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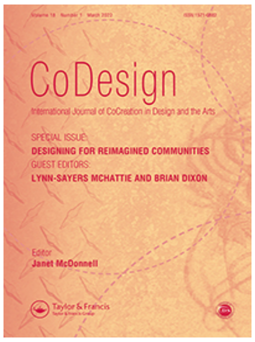

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Local adequacy as a design strategy in place-based making

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ABSTRACT
This article examines continuing appropriation of products and materials through the term 'local adequacy' and provides an alternative perspective on grassroots strategies of exercising control over technology by (re)connecting with the place of its making and using. To observe and document these strategies, we examine areas with challenging natural and infrastructural conditions, where local inhabitants collectively undertake creative action for building a comfortable living environment. Three cases in remote areas of Russia show that local adequacy is formed though identities reflected in both practical and symbolic value of products, competences that allow products to be used, maintained, and upgraded; and materials through which makers are included in a broader economic and technological context.

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Remoteness; transport vehicle; grassroots; user community; DIY; Russia

1. Introduction

Grassroots strategies of exercising control over technology by (re)connecting with the place of its making and using are of continuing interest to design and innovation researchers (Campbell 2017; Usenyuk, Hyysalo, and Whalen 2016; Smith 2017). The pioneer of history and philosophy of technology Lewis Mumford (1964) brought to the fore the democratic nature of technologies that are locally assembled, maintained and repaired, and in so doing provide a mutually nurturing relation between technology and humans in a local setting. Mumford observed that such designs are seldom optimised or aim at long reach over spatial and social contexts. In this capacity, they are commonly belittled by the planners of large optimised systems that tend towards high efficiency, wide reach, central control, and concentration of resources and power (ibid). At the same time, such human-scale locally anchored designs continue to draw attention as a more socially and ecologically sustainable alternative in critical social analysis (e.g. Illich 1973; De Laet and Mol 2000; Smith 2017) and in participatory and community based approaches to design (e.g. Henderson and Kyng 1991; Suchman 2002; Voss 2009; Botero 2013) as they arguably result in fewer negative externalities such as waste, pollution and social injustice. Yet, to understand how locally anchored grassroots strategies work and how designers could contribute to them, an improved understanding is needed regarding the variation in use/misuse/reuse/redesign both on the level of the product and on how products and materials are engaged in specific forms of use within

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the space-time of a particular locality (Kohtala, Hyysalo, and Whalen 2020), as well as the performance of individual components and systems in various natural, socio-cultural, and economic realities (Isaksson and Eckert 2020).

To this end, we elaborate on grassroots design strategies in continuing appropriation of products and materials through the term 'local adequacy'. We examine its constituents in remote, peripheral areas with challenging natural and infrastructural conditions, where local inhabitants collectively undertake creative action as the only possibility for building favourable living environment (Manzini 2019) – and, by so doing, extend the life cycle of parts and materials but also give them new longstanding lives.

We start by reviewing how local adequacy is interpreted in the research literature and then move on to discuss our geographical and conceptual focus on remoteness/rurality and roadlessness. This is followed by a description of our fieldwork and analysis of three case studies from localities in Russia. The empirical and theoretical implications of the case analysis are summarised in the concluding section of the article.

1.1. Local adequacy as an alternative design approach

Dictionary definitions suggest that '*adequacy' is the state or quality of being satisfactory or acceptable in quality or quantity (Merriam-Webster)*. This definition thus does not imply that such a state is optimal, i.e. made by the best or most effective use of a situation or resource; rather, it is one that 'does the trick' in specific circumstances. Attention to locally adequate designs and design strategies has a long legacy.

To gain a deeper insight into locally adequate designs and their relation to the revaluing and recycling of materials, we need to proceed from studies of users and grassroots innovation to social anthropology and design research.

Contexts in which locally sufficient design and building skills become paired with a desire to address unmet needs in local communities have been highlighted by ethnographers in many parts of the globe. In mobility solutions alone, whole local cultures of vehicle reassembly and improvement have been documented for trucks in Sudan (Beck 2009), motorcycles in Mongolia (Fraser 2018), jugaad motorcycles and tricycles in India (Singh, Sharma, and Mahendru 2011), trucks and karakats in the Russian North (Hyysalo and Usenyuk 2015; Sirotina 2011; Laviolette and Sirotina 2015; Usenyuk, Hyysalo, and Whalen 2016) and furkonis in Greece (Papazafeiropoulou 2012). Examples in other domains embrace a diverse range of products: bush pumps (De Laet and Mol 2000), rainwater harvesting systems (Freire, Levänen, and Bonvoisin 2021), solar heat collectors (Ornetzeder and Rohracher 2006), self-built wind turbines (Nielsen 2016; Latoufis and Tympas 2018), and other small scale renewables (Hyysalo 2021).

