Arctic design methods: Developing technology for onboarding life in the extreme environment

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Abstract. The paper reports the results of a 3-yr long research project (2017-2020) into Arctic design and its potential to contribute to the development of the Russian Far North, with emphasis on mobility in conditions of underdeveloped infrastructure and remoteness from economic centres. By way of employing the case study approach, we conducted several expeditions to explore DIY transport vehicles created by inhabitants of the Russian hinterland. We elaborate on the results of data collection and analysis to propose a triad of design methods aimed at working with local makers. The overall approach is illustrated with conceptual sketching. In the final discussion of the results, we outline potential directions for further research.

1. Introduction

The Russian Far North with its thinly scattered population, long distances and lack of roads and infrastructure presents a major challenge in terms of sustainable development and, in particular, strategic transition from ‘conquering’ the northern frontiers to ‘onboarding’ life in the North. A team of design researchers carried out a three-year research project (2017-2020) by way of contributing to the solution of this national priority based on the research and design expertise of the Arctic Design School (ADS) set up within the Department of Industrial Design at the Ural State University of Architecture and Art (USUAA) in the early 1980s, now the university’s major lab for design research. Within the framework of this project, the existing principles and practices in the area of design for extreme northern environments were reviewed. One of the outcomes is a triad of design methods aimed at developing artifacts and technologies that would better serve people in remote/isolated areas with severe climatic conditions.

1.1. Thematic Focus

The main design and research challenge stems from the basic characteristics of human-technology interaction in the extreme environment of the Arctic/North: in such conditions, man relies on technology, which is more vulnerable than in other climates and is more difficult to maintain and repair, resulting in growing psychological tension in the user. Thus, the research question is: what kind of man-made environment should there be for the Arctic, and what technological and aesthetic characteristics would it have? With reference to the professional specifics of design: how should the special “Arctic materiality” be designed, including industrially produced objects which should support and protect...
human life while causing no damage to the nature?

For design professionals, this means that “arctic adventure” cannot be regarded a “specific case” for design practice; it is an independent area in its own right. Hence, there is little rationale in using existing design principles, methods and techniques developed and tested in more “civilized” environments and moderate climatic conditions. According to Nigel Cross, improving the design process implies the development of new design methods [1, p. 46]: in our case, this means that design for an extreme environment requires developing its own set of tools and systematic procedures that would ensure the expected tangible outcome.

Having studied a historical array of scientific and technical experiences in the creation of “object-spatial environment” for the conditions of the Russian North [see, for example 2–4], we discovered a rather scarce toolkit based primarily on the modernization of existing prototypes of either dwellings and clothing or machinery and other equipment developed for other conditions (more the comfortable climate of the midlands) and for performing other functions, with minor adjustments for the harsh climatic conditions of the North. The inability of the industry to meet the need for reliable, convenient and affordable transport engendered a spontaneous amateur design movement. These specimens and practices of “amateur design” – particularly in the field of transportation – inspired us to develop special design methods, homemade craftsmen being priority target users of the practical results of our work.

2. Data and methods

The development and testing of a set of design methods for the Russian North/Arctic extreme environment envisaged in the project required the use of the case study approach outlined by Yin as a “linear, but iterative process” [5] that appears to be especially useful when research is in its early probing stage. The main source of information for the study of appropriate arctic design technologies and practices was ethnographic explorations: during the period of 2017-2020, we made five expeditions (Arkhangelsk Oblast – 1, Ulyanovsk Oblast – 1, Perm Krai – 2, and Yakutia – 1) involving participant observation and participation/co-creation with the user [6].

Based on the array of empirical data obtained, we focused on the transport sector for two reasons: (1) the paramount importance of the theme of mobility in an extreme environment with poorly developed infrastructure and long distances from economic centers; (2) opportunities for testing design methods developed on live material from the regions under study, with subsequent possible applications in housing and equipment design. In order to strictly and unambiguously interpret our observations, hypotheses and proposals, we focused on a specific scale – movement travelling to meet personal domestic needs and micro-mobility implemented in small-size "transport units" of 1-2-seat ATVs.

The case study we present in the section below is grounded in the village of Pozhva in the Perm Krai, a center of user community innovations in the field of transport that was discovered and surveyed twice: in March 2018 and July 2019. The fieldwork included participant observation, semi- and unstructured interviews with 14 participants, age ranging from 45 to 63, and a co-design experiment with the proposed set of methods applied to the development of all-terrain vehicles by teaming up amateurs (3 persons), design students (4 persons) and a design professional (1 person).

