 1978; Soppela et al., 1986), cuts and composition of Arctic traditional fur clothing, heat transfer effect of special structural elements of aboriginal clothing, various protective properties of materials to reduce negative environmental effects, e.g. wind-chill, precipitation, etc. (Hatt, 1969; Oakes et al., 1995; Cotel et al., 2004).

However, despite a substantial amount of literature on this topic, there is a clear gap in data concerning particular aspects and practices of human-clothing interaction that make a human being invulnerable in a harsh northern climate.

According to Nuutinen (2015), the basis for unveiling and understanding special needs related to human existence in the Arctic region is, in fact, an extensive *design competence*. In this article, we intend to make a contribution to further discussion of the concept of *Arctic design* (Tahkokallio, 2012) employed as an analytic lens to investigate and understand Arctic-related needs and challenges.

At a practical level, indigenous designs – carefully pictured and described in researchers' journals and field notes – formed a rich database for “cultural appropriation” as “a mode of cultural engagement dependent on an ability to separate a given object or design from its cultural milieu for the purposes of its employment in a different one” (Shand, 2002, p. 56). As Shand continues, there are two essentially different forms of appropriating the culture:

- *mimetic*: attempting to represent physical and/or metaphysical truths distilled from non-Western practices (Shand, 2002, p. 57);
- *semiotic*: the appropriated object obtains its own validity irrespective of the meanings of the original (Shand, 2002, p. 57).

² Most of the cited literature in this section is rather old because, to our knowledge, there have been no recent relevant studies of the hair morphology and heat insulation value of the fur of reindeer/caribou (*R. t. tarandus*).

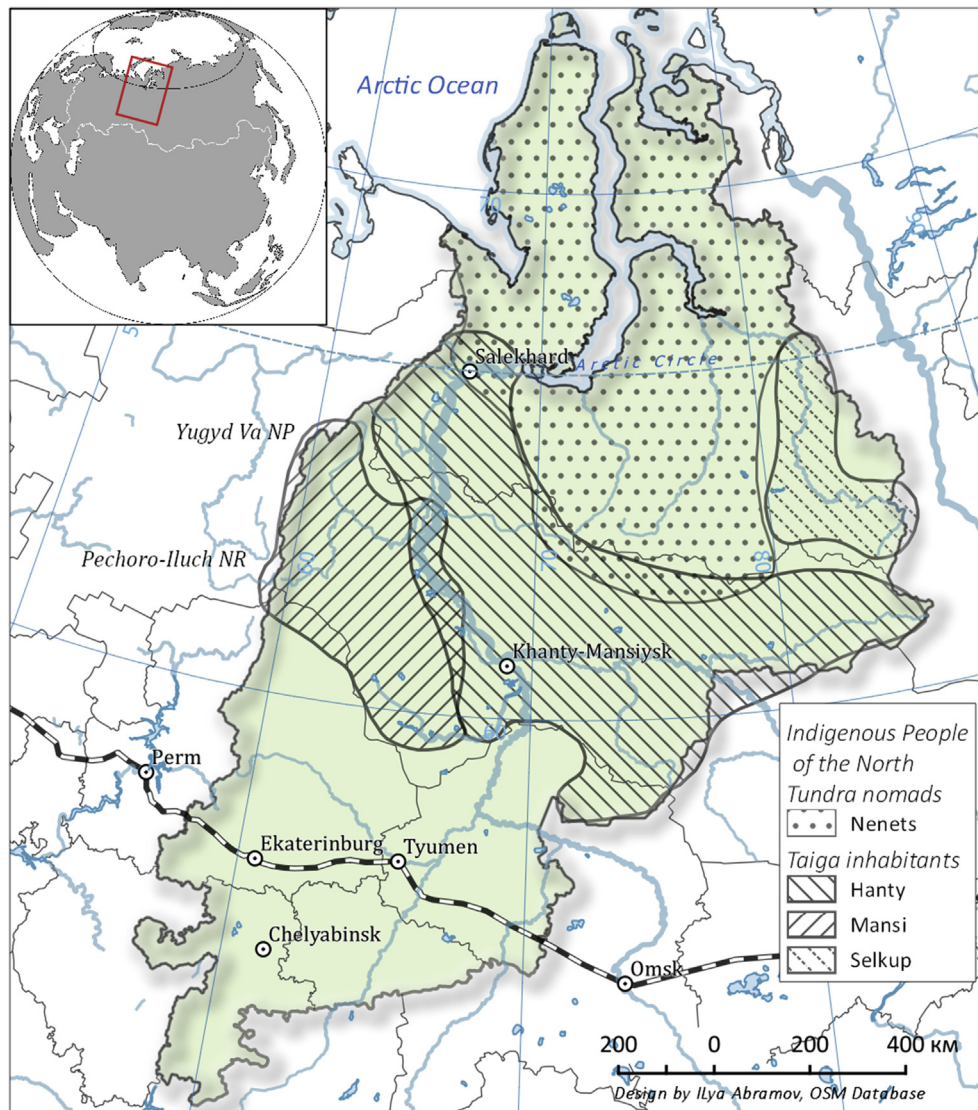


Figure 1. Indigenous areas of the Ural Federal District, 2019. Courtesy of Ilya Abramov.

In the context of severe environmental settings, the former often becomes an integral part of survival measures: one of the well-known examples is the effective performance of the Inuit style fur clothing that eventually became one of key factors the success of Amundsen's attempt to reach the South Pole in 1911 was based on (Færevik and Wiggen, 2014). The latter, however, often leads to using indigenous cultural heritage in the wrong/unethical way and for the wrong purpose. The detailed investigation of these issues is beyond the scope of this article. Instead, we confine ourselves to the designerly observation of functional properties of traditional clothing and their meaning for human adaptation and survival in the extreme environment of the Arctic region.

3. Methodology and data

In terms of methodology, to better understand the origin and functional and environmental characteristics of indigenous designs we employed both the *anthropological approach*, and the *biomimetic/bio-inspired approach*.

Qualitative data came from participant observation as well as unstructured interviews with 21 participants – primarily Nenets women, age ranging from 14 to 67 – over the period between 2013–2016. Also, materials from earlier expeditions conducted by one of the authors in

1980s–1990s, such as field notes, photos, and drawings (including verbal and visual documentations of personal testing of the traditional Nenets outfit in different conditions), were analyzed and integrated into the current research narrative as firsthand empirical data. The Expert Committee of the Ural State University of Architecture and Art reviewed the study and stated that ethical approval was not required.