The dynamics involved have been covered systematically in innovation studies over decades, which have demonstrated how many human needs remain invisible or appear unprofitable to producers, a common phenomenon in more affluent and industrialised contexts as well (Von Hippel 2005, 2016). The unserved users end up serving themselves by creating novel designs from the resources that are available to them. Initially identified in contexts such as scientific instruments and sports communities, this trend has since been found to take place in various other walks of life (e.g. Riggs and Von Hippel 1994; Lüthje, Herstatt, and Von Hippel 2005; Von Hippel 2016). There are various reasons why people's needs for goods and services remain uncatered for: difficulty of knowledge transfer between producer and user (Von Hippel 1994); user needs are too particular or fast moving for producers to profitably recoup their foreseeable design and marketing costs (Baldwin and Von Hippel 2011; Hyysalo 2021); producers fail to allow for people's paying ability (Hyysalo and Usenyuk 2015; Smith 2017), etc. One the other hand, skills and tools needed to design and implement solutions have improved enormously with growing access to less expensive and more efficient power tools, digital design and manufacturing software, open source software, sharing platforms and other Internet based sharing and most recently distributed manufacturing equipment (3D printers, laser sintering equipment, etc.) (Von Hippel 2005; Abel 2011; Kohtala, Hyysalo, and Whalen 2020). Coupled with globally rising levels of secondary and tertiary education, this has dramatically increased the capacities that people in different professional and everyday life domains hold in developing design responses to their own needs (Hyysalo 2021). The favourable need-solution conditions were characterised as 'users low cost innovation niches' (Von Hippel 2005): user-built solutions are often rough, crude and difficult to use, but they are good enough to meet or alleviate the need that a particular user or users are facing, that is they are locally adequate even if too crude for wider use (Baldwin, Hienerth, and Von Hippel 2006; Hyysalo 2009). It is important to note that locally adequate designs, even if produced in under-resourced and peripheral contexts, feature many commonalities with the present pinnacles of DIY creativity such as digital-physical maker spaces (Kohtala 2016; Kohtala, Hyysalo, and Whalen 2020).

User-designers alter creatively not only objects but also tools and means, uses, meanings, local settings and social organisation (Kohtala 2016; Kohtala, Hyysalo, and Whalen 2020). The repurposing and revaluing of material and technical flows in these remote and peripheral settings is instructive beyond their remote and resource scarce nature and thus should be examined in more depth as some of the emerging patterns may be particularly clearly revealed. After all, in these circumstances people have to create solutions 'for real', not just for fun or for trialling new socio-material relations as tends to be the case in grassroots design and innovation activities in industrialised centres (cf. Abel 2011; Kohtala 2016). These settings also guide our attention beyond the phenomenon of people developing locally adequate designs towards patterns of achieving local adequacy in practice (Shove et al. 2007). Social practice theory provides useful cues to what we should pay attention to when considering the emergence and evolution of locally adequate designs. Shove, Pantzar, and Watson (2012) assert that practices emerge through the interplay between *materials, competencies* and *meanings*. As we discuss below, local adequacy is typically anchored, socially and infrastructurally, in historically formed communities and identities of practitioners (Wenger 1998; Chaiklin and Lave 1993).

1.2. Rural remoteness and remote rurality

In the increasingly shrinking and opening world, there are still places that remain difficult to access and communities that stand away from dominant cultural, economic and political aspects of society, such as strive for connectivity, progress and organised planning (Hussain 2015, 4; Penfield 2019, 233; Bolton 1992; Barca, McCann, and Rodríguez-Pose 2012). Russian/Soviet northern and sparsely populated areas feature a degree of hostility in terms of cost, time, and effort required to reach the 'possibility of exchange over space' (Larkin 2013, 327; Slavin 1962; Kosmachov 1974) and an associated 'paradox' (Nefedova and Pallot 2006): a massive turn of the population of a northern, cold country towards nature – land, river, forest – as a means of survival. Officially, the rural population of Russia is about 37 million (Rosstat), increasing seasonally to 75–80 million people out of the total of 137 million (Nefedova and Pallot 2006, 7, 28). The underlying reason is the history of past and present deep and chronic economic and social crises disrupting the normal system of connections and division of labour, including between town and countryside.

Despite this, remoteness and otherness remain key concepts for positioning the rural way of living in Russia. Humphrey notes how places become remote with reference to what was happening in Russia: Many settlements were abandoned, small mine fields and industrial facilities were closed, once thriving agricultural areas became overgrown, and transportation services ceased to exist. Such places have become 'remote', what they were not previously. In general, it can be stated that the areas that are considered remote have grown noticeably and are getting closer to major cities (Humphrey 2014, 9). Life in a hinterland is considered to be different from the everyday life in a city. It can either be remote in a purely geographical sense (like Moseevo in our case) or symbolically (like Pozhva or Tatarskiy Saiman in our study, which are reachable by regular motor roads but are symbolically abandoned because of their destroyed state-owned infrastructures). In contemporary Russia, it is the urban residents who seem to need the idea of remote territories (hinterland) the most (Humphrey 2014, 18).

Anthropological studies on remoteness and remote communities offer a different view. Based on his studies in various localities of Scotland, Nigeria, Cameroon, etc., Ardener states that remote areas are full of innovators: anyone in a remote area feels free to innovate (Ardener 2012, 527). As a result, the materiality of remoteness consists of the remains of failed innovations and dead economic periods, scattered in the landscape – overall, remote areas are full of rubbish (Ardener 2012, 528–29), where rubbish presents a potential resource to locals and a disturbing obstacle to strangers/outsiders. The spatial and socio-cultural isolation also has the potential to limit collaboration and interconnectedness but also open up spaces of creativity for localised populations and become the basis of inspiration and adaptability (Kuklina and Holland 2018). Gibson et al. also point out the 'creative freedom' of remoteness – because of the distance from metropolitan trends, fashions and compulsions (Gibson, Luckman, and Willoughby-Smith 2010, 31).