3. Results

3.1. Methods

The triad of design methods developed in the course of the study encompasses various scales and “spheres of influence” in design for extreme environments: progression from external superficial transformation of a one-off thing (method of composition keys) to the development of a geographically confined and locally rooted system of objects (factor method) and, ultimately, facilitation of locally appropriate and accepted technologies and equipment improving human life (co-authorship method). These methods may be used separately or constructed into a “road map” to a new, more attractive lifestyle and a new culture of living in remote, sparsely populated areas with a severe climate. Sticking to the report style of this paper, we provide only a brief portrayal of the methods, while a detailed description with illustrations is presented in the collective monograph [7] and on the project website.
3.1.1 Method of composition keys

Objective of use:
- For targeted improvement of usability in various cases, for example, where a transport vehicle needs to be raised to the level of a commercial product, particularly where the object to be improved presents a product in which engineering solutions have been implemented – from reducing friction in individual components to increasing energy efficiency – without due regard for its aesthetics/design.
- For upgrading objects which have their functional qualities preserved but aesthetically are outdated and require visual/stylistic reincarnation.

The essence of the method implies translating the image of the initial object into the language of a formal (non-pictorial) composition and developing a “composition key”, i.e. a two-dimensional abstract composition containing in laconic form concentrated information about the visual characteristics of the object – the compositional center, rhythm, symmetry, etc. The next stage involves analyzing and reformatting the initial composition key allowing for up-to-date requirements and new trends in various areas of science, technology, and culture (for example, enhanced safety in operation, protection against adverse natural and climatic elements, eco-friendliness, latest technological achievements and modern materials, imagery and stylistic characteristics of the brand, etc.), and creating a new image of the product based on the modified composition key.

Expected outcome: the method is aimed at facilitating psychological and emotional adaptation to the environment achieved by means of ensuring the unity of functional, structural and aesthetic qualities of man-made things. A conscious application of the law of artistic composition results in a product with “ideal” consumer characteristics – utmost correspondence to the intended use and satisfaction of all aspects of sensory perception.

3.1.2 Factors method

Objective: to develop an informative and comprehensive brief for designing a mass-produced/batch product: perform an analysis of the form and technical structure of a DIY off-road vehicle in order to elicit the local factors that are important for developing a lightweight off-road transport. In design, these factors are called form-generating – they make up the basis of the design process to resolve the issue of travelling where there are no roads.

The essence of the method: it is a sequence of analytical actions of browsing (mentally) through all links between the form of the product and the conditions of its functioning in the environment. The list of actions is characterized by step-by-step transition from identification of explicit (obvious, visible) factors to concealed ones, from passive contemplation of the form to its active apprehension.

Expected outcome: the method reveals an array of environmental factors that are most characteristic of a particular area. In so doing, there is no need to describe or note or take into account individual factors (cold, damp, wind, etc.); of greater importance is the unique combination of factors, their inter-relations and respective form-generating techniques that have become traditional for the indigenous culture. Knowledge of these combinations provides the designer with exhaustive information for handling design problems, with a ready-made program/algorithm of form-building. The tangible embodiment of this algorithm is a product with a clear/ideal destination. It should be noted that for each remote region of the country there is its own combination of factors and respective system of form-generation techniques.

3.1.3 Co-authorship method

Objective of use: to create conditions for a creative contribution from the user to the development of an absolutely new object/product for oneself. The co-authorship method presents construction of a context for designing while part of the design work is realized by the user from the set of components, or “semi-finished products”; using the instructions developed by designers.
The essence of the method: it is based on the natural ability of man to improve and tailor things and technologies to “fit” his needs by identifying “weaknesses” as a potentiality for improvement, find new uses, etc. The method itself is realized as an asynchronous sequence of actions/iterations: designers suggest a certain provocative solution, which is then modified and improved by users; the designers then get feedback on how it was implemented in the object, resolve problems or propose new provocations; the users pick them up and continue, etc. The iterative process of working, as a rule, happens in real settings and is not limited in time.

Expected outcome: the method results in a thing which is still unfinished while the process of endless modifications and adaptations of the object to the user’s needs and to the environment has and can have no final solution. In this case, the product “grows out” beyond being a commodity and turns into a “live” object, literally animated by its owner and co-author.