Regarding the biomimetic approach, also known as *bionics*, *biomimicry*, *biognosis*, etc., we rely on the understanding by Papanek placing this approach among “typical creative thinking methodologies” and other ways of forcing new thinking patterns: along with brainstorming, morphological analysis, and other techniques (Papanek, 1985). In recent research literature (Sanchez et al., 2005; Bhushan, 2009; Kapsali, 2009; Lenau, 2009; Lodato, 2010; Kennedy et al., 2015) biomimesis appears as a fruitful combination of environmental and human ecology that stimulates the ideation of new properties as well as clever and sustainable methods for developing materials, technologies, and processes and thus paves the way towards circular design (Moreno et al., 2016).

When it comes to real-life implementations, the fur clothing of northern natives is often considered as one of the simplest and straightforward examples of using direct analogy from nature (Lenau, 2009). At a practical level, however, it is a long way from the animal fur as a natural analogy to become a functional fur coat for an Arctic dweller. Thus, a

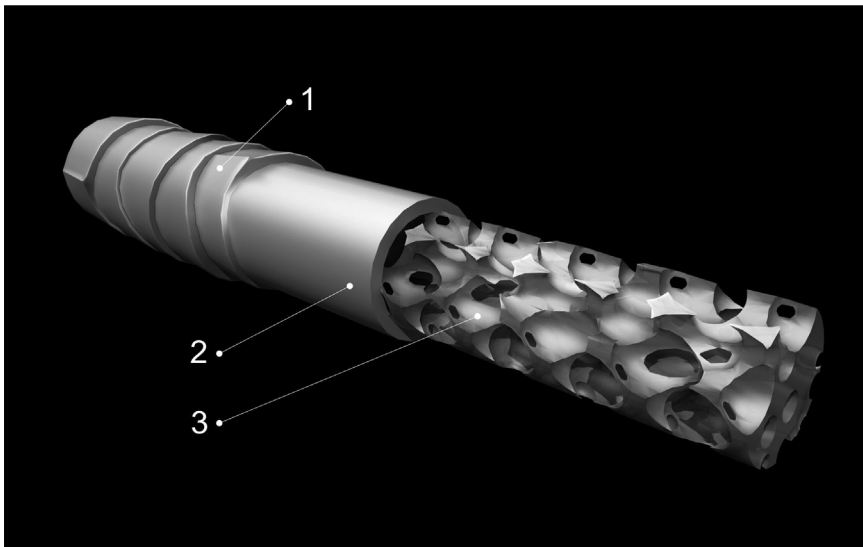


Figure 2. The model of the microstructure of reindeer hair. 2019. Compilation of sources. Courtesy of Denis Kukanov. Explanatory note: 1 – the cuticle is a scaly layer consisting of flat, cornified, transparent cells that protect the underlying layers from environmental exposure. 2 – the cortex is a cortical layer consisting of cells closely adjacent to each other with pigment grains longitudinally stretched and arranged along the length of the hair. This layer is poorly developed, which explains the fragility of deer hair. 3 – the core is a layer consisting of dried cornified formations, the space between which is filled with air, which explains the heat-insulating properties of deer fur.

more nuanced study is required to reveal and understand the hidden principles of the functionality of traditional Arctic garments.

To accomplish this, we complement the biomimetic methodology with the so-called *cultural mimetic approach* established at the School of Arctic Design, Russia, that aimed to discover and integrate the indigenous know-how into modern design principles and practices (Usenyuk-Kravchuk et al., 2018). The very concept of *cultural mimesis* comes from anthropology with the meaning of “the imitation or mirroring of cultural practices across borders of difference” (Friedman, 2007, p. 46; original concept in Taussig, 2017). In the specific design context, the concept was adopted and further explained in the doctoral study of one of the authors (Garin, 1991), where *cultural mimesis* meant the deliberate imitation of a form/material/process originated in nature but already appropriated, tested for an extended period of time, and eventually integrated into a way of living of a certain community as a design standard. In other words, this approach is about appreciating and learning from what has been achieved by indigenous communities of the Arctic to date. In a similar vein, Hardt formulates the general task for Arctic design professionals: “to analyze and adopt existing design principles from the Arctic and to make these available to the rest of the world while respecting the intellectual property of indigenous peoples” (Hardt, 2012, p. 57).

In the next section, with the aid of the methodology described, we present the traditional clothing of the Nenets reindeer herders from the design perspective.

4. Results: the traditional fur clothing revisited

The variety of forms of arctic clothing and related practices/activities is rather high, so we concentrate on the limited number of such forms and activities – those we could obtain first-hand data on – in order to gain insight into the details and thus ensure the validity of the results of the study.

The object under study is the traditional set of Nenets male clothes made of reindeer skin, i.e. a hooded one-piece coat *mal'tsia* and stockings/boots *piwa*³. This is an integral set, which fits to varying natural context, climatic conditions, type of physical labor, and energy expenditure.

³ Aiming at consistency, from here and further on, we will use Nenets terms for pieces of clothing and related materials, even though, during the field interviews, some of our informants used terms specific to the local Russian-speaking population inhabiting the North-Western Siberia.

We divided our presentation into two sections concerning, respectively, biological and cultural dimensions of traditional fur clothing. Each of these sections contains ethnographic descriptions from the field diaries to capture the situatedness of the objects and practices under study, as well as specific functional characteristics attached to them.

4.1. Biological dimension of traditional clothing

Reindeer fur clothing became an integral part of the culture of the Arctic natives. According to Stefansson (1974), Arctic people living throughout the circumpolar region have time-tested their reindeer skin clothing ensembles for 3000–8000 yr. Watching the animals, and marveling at their resilience to harsh conditions, human beings could not do anything better than imitate reindeer by adopting their habits, behavior, and, most importantly, borrowing the basic means of protection from the winter cold, i.e. the fur/skin.

The reindeer fur consists of thick and hollow guard hairs (Figure 2) and of dense underfur, i.e. woolen hairs (Timisjärvi et al., 1984; Soppela et al., 1986). The underfur of the reindeer is of particular importance since it effectively prevents the movement of air within the fur itself and thus reduces heat dissipation via convection (Swan, 1974; Timisjärvi et al., 1984). These layers altogether provide extremely effective insulation, which is in many respects superior to modern synthetic materials (Cotel et al., 2004). Indeed, the reindeer can endure cold as severe as -62°C without evident difficulty (Soppela et al., 1986, p. 273). Moreover, as Irving noted, the insulating fur of the larger arctic land mammals conserves their bodily heat so well that the metabolic cost of maintaining warmth in arctic cold is no greater than in milder climates (Irving, 1968, p. 593).