In line with the theme of this special issue, we define 'remote community' as a socio-spatial relationship of people, nature, and technology rather than as a solid, externally defined group of 'others'; being detached, it is always open to reconfiguring and reimagining. Such communities, we argue, are particularly important since they provide rich grounds for revisiting how technologies function, how they are (re)configured and (re) used in ways that are not visible within the infrastructures and connections typical to industrialised densely populated areas (Hardy et al. 2019; Kotut 2020).

2. Case studies and data collection

Studying vehicle design and making practices in *rural* (or, more literally, *roadless*) contexts is not an easy task since it is not often that such information becomes public domain. In the absence of a legal framework for official registration of DIY vehicles, people's go-anywhere vehicles, tractors and boats born in garages are essentially 'outlaws', and their owners do all they can to avoid any official control in relation to both the vehicles and any income received with their help. The underground status of rural mobility starts with obtaining materials and parts 'under the counter' and extends to using DIY transport for illegal purposes (for example, poaching and illegal fishing).

To fill this gap in knowledge, we ventured on a field study tour to remote areas of Russia. By that time, we had equipped ourselves with information on DIY activities to meet local mobility needs in the periphery areas of the Russian North within the broader context of a so-called 'repair society', namely the vehicle making, repurposing and maintaining practices in Soviet and post-Soviet Russia (Gerasimova and Chuikina 2009; Golubev and Smolyak 2013; Golubev 2020). This vast evidence of stand-alone making/inventing activities was sifted for examples of user communities or collectives (Von Hippel 2005; Verhaegh, van Oost, and Oudshoorn 2016) and their enduring activities that involved specific labour organisation and knowledge production. From our resulting set of data, we purposefully extracted three cases as representing a broad range of variations in 'dimensions of interest' (location, technologies and practices), each case having its own intrinsic value (Stake 2000).

Our ethnographic expeditions provided exclusive knowledge about the development and use of DIY transport vehicles in Ulyanovsk Oblast (the village of Tatarskiy Saiman), Arkhangelsk Oblast (Moseevo), and Perm Krai (Pozhva) (Figure 1). Immersing ourselves in rural life, we conducted in-depth confidential interviews with residents, placing emphasis on the theme of technical creativity. The typical line of questioning encompassed the following topics, with some local variations: local history of the phenomenon, local names and modifications, vehicle anatomy, design and manufacturing process, makers' motivation, and geography of use. The research team members sketched surrounding landscapes and, in parallel, observed, studied and recorded real life in these remote areas using photo and video cameras and voice recorders. As a rule, the locals responded with lively interest and enthusiasm to our quests and willingly shared stories from their lives, in which DIY transport vehicles were important 'characters'.

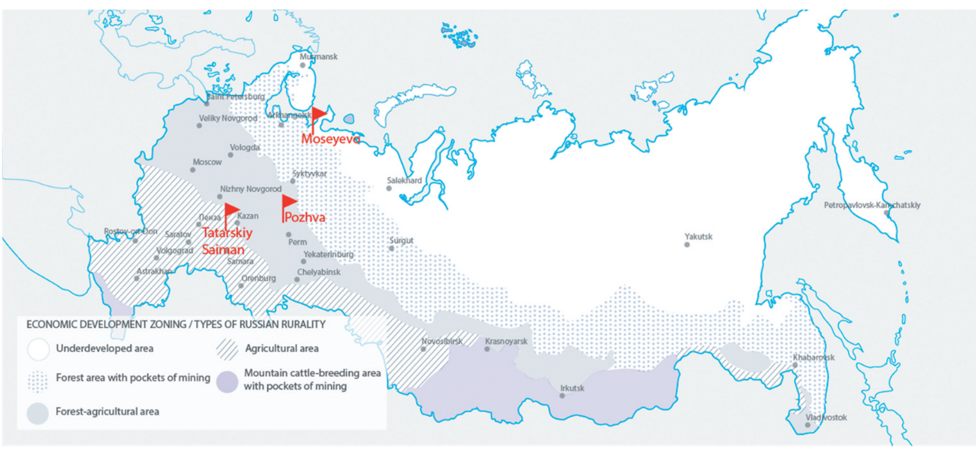

Figure 1. The geographical context of the study. Three cases are probes into three different types of Russian rurality: the borderland between underdeveloped area and forest area, forest-agricultural area, agricultural area. Map by Irina Osadcheva, a research team member, adapted from (Nefedova and Pallot 2006).