3.2. Case study: Pozhva “Jeeps”

Pozhva is a workers settlement established in the mid-18th century at Stroganovs’ iron-making mill on the river Kama in Perm region. Later, the mining business declined but in the 20th century its human resources and technologies found use at Pozhva Machine Engineering Factory manufacturing firefighting equipment. In the 1990s, the settlement became known for its production of light-weight off-road vehicles on low-pressure tires (Fig. 1) – the locals called them “jeeps” despite the fact the vehicles did not have a cab. The general “jeep” concept was borrowed from technical periodicals and adapted to local potentialities and conditions. The design that became classical was a four-wheel rear-drive arrangement with low-pressure tires; it was equipped with the Izhevsk motorcycle engine. The frame was welded at the factory using what was available at that time, and then it was fitted out in private garages. Amateur mechanics also assembled four-wheelers, articulated vehicles and vans, but these were one-off specimens. Pozhva thus grew into an off-road vehicle making center in the Kama region, reaching a peak output in 2000-2007 when the Internet helped promote it across Russia; where the choice of mass-produced cross-country vehicles was still limited. The owners tried repeatedly but failed to get their products legalized by the Gostekhnadzor technical oversight agency to enable their use “on-road”, which only served to have the “off-road” label getting stuck to them.

3.2. Conceptual sketching

The basic set of essential characteristics which an ideal transport vehicle should have for the northern (roadless, climatically severe) conditions includes: autonomy (minimal requirements as to infrastructure needed), maneuverability, eco-friendliness (low ground pressure), economic efficiency, maintainability, and customizability.
This section presents a series of conceptual sketching proposals, a designerly reflection on the structure and visual appearance of the Pozhva “jeep” and a “rough” idea for a light-weight small-size ATV. The rectangular-section metal frame of this ATV is arranged longitudinally. The rider sits on it as on a motorcycle. The wheels are tubes. The frame allows a cage or overhead structure to be mounted. There is no suspension. Thanks to large shock-absorbing wheels, the roughness of the terrain is dampened effectively. Drive is through the rear wheels, the front wheels being steerable. The ATV is capable of fording shallow water and can carry small weights. With minor modifications of the wheels, this updated “jeep” could find applications in various areas – from flat and swampy to hilly and snowy terrains of the Russian North.

![Image of Pozhva “jeep” proposals](image_url)

**Figure 2.** Modifications of the Pozhva “jeep” for different conditions and user needs. Images by N. Klyusov, 2020.

### 4. Discussion

In the project reported, we focused on considering small-size transport within the systems of geography and culture by way of expanding professional designer sensitivity to the context of technology creation and use. Our results thus contribute to the discussion on the geographical construction of technology (G-COT) and the potential of remote areas to evoke people’s creativity as technology users [see more in 8–10].

While aimed at solving mobility problems in remote areas with extreme climatic conditions, the proposed triad of design methods is not limited to the geographical borders of the Arctic / Far North. In this vein, a comparably vast, remote, and extreme African continent, i.e. a space for makeshift solutions to everyday basic needs [11], can provide yet another “testing ground” for further research and co-design practices with lay designers. With these methods – based on a competent design interpretation of local knowledge embodied in objects and technologies – we aim to contribute to the ongoing debates on decolonizing design [12].

Based on the analysis of the collected empirical material, we claim that inventiveness, self-organization and cooperation are the hallmarks of the northern communities defined by remoteness and harsh climatic conditions, which is also reflected in design as an activity to organize autonomous life support in an isolated/extreme environment [13]. Even at this stage of initial formulation, which
definitely needs to be tested, this statement represents a discovery in the field of design and, in a broader sense, in the field of human-technology relations.

5. Conclusion
The paper presents an alternative view of the phenomenon of the extreme environment as a space of new opportunities for designing locally appropriate solutions, particularly all-terrain vehicles. By exploring DIY means of transportation created by inhabitants of the Russian hinterland, the work provides insights into local practices of physical development and expansion of geographical space. These means and practices are presented as innovatory resources for designing customized small-sized vehicles. To use this resource efficiently, we have developed a unique set of design methods that combines sensitivity to socio-cultural aspects with artistic and aesthetic tools. These methods are unique to the Arctic Design field and, at the same time, available for use in other extreme contexts. We have arrived at this result by addressing the theme of territorial distance, isolation, and transportation as a means of overcoming them. Roadlessness and transport irregularity are, of course, key characteristics of the Arctic in the context of its industrial development and resettlement, but quite similar extreme manifestations of isolation and roadlessness and the need to overcome these problems can be found literally a hundred kilometres from any major city across Russia.

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