As Richerson and Boyd (2005, p. 159) pointed out, marvelous adaptations found in any culture are typically solutions to problems posed by particular environments. In the case of the Nenets, the identity and functional properties of their traditional clothing are a result of several centuries-long migration – with purpose of hunting and then domesticating reindeer – from middle to high latitudes (Golovnev et al., 2016) embodied in the transformation of sewing patterns, lines and materials determined by the necessity of adapting to changing environmental conditions. In its current form, the Nenets clothing has existed, approximately, since the 17th century, and has remained almost unchanged to date.

The example of Nenets clothing puts forward the principle of borrowing from the nature, that is, from the reindeer per se. The entire skin is divided into three parts (Figure 3): *tai* (skin from the facial part), *hoba* (skin from the main body), *pena* (skin from the legs of a reindeer).

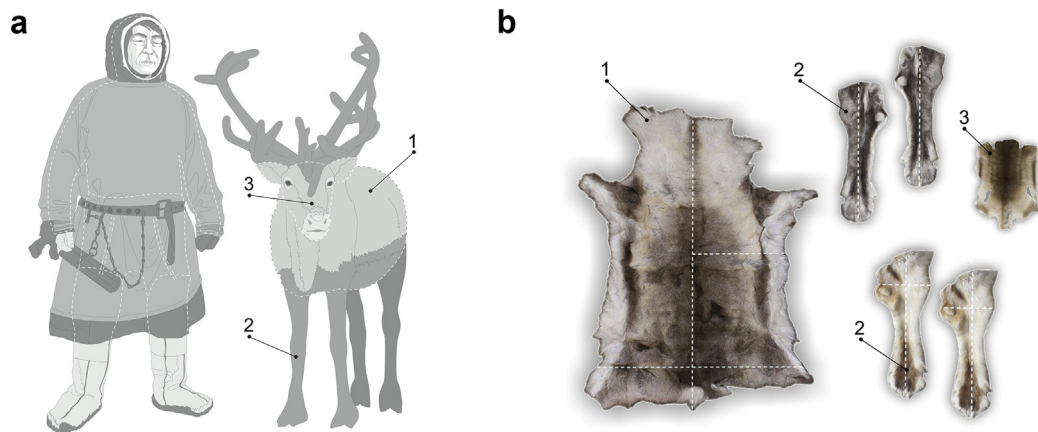


Figure 3. Biomimetics of reindeer: a) a reindeer as transformed into the set of clothing; b) parts of the hide as used for clothing items. 2019. Courtesy of Denis Kukanov and Olga Kukanova. Explanatory note: 1 – *hoba* (skin from the main body), 2 – *pena* (skin from the legs of a reindeer), 3 – *tai* (skin from the facial part).

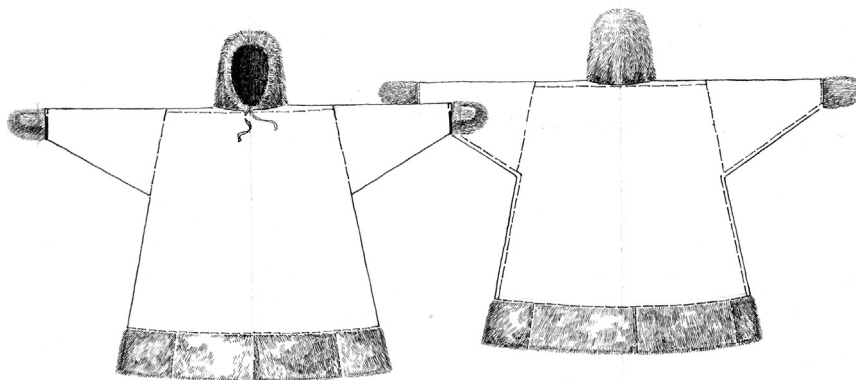


Figure 4. *Mal'tsia*. 1991. Courtesy of Nikolai Garin.

The biomimetic essence of human-reindeer relationship becomes visible through the example of the Nenets traditional set of reindeer clothing that includes a fur coat and stocking-like boots. In the same way as a reindeer, a man distributes all these parts on his body and so literally gets dressed like a reindeer: boot soles are made from the “brush” part, *hoba* is used for the main part of the coat, and the brow skin and *pena* are used for the hood, mittens and boot tops (Figure 3).

For Nenets people, their clothing is their “second skin,” almost inseparable from its owner, sometimes worn for days. As one of our informants formulated it, “that’s what makes me invulnerable.” (Conversation with anonymous male informant, 44, Baidarat tundra, YaNAO, 2016) Clothing ensures stable, comfortable conditions for living and working under extreme climatic conditions. It also shapes and sustains the identity of nomadic culture. For centuries, the Nenets have kept their traditional ways of clothes making. However traditional, these clothes allow them to drive around on their snowmobiles and fully enjoy benefits of using other contemporary devices, including satellite communications and the Internet. As the majority of our informants – both young and old, males and females – said: “There’s nothing better than *piwa* and *mal'tsia*,” or “A Nenets without a *mal'tsia* is not a Nenets.”

4.1.1. Fur coat

Mal'tsia, a pullover outerwear with a hood and mittens sewn to it, is a unique and unsurpassed type of clothing worn by northern natives (Figure 4). It takes five or six reindeer skins to make a *mal'tsia*. Its conical shape helps keep the main parts of the body, the back, the sides, the chest and the shoulders, warm and cozy.