We collected data from March 2018 to August 2019, in two phases: first, early probing among local dwellers and makers in the villages of Pozhva (March 2018), Tatarskiy Saiman (July 2018) and Moseevo (August 2018), followed by a quest for more detailed information through an additional field trip to Pozhva (July 2019), and contacts with our informants via social networks during the pandemic lockdown of 2020. The demographic profile of the informants contained predominantly males aged 42–65. The youngest were 20 (Pozhva) and 26 (Moseevo), and the oldest was 80 (Tatarskiy Saiman). Also, there were 5 females (one of them was an active maker and racer (aged 36, Pozhva); the others were makers' relatives (aged 55–62). We examined DIY vehicles separately in each region to identify local innovations and describe their operation in micro-mobility contexts. We employed between-method triangulation combining interviews, archival data, and participant observations. Altogether, we conducted 34 interviews (semi-structured; each typically took from 30 to 120 minutes, either taped and transcribed or using handwritten notes) involving local inventors and their families and other community members. To contextualise the ethnographic data, we also delved into archives, including publications in local newspapers, popular magazines, and public information (e.g. online profiles in social networks and DIY Internet forums in which people talk about their vehicles under the shelter of anonymity and approximate location), as well as informants' personal photo-archives.

In this paper, we put these stories together for the first time to reveal various facets of the same phenomenon of local adequacy, highlighting similarities and differences between the regions under study primordially dissimilar in environmental extremes, people's mobility needs, technologies, facilities, and tools and skills. The cases illustrate the phenomenon of collective inventive activities in which everyone creates something for themselves by necessity but the outcome of this ubiquitous creativity is an innovative collective pool of resources, and this is where we turn our attention to next.

2.1. Case study 1: the 'top-top' village

We begin with a case from the village of Tatarskiy Saiman, Ulyanovsk Oblast, an agricultural settlement where working animals were replaced with mechanical equivalents. In the early 2000s, the village became nationally famous by setting a kind of record: its 610 households owned 320 self-made automobiles, so-called 'top-tops' or 'drandulets' (bangers) (Za rulyom, 2002 2002, 124). Those vehicles had been made since the late 1980s – early 1990s according to the same recipe from written-off parts and components (Figure 2). Their main function was to substitute for private workhorses forbidden at one point during the Soviet collectivisation process to encourage mechanisation.

> Back then, no horses – no transport. But [top-top] was like a horse; there was one in nearly each yard. They were used to plow, carry firewood from the forest, hay from the field — very handy. (Kharis, 80, and Rakip, 70).

Figure 2. Classic 'top-tops'. Photos by Daria Zhukovskaya, a field team member, June 2018.

Parts and materials became available in rural areas across Russia in the early 1990s when collective farms collapsed (with the collapse of the Soviet Union). Access to numerous write-off junkyards was easy, and spontaneous 'public' (i.e. no one's) dumping sites were sources of free parts enough to assemble a vehicle, as local joke went

> If one walked into a junkyard, he would leave it in a week, driving. (Ravil, 78).

Why is it so then that 'top-tops' were not invented and assembled in any other neighbouring villages but in the village of Tatarskiy Saiman? As the locals explained it, the DIY vehicles were made and used just here because the small collective farm could employ only so many residents; the others had to find work elsewhere to earn money for a living. They often spent months away from home, coming back to take care of their households in the growing season. It was expensive and demanding to keep a horse, so they invented 'a thing that doesn't need to be fed; just get it started any time – and off it drives!'

As public property (facilities, land, forests and also landfills) was privatised, everything became less accessible and expensive for villagers. As a result, many of them gave up making vehicles; neither can they repair what is available in the household as parts are now expensive or discontinued by manufacturers.

> Now all of the junk is sold for scrap. On mine [top-top], the carburetor doesn't work, it wouldn't start, and there's nowhere to get hold of it; they are no longer manufactured (Yakhiya, 79).

However, in the new economic conditions, the top-top technology has taken another turn through the invention of a so-called 'versatile tractor' (Figure 3). The next stage of evolution replaced the original practice of making and using top-tops because of changing user needs and expectations. The 'top-top 2.0′ is not just a substitute for a workhorse; it has an expanded functionality, and therefore is more complex mechanically and a more reliable source of income. These next-generation vehicles have nearly all parts (cheaply) available from official suppliers (with only some units taken off junk machinery), although it may take some years to get hold of parts and assemble one. Currently, there are four such vehicles assembled and operated in the village.

Figure 3. Top-tops 2.0/versatile tractors. Photos by Daria Zhukovskaya, a field team member, June 2018.

Considering this case in terms of local adequacy brings to the forefront three distinctive aspects:

(1) The maker's *identity*, reflected in both the practical and symbolic value of the product, and the *meaning* of making as a creative process. While emphasising the economic benefit of possessing a top-top ('I fuel it once, and then it keeps working for a long time'), locals constantly mention the 'ingenuity' of the design as the result of their own thinking/creativity.

> I didn't look it up anywhere, my idea altogether, all by myself. / . . . / In Belarus, they make tractors like this, for 10 millions — [if] you've got such money, and you can buy them, but no such things are made here. (Rafik, 60, maker and owner of a 'versatile tractor').

(2) The essential *competences* the locals possess, which allow them to source components, design, assemble and maintain the vehicles.

> We get all [parts] from dumps at the village edge, exchange them, buy them. / . . . / It took me two months to make this one, before and after work. [I've got] a turning lathe, a driller, a welder . . . (Rafail, 59, maker and owner of two different 'versatile tractor' models).

Also, engaging in the process of assembly from scratch, makers then tend to take it as a living helpmate rather than just a machine. 'Animation' starts subconsciously as more and more parts come around and are fit together and the vehicle starts taking shape, and then becomes explicit with a name given to the vehicle being made. Some examples are: *Toiler, Positive, Scania, Dryndul*, etc.

> My husband used to drive an old large green tractor in the past. Then once he came back on this one, and we also painted it green, and my classmate saw it and says, what's that? Has yours given birth to a son? (laughing) Our son, yes. Like a cow calves, so does our tractor. It is more valuable than a car. (Raisya, 60).

(3) The *materials* through which rural makers are included in a broader economic and technological context. Local amateur designers see their future with access to mass-produced commercially available and affordable parts – easy to find and replace – and undercarriages that could be modified if needed. These thoughts and visions have a real addressee, namely UAZ, one of Russia's largest automotive plants located in the regional capital Ulyanovsk.

> Their [UAZ] parts are good, but not the final cars. They could sell them separately – the entire country would queue up! (Rafail, 59)

2.2. Case study 2: 'cosmic conversion'

In this case, the state-induced major technological and military projects created conditions for the emergence of the local making practice. The remote village of Moseevo, Arkhangelsk Oblast, is located by the river Pyoza, which connects its 70 inhabitants with the outer world. The main means of transport is 'zyryanka', a long boat with a flat bottom and low draft for floating over rapids. It is traditionally made of coniferous wood, an abundant local material.

In the 1990s, Moseevans started making boats from high-quality stainless steel obtained from rocket stages they found in the tundra after launches at the Plesetsk launching site. The militaries did not care to pick up and recycle them and, therefore, local residents utilised rocket remains (including sheet metal) in their households by making shovels, sleds, and, after some thoughts, adjustments and preparations, and boats (Figure 4). Some stages of the process were completed collectively, e.g. sourcing and preparing material, and makers jokingly began calling their manufacture 'cosmic conversion'.

> We started finding [rocket] stages first in the 1990s . . .. Inside there were contacts, platinum, gold, silver. Nobody collected the metal, they left it for us. It wasn't worth anything at that time. / . . . / After we'd built our first boat, orders came around, and we understood it was a goldfield, that metal. This boat would negotiate any shoal and wouldn't need any repairs. (Vasily, 66, electrician)

Figure 4. Examples of use of 'space metal'. Photos by Alexandra Raeva, August 2018.

The case of 'cosmic' boats is particularly remarkable for the scope of the creative process as it spans from material to tools and, ultimately, to a product. The unique metal encouraged people to create absolutely novel attachments and adapt existing farming tools to their needs (Figure 5).

> [Out of the tools] we first contrived attachments for the chainsaw. It's only at home where an angle grinder and a disk can be used. When in the woods, on the marsh, there's no electricity. We looked for and ordered attachments from manufacturers. Later we started mounting metallic mill cutters— for wood, steel, etc. I borrowed some tools from the neighbours, but mainly everything is my own. You also need [special] pliers and tongs — to clamp things and to bend the beak — a contrivance — 'zagibulina' (a bender), a metallic arm. We make everything ourselves. We even cut rivet pins from fiver-wire or, rarely, order pins from suppliers. (Vasily, 65, ex-clerk of the district administration).

The evolution of 'cosmic' boats consisted of gradual elaboration of design and functional characteristics of boats along with developing and improving tools. As the boat-making process and practice improved, the length of the boat increased to 2–2.5 m, and its load capacity to 2–2.5 metric tonnes. As a result, the 'cosmic' boats outdid the commercially available models made of duralumin alloys in performance and load capacity and their making turned into local (underground) business.

With evolution, the very process of sourcing the material also changed – both economically and technologically. In the second half of the 1990s, rocket stages stopped falling down in this area and supplies of the 'cosmic' material were running short. Today, remaining rocket scrap is located with the help of drones, and the cost of the metal increased due to increased search and delivery expenses. However, being located closer to the rocket scrap dumping area, the village of Moseevo now has four more new boats constructed since the beginning of 2018 by collective effort. According to the DIY designers, the main incentive for them remains to be additional income, with an 'added value' of adventure in this business.

Figure 5. For working with the four-millimetre sheet metal, the local boat-makers crafted (top left) a bender (*zagibulina*) for shaping the beak and sides of the boat; (bottom left) a wooden vice for clamping workpieces in place; and (right) a new metal cutter for the 'Druzhba' gasoline chainsaw. Photos by Alexandra Raeva, August 2018.

> Back then we would look for it around marshes, on foot, a week in the forests, spending the night in a log cabin and the day walking and resting. Now there's everything you need: The Internet, drones. (Nikolay, 56)

Moseevans developed their own strategy of managing risks in addition to the officially statuted annual medical examinations:

> We knew how many heptyl rockets were launched and fell down – this is official information provided by the cosmodrome. Also, toxic/heptyl rockets are easy to recognize – they have stiffening ribs. When we found them in the wilderness, we looked at all the boxes and labels to find out the year. We did not take the bodies, only internal components. We also marked their locations on the map and left the metal untouched. After some time – a year or so – we decided to take the metal home, and my brother came with a dosimeter, checked the level of toxicity: everything was fine. (Vasily, 65).