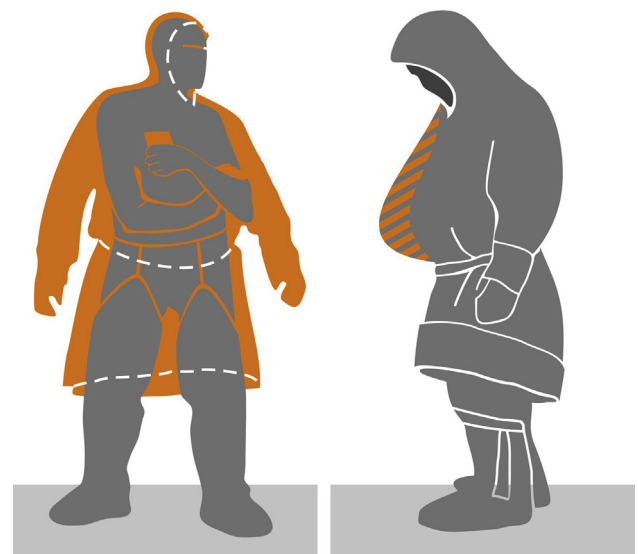


Figure 5. Variations of use of the internal space of the *mal'tsia*. 2019. Courtesy of Denis Kukanov. Explanatory note: Left: the mittens have slits which enable one to release hands for doing something or for ensuring quick thermal regulation inside the garment. Right: if girded, the *mal'tsia* forms folds and fits closely against the thighs preventing draught effects inside it. Also, girding creates an additional pocket inside the *mal'tsia* at the belly, etc.

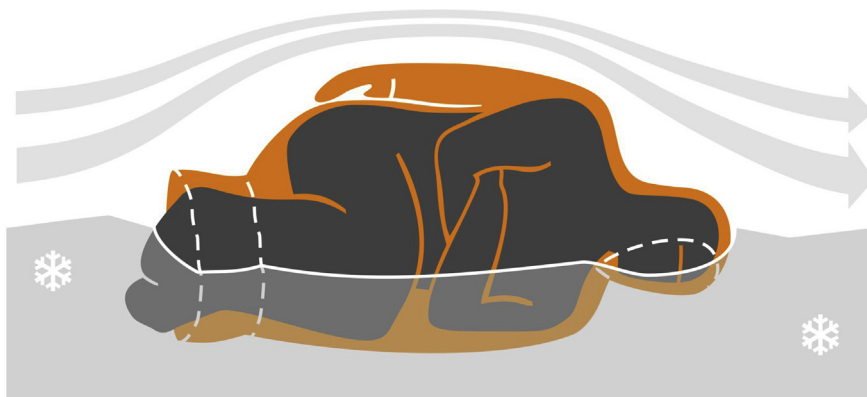


Figure 6. Sleeping in the *mal'tsia*. 2019. Courtesy of Denis Kukanov. Explanatory note: If it comes to sleeping out in the snow as the grouse does, the *mal'tsia* is turned into a kind of module, a cocoon, or a tightly closed sleeping bag. To do this, the native takes off his belt, bends his knees a bit, pulls them together and “girds” his legs right under them. Then he pulls his head inside the *mal'tsia* and uses the hood to shut off the neck hole as if with a plug, pulls his arms into the *mal'tsia* through the wide armholes, “hugs” himself and falls down on his side right into the snow.

Mal'tsia is invariably worn together with *piwa*, fur boots. Together, they protect the human body reliably against any temperature, wind and snow. As our ethnographic data suggest, this set of clothing is a multi-functional transformer characterized by expanded adaptability to specific scenarios in the system “man-clothing-environment”, its configurations vary depending on the natural context, climatic conditions, type of physical labor, and energy expenditure.

Also, like all fur things of the northern natives, *mal'tsia* is a particularly ecofriendly product, being fully biodegradable. Once worn out and thrown away, it can be eaten up by lemmings, hungry dogs, foxes or wolves because it does not contain anything artificial. Even the threads that are used for stitching the hides together are made of reindeer spinal tendons.

In their daily living, tundra Nenets are inseparable from the things that they traditionally use, things that “enhance” their owners and endow them with special “superpowers”. With this clothing, a Nenets can sleep in the snow, float on the water, walk on deep snow without sinking, walk on ice, etc. (Figures 5, 6, and 7).

4.1.2. Fur boots

To ensure the full protection from the cold *mal'tsia* must be complemented with *piwa*, i.e., stocking-like boots with the fur on the outside.

First the native puts on “*tobak*” or “*libtad*” (terms in (Amelina and Normanskaya, 2013, pp. 34–35), we will use “*tobak*” further on), also crotch-high stockings made from “*peshka*”, a reindeer fawn (*suyuko*) hide with its fur on the inside. *Tobak* are worn indoors in the chum or log cabin. One can even sleep without taking them off. For walking outside, the *piwa* are put on over the *tobak* (Figure 8).

After putting the *piwa* on, they are tied up to the body belt with leather strings. Before putting the *piwa* on, a tuft of grass is placed on their bottom as a pad between the *piwa* and the *tobak*.

Tobak soles are made of the same material as that of the boot top (*peshka*). As for *piwa* soles, it is a difficult and time-consuming process to make them. As noted above, soles are also made from the part of reindeer hide called *vera* or *tschetka* (literally a “brush”): this is a hide removed from the space between the hoof toes, where it is very thick and covered with tough fur (like hog bristles) with hair twisted like spirals (Figure 9).

This tough and springy fur prevents ice and snow balls from building up in this place when the animal is crossing alternatively slushy ice and snow areas. This growing ball could easily tear the hoof apart as it happens to dog feet in similar situations of ice and snow. In such cases, dogs themselves would bite out these ice balls.

As for the reindeer, the fur between its toes does not allow ice balls to form thanks to its resilience – it breaks and throws off any ice forming on it. Moreover, the spiral twisted fur prevents reindeer from slipping on snow.

Continuing our biomimetic exploration, let us consider in detail how such boots “work” in the natural environment, particularly in wintertime.

Piwa are mainly exposed to loads from the snow cover with their top front parts. When an ice crust forms on the snow after sudden winter thaws, which are not infrequent in the north, it can cut animals’ legs like a knife. The same can happen to the *piwa* when walking through the snow with an ice crust on its surface. If the *piwa* are made correctly from strong skin, they can successfully withstand this problem (Figure 10).

To conclude the biomimetic approach, let us have a closer look at some practical benefits for human health behind such dressing.

As noted above, reindeer fur does not allow the air movement along the body. There is no draught effect between the body and clothes because the fur hairs press tightly against the body and accurately copy its “curvature” without any gaps. The conical shape of the *mal'tsia* makes it possible to concentrate heat in the most important places of the body, i.e. the back, sides, chest and shoulders.

Also, in case of physical activity entailing intensive body perspiration, tubular/hollow hairs effectively bring out the moisture. This process keeps the human skin within a few degrees of the internal temperature – the same as considered comfortable in warmer climates.