In terms of local adequacy, this case suggests that materials as the most distinctive aspect determine the other two: meanings and competencies.

(1) Engagements with the 'alien' material have yielded a new generation of traditional transport vehicles with new/advanced functions and parameters – by dint of time and effort from the entire community, thus constructing the *meanings* and value of both the making process and its outcomes. People willingly invest their resources – time, energy, money, etc. – to find the material. The finished products – boats – possess both a practical and symbolic value that makes them suitable for personal use and worth sharing/disseminating/selling. Last but not least is the value (and necessity) of the community input. Locals constantly refer to peer support available at every stage of the making process: from searching for and preparing the material to final assembly.

> In the 1990s, we teamed up to go and get metal. It is better than doing it alone. / . . . / And if you don't know [how to make this or that], you'd go to the village and ask those who do the same. (Pavel, 60, electrician).

(2) The collective pool of competencies allows the 'domestication' of the externally originated material by use of self-made 'bricolage' tools.

> Nobody taught me specially to work with [space] materials. You'd approach one to have a look, then another. If I didn't like anything, I'd make it my own way. Imagination works, it does. We're nearly all self-taught, working on enthusiasm. (Victor, 51, stoker in the local administration building).

Also, like most DIY enthusiasts, local makers do not make any drawings or preliminary calculations, keeping everything in their heads. Changes and improvements to the design are made spontaneously as they occur to the maker in the course of 'talking' to the material or as may be needed there and then: thus, for instance, sledges may be given a door or hinged sideboards.

(3) The nature of materials places design and making activity within a broader economic and political context that makes it possible in a certain space-time. In this context, locals' dependence on high-tech materials is combined with their attitude of keeping distance from the State at all levels: from sourcing the materials to registering the products.

We do not have any issues with the authorities. You can register your boat, if you like, but I registered only my duralumin one, not the handmade. If I get caught, I'll be fined, that's clear. (Vasily, 65)

2.3. Case study 3: Pozhva Jeeps

We end this narrative with a story of lightweight ATVs on low-pressure tires manufactured collectively in Pozhva, a former factory's settlement with 3000 residents in Perm Krai, by a mill that fabricated steam ships and machines, and locomotives in its 250-year history. In the last years of its life, it specialised in the manufacture of powerful firefighting technologies before closing down in 2014. In the 1990s, the mill became an informal centre for unique off-road vehicle assembly business on 'pneumobiles' (or 'jeeps', although they did not have any cab) (Figure 6).

The mill provided tools and materials as well as collective expertise and workshop space where workers spent their free time making various small-size units (sprockets, frames) that required turning, milling, and welding. The vehicles were then fitted out and tested in the semi-handicraft conditions of private garages (Figure 7), which enabled making 'jeeps' in small production runs (5 machines per craftsman in 10 years).

The basic need for the emergence and spreading of DIY off-road vehicles stemmed from the lack of personal household vehicles for hunting and fishing. Motorcycles did not meet the requirement of all-weather and all-season use while for cross-country terrains they lacked a gear reducer. Local fishermen needed a lightweight off-road vehicle for

Figure 6. Pozhva 'jeeps' and their makers/owners. Photos by Ilya Abramov, a field team member, March 2018.

Figure 7. The workshop and tools of Pozhva's best-known handyman in making cross-country vehicles on low-pressure tires. Photos by Ilya Abramov, a field team member, March 2018.

driving across the Kama Reservoir in the wintertime. The Pozhva snow-and-marsh 'jeep' was unsurpassed in driving over the first ice and melting spring ice, and during thaws. Moreover, it was used for delivering firewood from timber allotments and for haymaking for household cattle. Practically all owners called their 'jeep' a 'breadwinner', emphasising its versatility, reliability and easy maintainability. Even if a family afforded to buy a 4 × 4 car or a snowmobile in the 2000s, the role of an absolute go-anywhere vehicle was reserved for the 'pneumobile'.

> Back then, we used to say: you've got a 'jeep', and you've got everything in your home — fish and meat." (Vladimir, 60).

> You can't do without a 'jeep' even today. You can drive around on it any season of the year. Fishing or mushroom picking — anywhere." (Vasily, 55)

The general concept of this off-road vehicle was borrowed from Soviet technical magazines and adapted to local potentialities and conditions. The classical arrangement of a four-wheel rear-driven arrangement with low-pressure tires and motorcycle engine (Hyysalo and Usenyuk 2015) resulted from almost two decades of trial and error design. The evolution consists of four clearly consecutive stages with a step back to stage 3 (Figure 8).

> The reason [for switching from three wheels to four] was stability. It can float, doesn't sink, stays balanced on water (Vladimir, 56).

> The [three-axle] Puma was much heavier than a regular one, much more expensive, and not as functional in everyday life. Yes, the engine is more powerful, it can carry more people, but in the end we used it only for entertainment – with friends on fishing trips. (Vasily, 50).