To make full use of these effects, one has to wear the fur clothing in the traditional way, i.e. on the bare body with the fur inside. Each hair has special form of small cones inserted one into another (see the cuticle layer in Figure 2). These “cones” make the hair’s surface scratchy: while a person is moving, the hairs are massaging/scratching the skin and thus improving blood circulation.

4.2. Cultural dimension of traditional clothing

In addition to addressing environmental and physiological requirements, clothes express associated cultural practices of a locality. Our field observations revealed not just general rules of behavior and particular principles and practices of making/using/maintaining of things but the dynamic relationship between materials, tools, and a personality of a maker. Below, we illustrate each of these aspects with the example of footwear.

4.2.1. Materials

For *piwa* boots, pieces are cut out of skins in a preplanned manner that makes the best use of the skin grain and thickness, hair color and direction. The pieces are selected and collected throughout a whole year (Figure 11). Even several years might pass before a piece of skin would find its place as a part of someone’s clothing.

4.2.2. Tools

While a man extends his hands with a knife and a rope (Golovnev, 2004), a woman augments her fingers with a needle and thimble. “I cannot stitch with Russian needles and thimbles; they steal my time,” – asserts one of our respondents, a 40-year old woman, a busy wife of a



Figure 7. Being on water in the *mal'tsia*. 2019. Courtesy of Denis Kukanov. Explanatory note: Thanks to the physical properties of its fur (tubular hair) and its design, the *mal'tsia* can keep its owner afloat on the water, should he suddenly fall into it (the majority of the Nenets cannot swim⁴¹).

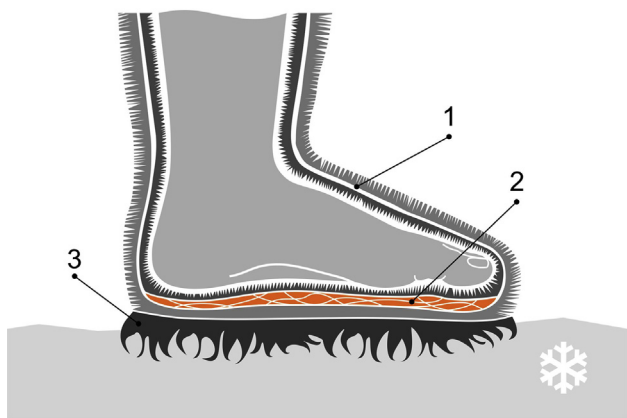


Figure 8. Layers of footwear. 2019. Courtesy of Denis Kukanov. Explanatory note: 1 – *piwa* and *tobak*, 2 – grass insole, 3 – soft non-slip sole.



Figure 10. Walking in *piwa* boots: the *pena* part sustains the front load. 2019. Courtesy of Denis Kukanov.

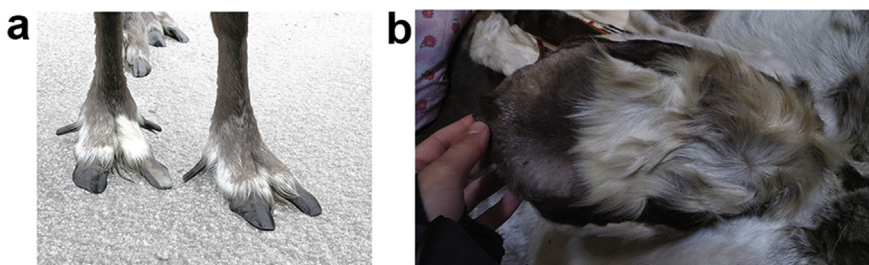


Figure 9. a) fur between reindeer hooves. 2016. Courtesy of Denis Kukanov; b) the sole of *piwa* boots. 2013. Courtesy of Svetlana Usenyuk-Kravchuk.



Figure 11. Pieces of reindeer hides collected by an 18-year old female informant as materials for footwear and bags. Baidarat tundra, YaNAO, 2013. Courtesy of Svetlana Usenyuk-Kravchuk.

specific sewing technique: the needle rests against the finger's side, and not at its tip.

4.2.3. A maker's personality

Sewing is the primary and endless/life-long activity of a Nenets woman. "My grandmother always said to me: Whenever you have a spare moment – do a stitch," – recalls our informant, a 56-year old woman (Interview with anonymous female informant, Baidarat tundra, YaNAO, 2013). She does not interrupt her needlework during our conversation.

A seamstress' personal touch predetermines functional characteristics and the entire appearance of the future piece. In terms of bodily engagements, footwear (as well as all other kinds of clothing) is made from fur/skin pieces measured using a complex hand-span system (Figure 12), which ensures both the precise measurement and a perfect fit of a complete piece of clothing.

This leads us to the aesthetic dimension of clothing expressed best by one of our informants, a 44-year old man, a hereditary reindeer herder: "In our clothes, the most important thing is not a beauty of the ornament, but the real beauty of the work: cuts, seams – everything that ensures strength and reliability. These elements are what stands for the dignity of both the wearer and the maker" (Interview with anonymous male informant, Baidarat tundra, YaNAO, 2013).

Nevertheless, the desire to adorn their clothes is not alien to Nenets: every craftswoman decorates her pieces in her own way by using a visual language of patterns embodied in combinations of beads, cloth, fur, and other elements. While there is a limited number of traditional models and templates approved by centuries, there is always a room for creativity at a micro-scale. Moreover, a skillful seamstress does not only remember many ornaments like an alphabet but comes up with her own "words." Thus, the process of making clothes ceases to exist as a mundane activity and turns into a specific type of communication – thinking and telling through cutting and stitching. As our female informant says with a smile: "I invented a new saying: As soon as a smart thought appears – do a