Today, Pozhva 'jeep'-making is a fully home-garage-based business. With metal scrap becoming more available, growing prices for new parts, and improving affordability of various off-road vehicles, 'jeep'-building declined to a hobby and additional income for

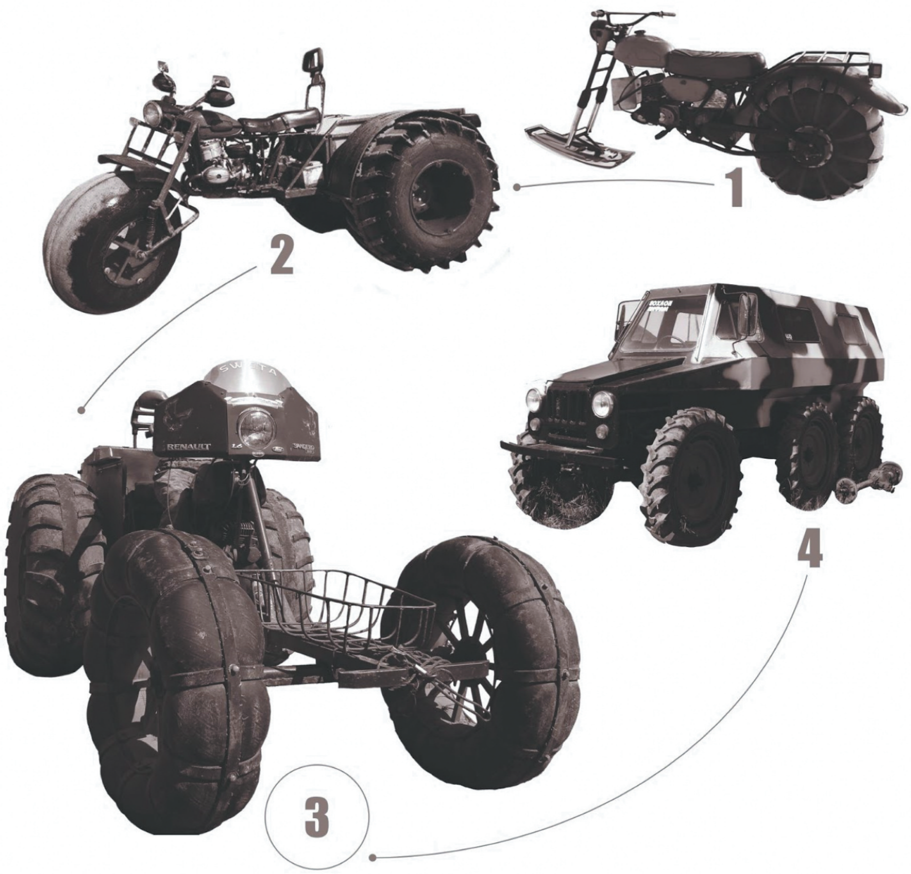

Figure 8. Four stages of Pozhva jeeps' evolution: (1) an early version with a front ski was made based on drawings in a Soviet DIY-magazine, (2) a three-wheeler was an all-season modification, later advanced to (3) a four-wheeler that became a 'golden standard'; and (4) a six-wheeler, which was a trial that did not fit in Pozhva's everyday living. Photos and compilation by Alexandra Raeva.

retired can-do's. Some cohesion is still there among the members of this business as ex-employees of the same company, with certain cooperation in exchange for money or services.

> Industrial and personal vehicle making – a world of difference. In a personal one, you need not only to mount a piece in place but also think of what you could make it from." (Vladimir, 60).

In terms of local adequacy, this case deepens our understanding of the identities-competences-materials triad:

(1) There is a specific 'Pozhva frame' as a result of the structural evolution, which accounts for a unique identity matched to the mill and locality of use (forests, rivers and the Kama Reservoir) and the purpose (fishing, hunting, household activities).

> It is an indispensable machine for our place. We use it to plow, sow, and haul hay. It can pass through snow, swim through water and swamps. (Sergey, 64).

(2) Working together and pooling their competences (in the form of the mill's collective) became crucial for the quality and depth of craftsmanship that the jeep makers could achieve. Also, the basic 'Pozhva skillset' – that is, the trained ability of a specific group and generation of factory workers to engage with tools and machines – is a product of the Soviet secondary/vocational education system. The design/making knowledge is stored exclusively in the visual memory of the local makers: nothing is documented or recorded or archived.

> I can say I made my 'jeeps' myself, every bit of them: I was a machine-tool operator at the mill, so I turned and milled things myself. (Alexander, 45).

(3) The Pozhva case deepens the discourse on relations between mass-production and customisation suggesting that widely available, mass-produced parts and materials can encourage the origination of locally adequate (and environmentally and culturally appropriate) products. Today, the limited availability and changing choice of components make it necessary to modify the construction of each next vehicle, which increases leadtime and is rarely beneficial for the design. For instance, the lack of 'Izh' motorcycle engines has led to the need to adapt Chinese Lifan engines, which are inferior in quality and do not fit in with Soviet motorcycle parts.

> We must move away from turnery; we should fully provide ourselves with parts from the aftermarket. The main thing is to make fewer homemade units to keep interchangeability of components. (Vladimir, 60).