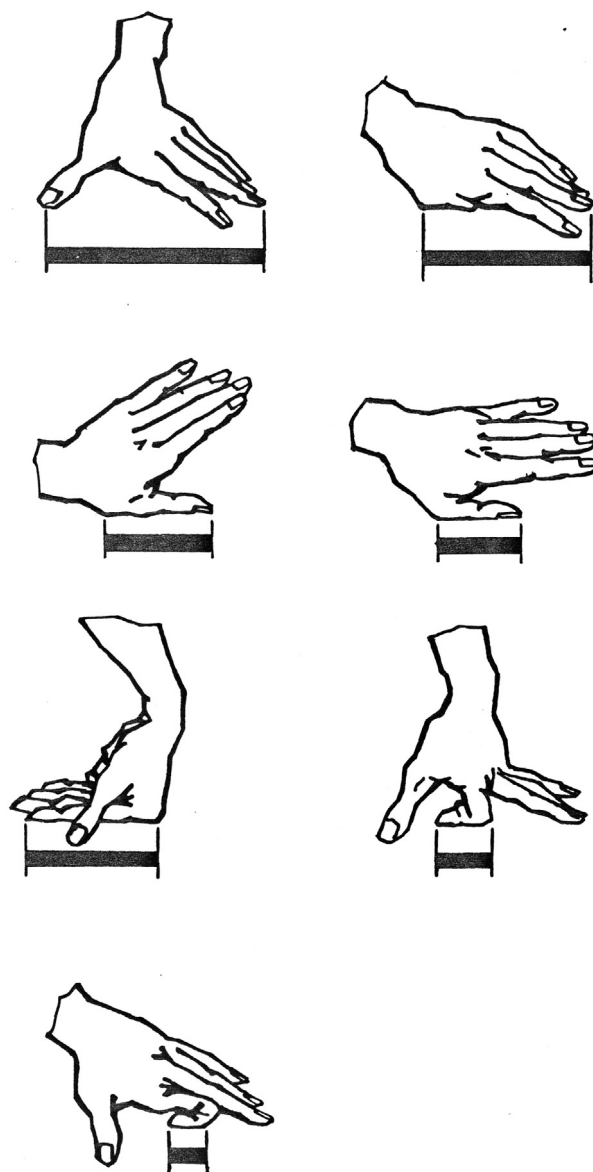


Figure 12. The system of hand measurements. 1991. Courtesy of Nikolai Garin.

stitch" (Interview with anonymous female informant, 56, Baidarat tundra, YaNAO, 2013).

5. Discussion

In our study, by reflecting on the empirical data on making and wearing traditional fur clothing among reindeer nomads from the Russian North, we eventually came up with two interwoven concepts of clothing. First, it is the result of the biomimetic appropriation of natural abilities of reindeer to withstand severe climates. In other words, borrowing from and imitating the wild nature and its species, reindeer in our case, which is in absolute harmony with the environment, the natives become as if similar to them to some extent, perceiving the world in the same way, being sensitive to it, and becoming it. In that light, the human feet in *piwa* feel very well the ground, the surface one is walking on and what he steps on. This quality ensures the full involvement of an individual – makes him/her "moving on the earth in a mindful way" (Conversation with anonymous female informant, 56, Salekhard, YaNAO, 2013).

⁴ The complicated relationship with water is deeply grounded in the Nenets culture. The majority of the Nenets cannot swim; however, this fact did not preclude them and other indigenous peoples of the North from being skillful sailors. As Kulemzin notes: "while bravely sailing on a fragile boat in the storm of the Gulf of Ob (sixty kilometers wide), Khanty and Nenets does not know how to swim, never swam in their life and were panicky afraid of water" (Kulemzin, 1992). Among natural reasons for the general inability to swim there are: cold rivers and lakes (even in summer), some of them with non-transparent water (of red-black color because of peat), muddy or clayey shores, and snaggy bottom, as well as the abundance of midges and mosquitos in the summertime.

The same applies to the clothing (*mal'tsia*), in which an individual feels safe from changeable weather and can focus on the main thing – surviving in the conditions of energy deficit (food, fire, motion). Also, the physical properties of reindeer fur are emphasized and enhanced in it by the design, components, and detailing of the finished product in wear.

Second, the example of *mal'tsia* and *piwa* illuminates the significance of clothing as a tangible form of adaptation to the extreme environment: the only possible human specimen to exist in the Arctic is an appropriately dressed human. Our field observations concerning biological and cultural dimensions of traditional clothes set the proper ground for this statement. This statement, in turn, is a consistent response to the call by Shercliff and Twigger Holroyd (2016) for constructing knowledge in the emerging area of craft research (Niedderer and Townsend, 2014). By observing and documenting the actual experiences of making and wearing traditional fur clothes, we revealed the dynamic relationship between tools, materials, and bodily identities. These findings are in line with research by Twigger Holroyd (Shercliff and Twigger Holroyd, 2016), in terms of taking a broader view on the relationship between the making and wearing processes.

To ensure the fully-fledged protection, the very process of making/sewing traditional clothes, as we described, has to move beyond a merely utilitarian activity. In addition to preparing materials, cutting and stitching pieces together, clothe-making generates both tangible and emotional values that would augment the present and shape the future living. This conceptualization is speculative, but it does provide useful perspectives for further testing and implementation through the cultural mimetic approach, namely developing design standards for the emerging multicultural community of Arctic newcomers. In this vein, the case study of the Arctic nomads' clothing provides an insight into a tricky question: what are the ways traditional clothing could not merely support the very existence in the extreme/severe environment but contribute to personal wellbeing? In addition to excellent insulation properties, the Nenets clothes have features which enhance their usability, expand their functionalities, and make them transformable depending on the situation. Thus, the example of the traditional nomadic clothing provides an insight into how to anticipate and facilitate a wearer's actions with a basic set of options and accessories readily available.

The outcome and contribution of this research is a better understanding of clothing as an integral component of the "Arcticness" (Kelman, 2017) or more personalized "Nordicity" (Hamelin, 1978), which mean the quality of being a part of the Arctic/North. With the example of traditional fur clothing of Arctic nomads, this understanding reconnects with actual research and development projects by designers on mixing clothing cultures and creating new traditions in the Arctic context (Konola and Kähkönen, 2015).

Throughout this article, we also argued that not only archaeologists could see human behavior reflected in artifacts, but other professionals engaged with the materiality of social living. For example, designers could intentionally observe and document the long-ago established standard/tradition of "being an arctic nomad" fixed in the world of things.

We would encourage others to pick up where we have left off and proceed with research on the innovative applications of this standard and its possible implications for contemporary design practice. More specifically, the current exploration into the Nenets people's tradition of creating a "second skin" constitutes a clear agenda for further research and provides a basis for developing a design concept of personal protective equipment for the Arctic conditions.

Considering other perspectives for further research on the topic of traditional clothes of Arctic nomads, we believe it is worth to examine the "thing's lifecycle." In conjunction with the systemic exploration into the nomadic way of living, it will help to reveal principles and practices of the natives' ecological and functional approach to making clothes.

To summarize, design research on the way of comfortable living and working in the Arctic zones needs to continue. It represents an efficient tool to reveal the value of knowledge of arctic natives about their

environment and bring it to the table for consideration of how social and cultural adjustments can rebalance physiological responses to stressful conditions.

6. Conclusion

This work investigated the domain of so-called "traditional" Arctic clothing. Through observing and analyzing clothing items in situ with activities of making and wearing, we revealed the principles of personal wellbeing embedded into a daily routine of reindeer nomads.

Joining the discussion on how the "material world" can facilitate human adaptation and wellbeing in extreme environments, we have demonstrated how insulation and morphological properties of reindeer fur have been utilized in the traditional fur clothes of Nenets nomads. These properties, on the one hand, encourage people to engage physically with natural materials through biomimetic borrowing. On the other hand, the forms of such borrowing prevent direct copying. Instead, they require to regularly rebalance the equation between what nature (reindeer) can provide and what the user/maker can utilize. Such "fluidity" of the relationship between available materials and acquired skills becomes a cultural standard. Further examination of opportunities and limitations within this standard can open new ground for research on adaptive processes, and, in some cases, challenge existing concepts of adaptation to cold and other manifestations of environmental extremes of the Arctic, and thus influence further plans for the Arctic development.

In terms of methodology, our study provides a fertile ground for mutually enriching collaboration between animal and human biology, ethnography, and design studies. While the latter can offer a new depth of immersion into technologies and practices of making and using things, the first two disciplines can inform the biological and cultural basis for these practices to emerge and develop.

Declarations

Author contribution statement

Svetlana Usenyuk-Kravchuk: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Nikolai Garin: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data.

Alexandra Trofimenko: Performed the experiments; Contributed reagents, materials, analysis tools or data.

Denis Kukanov: Contributed reagents, materials, analysis tools or data.

Funding statement

This work was funded in two steps, as follows: funding for the field-work stage came from the Ella ja Georg Ehrnroothin säätiö, Finland (project "Visualizing Arctic Mobility," funding decision 12.05.2012), and the Russian Science Foundation (project "Mobility in the Arctic: Ethnic Traditions and Technological Innovations," grant 14-18-01882). The main body of the work including data analysis and preparation of the article was supported by the Russian Science Foundation, Russia (project "Arctic Design: Methods of Technical Aesthetics for Development and Appropriation of the Russian Far North," grant 17-78-20047).

Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

References

- Amelina, M., Normanskaya, Yu., 2013. History of the protolanguage names of clothes and footwear in Nenets. *Ural-Altai Stud.* 13–62.
- Arzyutov, D., 2019. Off-the-Grid life of arctic nomads: social generating of electricity in the northern Yamal. *J. Sib. Fed. Univ. Humanit. Soc. Sci.* 8, 1356–1373.
- Bhushan, B., 2009. Biomimetics: lessons from nature—an overview. *Philos. Trans. R. Soc. Math. Phys. Eng. Sci.* 367, 1445–1486.
- Boas, F., 1964. *The Central Eskimo*. University of Nebraska Press, Lincoln.
- Castren, M.A., 2012. *Nordiska resor och forskningar*, 2. Nabu Press, Charleston.
- Cena, K., Clark, J.A., 1978. Thermal insulation of animal coats and human clothing. *Phys. Med. Biol.* 23, 565–591.
- Cotel, A., Golingo, R., Oakes, J., Riewe, R., 2004. Effect of ancient Inuit Fur parka ruffs on facial heat transfer. *Clim. Res.* 26, 77–84.
- Færevik, H., Wiggen, Ø., 2014. Clothing and protection in arctic environments. In: *Proceedings of Ambience 14&10i3m*. Presented at the Ambience 14&10i3m, Tampere, Finland.
- Friedman, S.S., 2007. Cultural parataxis and transnational landscapes of reading: toward a locational modernist studies. In: Eysteinson, A., Liska, V. (Eds.), *Comparative History of Literatures in European Languages*. John Benjamins Publishing Company, Amsterdam, pp. 35–52.
- Garin, N., 1991. *Dizayn Dlya Usloviy Kraynego Severa: Printsip Preyemstvovaniya Kul'tury Korennogo Naseleniya* [Design for the Environment of Far North: the Principle of Borrowing from Indigenous Material Culture]. Unpublished PhD Thesis. Stroganov Moscow State University of Arts and Industry, Moscow.
- Golovnev, A., Garin, N., Kukanov, D., 2016. *Reindeer Herders of Yamal (Research Materials for the Atlas of Nomadic Technologies)*. UrO RAN, Ekaterinburg.
- Golovnev, A.V., 2004. *Kochevniki Tundry Nentsy I Ikh Folklor* [Nomads of the Tundra the Nenets and Their Folklore]. UrO RAN.
- Golovnev, A.V., Lezova, S., Abramov, I., Belorussova, S., Babenkova, N., 2014. *Ethnoexpertiza na Yamale: nenetskie kochevia i gazovye mestorozhdeniya* [Ethno-expertise on Yamal: Nenets routes and gas fields]. Russian Acad. Sci. The Ural Branch, Ekaterinburg: ABM Press.
- Golovnev, A.V., Osherenko, G., 1999. *Siberian Survival: the Nenets and Their Story*. Cornell University Press.
- Hamelin, L.-E., 1978. *Canadian Nordicity*. Harvest House, Montreal.
- Hammel, H.T., 1955. Thermal properties of Fur. *Am. J. Physiol.-Leg. Content* 182, 369–376.
- Hardt, M., 2012. The story of the frozen ice or the art of sustainable design in the Arctic. In: Tahkokallio, P. (Ed.), *Arctic Design - Opening the Discussion*. University of Lapland, pp. 54–59.
- Harriss, R., 2012. The arctic: past or prologue? *Environ. Sci. Policy Sustain. Dev.* 54, 3–13.
- Hasnuln, V.I., Voytik, I.M., Hasnulnina, A.V., Ryabichenko, T.I., Skosyreva, G.A., 2014. Some ethnic features of northern Aborigines' psychophysiology as a base for survival in extreme natural conditions: a review. *Open J. Med. Psychol.* 3, 292–300.
- Hatt, G., 1969. Arctic skin clothing in eurasia and America. An ethnographic study. *Arctic Anthropol.* 5, 3–132.
- Irving, L., 1968. Adaptations of native populations to cold. *Arch. Environ. Health* 17, 592–594.
- Irving, L., Krog, J., 1955. Temperature of skin in the arctic as a regulator of heat. *J. Appl. Physiol.* 7, 355–364.
- Ivanov, S.V. (Ed.), 1970. *Clothing of the Peoples of Siberia: Collection of Articles of the Museum of Anthropology and Ethnography*. Nauka, Leningrad.
- Jackson, F.G., Brice, A.H.M., 2012. *The Great Frozen Land (Bolshaia Zemelskija Tundra): Narrative of a winter Journey across the Tundras and a Sojourn Among the Samoyads*. Cambridge University Press, New York.
- Kapsali, V., 2009. Biomimetics and the design of outdoor clothing. In: *Textiles for Cold Weather Apparel*. Elsevier, pp. 113–130.
- Kelman, I. (Ed.), 2017. *Arcticness: Power and Voice from the North*. UCL Press, London.
- Kennedy, E., Fecheyr-Lippens, D., Hsiung, B.-K., Niewiarowski, P.H., Kolodziej, M., 2015. Biomimicry: a path to sustainable innovation. *Des. Issues* 31, 66–73.
- King, J.C.H., Pauksztat, B., Storrie, R. (Eds.), 2005. *Arctic Clothing of North America: Alaska, Canada, Greenland*. McGill-Queen's University Press, Montreal.
- Konola, S., Kähkönen, P. (Eds.), 2015. *Arctic Wears - Perspectives on Arctic Clothing*, B. Reports 10/2015. Lapin ammattikorkeakoulu, Rovaniemi.
- Kulemzin, V.M., 1992. *Znakom'tes': Khanty: Monografiya* [Meet: Khanty: Monograph]. Nauka, Novosibirsk.
- Kvashnin, Y., 2010. *Sovremennyye etnopoliticheskiye Protsessy v Yamalo-Nenetskom Avtonomnom Okruge* [modern ethnopolitical processes in Yamal-Nenets Autonomous Okrug]. *Izv. AltGU J.*
- Laruelle, M., 2015. *Russia's Arctic Strategies and the Future of the Far North*, first ed. Routledge.
- Lenau, T., 2009. Biomimetics as a design methodology - possibilities and challenges. In: *Proceedings of ICED'09*. Presented at the International Conference on Engineering Design, ICED'09. Stanford University, Stanford, CA, USA, pp. 121–132.
- Liarskaya, E., 2010. Women and the Tundra: is there a gender shift on Yamal? *Anthropol. East Eur. Rev.* 28, 51–84.
- Lodato, F., 2010. The nature of design. *Des. Manag. Rev.* 16, 56–61.
- Moote, L., 1955. The thermal insulation of caribou pelts. *Textil. Res. J.* 25, 832–837.
- Moran, E.F., 2007. *Human Adaptability: an Introduction to Ecological Anthropology*, third ed. Westview Press.
- Moreno, M., De los Rios, C., Rowe, Z., Charnley, F., 2016. A conceptual framework for circular design. *Sustainability* 8, 937.
- Nansen, F., 1890. *The First Crossing of Greenland*, Vol. I. Longmans, Green, London.
- Niederer, K., Townsend, K., 2014. Designing craft research: joining emotion and knowledge. *Des. J.* 17, 624–647.
- Nuutinen, A., 2015. The future of arctic clothing. In: *Arctic Wears - Perspectives on Arctic Clothing*, Series B. Lapland University of Applied Sciences, Rovaniemi, pp. 162–180.
- Oakes, J., Wilkins, H., Riewe, R., Kelker, D., Forest, T., 1995. Comparison of traditional and manufactured cold weather ensembles. *Clim. Res.* 5, 83–90.
- Papanek, V.J., 1985. In: *Design for the Real World: Human Ecology and Social Change*, second ed. Academy Chicago, Chicago, IL. completely rev. ed.
- Richerson, P.J., Boyd, R., 2005. *Not by Genes Alone: How Culture Transformed Human Evolution*. University of Chicago Press, Chicago.
- Ricklefs, R.E., 1973. *Ecology*. Chiron Press, Newton, Mass.
- Sanchez, C., Arribart, H., Giraud Guille, M.M., 2005. Biomimeticism and bioinspiration as tools for the design of innovative materials and systems. *Nat. Mater.* 4, 277–288.
- Schlander, P.F., Walters, V., Hock, R., Irving, L., 1950. Body insulation of some arctic and tropical mammals and birds. *Biol. Bull.* 99, 225–236.
- Shand, P., 2002. Scenes from the colonial catwalk: cultural appropriation, intellectual property rights, and fashion. *Cult. Anal.* 3, 47–88.
- Shercliff, E., Twigger Holroyd, A., 2016. Making with others: working with textile craft groups as a means of research. *Stud. Mater. Think.*
- Sokolova, Z.P., 2009. *Khanty i mansi: vzglyad iz XXI veka* [Khanty and Mansi: The view from the 21st century]. Nauka, Moskva.
- Soppela, P., Nieminen, M., Timisjärvi, J., 1986. Thermoregulation in reindeer. *Rangifer* 6, 273.
- Stammler, F., 2005. *Reindeer Nomads Meet the Market : Culture, Property and Globalisation at the "End of the Land"*. Lit, Münster.
- Stammler, F.M., 2009. Mobile phone revolution in the tundra? Technological change among Russian reindeer nomads. *Folk. Electron. J. Folk.* 47–78.
- Stefansson, V., 1974. *Arctic Manual*. Greenwood Press, Westport, Conn.
- Swan, H., 1974. *Thermoregulation and Bioenergetics: Patterns for Vertebrate Survival*. American Elsevier Pub. Co, New York.
- Tahkokallio, P. (Ed.), 2012. *Arctic Design - Opening the Discussion*. University of Lapland.
- Taussig, M.T., 2017. *Mimesis and Alterity: a Particular History of the Senses*, Routledge Classic Texts in Anthropology. Routledge, Abingdon, Oxon, New York, NY.
- Timisjärvi, J., Nieminen, M., Sippola, A.-L., 1984. The structure and insulation properties of the reindeer Fur. *Comp. Biochem. Physiol. A Physiol.* 79, 601–609.
- Usenyuk-Kravchuk, S., Garin, N., Gostyaeva, M., Konkova, Y., Mingaleva, A., 2018. Arctic dimension in design education: how the place matters. In: *Relate North: Practising Place, Heritage, Art & Design for Creative Communities*. Lapland University Press, Rovaniemi, pp. 56–85.
- Volzhanina, E., 2017. Socio-demographic aspects of the Yamal Nenets people according to all-Russian censuses of the 21st century. *Vestn. Arheol. Antropol. Etnografi* 120–130.