3. Discussion

The cases presented above show a reality lying outside the western industrial wealthy countries, which flooded the world with stuff that nobody wants and needs. If not treated as trash, the available parts and materials, including even relatively high-quality components which have lost their original function and value, provide an opportunity to make something creative and useful out of them. For people with appropriate skills, creating locally achievable designs is more valuable than other options of spending their time and money, e.g. trying to save money to buy a 'normal' car. The complex process of making, using and maintaining has value beyond the technology it produces. With reference to the observed contextual/geographical 'stickiness' of local transport solutions, such vehicles attain their best adequacy at the place of their origin in the hands of their makers. Otherwise they could turn out to be useless and – in the context of a severe environment – even dangerous if transferred to other settings and users.

The combination of unmet needs, available materials and local competences with the identity of everyday ingenuity becomes effective where design and building converge in a temporal and spatial organisation that differs from prevalent ones in industrialised centres. Repurposive machine building is practiced on the margins of other activities, often during a seasonal slack that offers s some timeslots empty of other possibilities and responsibilities. There is a drawn-out purposiveness in and physical space available for gradually working on a novel transport machine or a boat as the parts, materials and time become available. These user-designers are experts in local conditions of use making: this combination gives them the ability to assess and adjust design choices in the face of the availability (or lack of) parts and materials.

These dual competencies fitting in with local conditions and local making also result in patterns of evolution in the form of a technology and practices of making and using it. Designs are suited to local conditions and altered to improve their adequacy therein. Over time, this results in 'proximal' – locally anchored and applicable – design heuristics and principles for attaining adequate constructions notwithstanding variations in available components, tools, materials and skills (Usenyuk, Hyysalo, and Whalen 2016; Hyysalo, Johnson, and Juntunen 2017). Whilst adequate for successful making, these evolutionary principles and the resulting constructions are rarely 'optimized' in any respect. Difficulties in specifying all factors that affect the designs together with temporal, spatial and quantitative unpredictability in available materials, manufacturing skills and technologies render proximal designs and designing a more workable way to exercise careful stewardship of local resources.

The meaning of (re)valuing for local adequacy in design is summarised in five practical implications.

First, through the lens of industrial design as a form of commercial yet artistic activity (Eder 2012, 2), a locally adequate DIY vehicle could be considered a multiply tested engineering base ready for further 'dressing' by design professionals. In the short run, the designerly task of turning DIYs into commercial products implies making them user-friendly for a broader spectrum of potential users (Hyysalo 2009) and visually more attractive. Therefore, their observable shapes call for immediate aesthetic transformation and working 'outside inwards', defining the observable envelope (Eder 2012, 2–3), but keeping locally adequate internal constituents in place (Usenyuk-Kravchuk et al. 2019).

Second, through the lens of designing for mass production, a locally adequate DIY vehicle should be seen as tangible embodiment of both need and solution information and information regarding how these interrelate in a working design (Von Hippel and Von Krogh 2015), indicating for manufacturers means and ways of suited mobility to a particular area, although without traditional assembly drawings and material specifications. A DIY vehicle embodies the features and requirements imposed by both the user and the environment of use: from ergonomics and cultural identity to climatic factors and landforms. Here designers' task is not to improve/humanise the observable (clumsy) shape but to put it under a microscope and examine for 'what, why and how to make?' for developing a locally adequate yet industrially manufactured product.

The third implication directly relates to the co-design and community focus of this special issue: local adequacy comes out as a conscious attitude to the design process that strengthens horizontal collaboration and yields efficient participation. The presented cases are, in fact, learning examples of how the different actors – both human and non-human – are taken closer to each other and affect the very process of co-designing to achieve comfortable moving and, eventually, a way of living in a particular locality. Furthermore, the achieved and regularly exercised collaboration between actors in the design process strengthens the spatial and socio-cultural embeddedness of both makers and their products. In this sense, local adequacy and its practical achievement in materials, competencies, meanings and identities of people involved spells out a yardstick for creating designs and design strategies that are in local control for extended time period (cf. Hartswood et al. 2002; Botero and Hyysalo 2013).

Fourth, repurposing parts and materials is a globally important phenomenon, reported widely in different remote and developing country settings. It calls for regulatory and design actions towards design for dis- and re-assembly of products in industrial centres and their recycling infrastructures. Literally, this calls for a broader view acknowledging that much of the machinery and electronics parts from the civilised 'Global North' will find their way into various developing countries and remote settings for further reappropriation if their design allows being worked with general-purpose tools (rather than non-standard or make-specific keys).

Fifth and final, local adequacy increases attentiveness to qualitative aspects of technology, and thus contributes to a broader view on social and environmental sustainability. For example, as we observed, vehicles that are loved and regularly taken care of live longer and thus represent a locally adequate meaning of sustainability despite their gasoline engines. Qualitative characteristics of human-technology bonds are usually silent in substantiating design and engineering solutions and typically missing from design/engineering codes and guidelines that primarily focus on quantitative/measurable outcomes. Although technical performance indicators usually determine the choice of a transport vehicle, qualitative aspects can influence this choice by adding an extra (personal and locally grounded) value for its user(s).

These implications together support the article's central argument on the meaning of local adequacy in design: on the one hand, it serves as a motivational and practical place-based medium for grassroots innovation; on the other hand, it sets criteria for efficient/successful proximal design endeavours.

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