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Scalar trajectories in design: The case of DIY cloth face masks during the COVID-19 pandemic

ABSTRACT

The article examines an artefact of everyday design – the Do-It-Yourself (DIY) cloth face mask employed against respiratory infections – to interrogate scale and scalar relationships. This lens reveals new perspectives on how practice-based design research can mobilize scale in more nuanced ways. The authors propose that DIY face masks, as artefacts of mundane design engagements both with material (cloth and thread) and with sharing of knowledge (about design, craft and practice), globally and within local networks and communities, direct our attention to scale as a matter of relations, engagements and emergent trajectories. Through empirically led exploration combined with approaching making as sense-making, the article highlights the multiplicity of design artefacts emerging in DIY mask design spanning several scales and introduces the notion of scalar trajectories across multiple design engagements.

KEYWORDS

design engagements
Denmark
Hong-Kong
scale
scalar relations
sewing patterns
every day design

INTRODUCTION

One of the central tenets of contemporary design's customary preoccupation with scale has been that of 'taming' and managing scale, mostly as an issue of size and growth. This preoccupation translates to the development of a plethora of tools and strategies to allow designers to move – and work – from one (usually small) scale to another (usually larger), in nested hierarchies of sorts, while other important scalar relations go unattended. The fixation on taming and managing is illustrated by a popular essay in which urbanist and designer Dan Hill cites the predicament famously faced by Finnish architect Eliel Saarinen: 'Always design a thing by considering it in its next larger context – a chair in a room, a room in a house, a house in an environment, an environment in a city plan' (2012: 35). Hill nonetheless hints at the possibility of there being more than size and growth relations at play. He calls for design to embrace not only 'matter' (i.e. the 'artefact') but also the 'dark matter', by which he refers to things such as policy, regulations and organizations, a kind of meta-level 'context'. Design, in his view, should swing between the meta and the matter, thus opening opportunities to understand and articulate broader ('wicked') problems and enabling practitioners to ask the right questions and explore them through concrete interventions.

We are inspired by Saarinen's and Hill's invitations to consider the designed artefact in its extended context(s), including the apparent dark matter. However, our intention is less prescriptive. At the same time, we question the 'nested contexts' approach to scale in design. By considering the Do-It-Yourself (DIY) cloth face mask as a particular type of design artefact, we interrogate scale and scalar relationships. Through this lens, we open avenues to the ways in which practice-based design research can mobilize scale in a more nuanced manner.

Face masks or face-coverings are material artefacts intended to cover the wearer's nose and mouth for purposes of reducing the spread of respiratory droplets and aerosols, thereby limiting the transmission of viruses, such as the one behind COVID-19, SARS-CoV-2 (Brosseau et al. 2021; Howard et al. 2021). Besides serving as material artefacts and tools for public-health interventions, they can be perceived as political symbols. Such perceptions readily coalesce in how 'red states' and 'blue states' in the United States might diverge their interpretations of such masks and in the kind of message projected there by wearing one or declining to do so (Kahn 2022). Recent years witnessed these artefacts gain centrality with regard to many controversies as COVID-19 spread. In particular, the initial global shortage of personal protective equipment, medical-grade masks included, triggered grassroots sharing of information on how one could create such artefacts from the materials to hand and via alternative means of production. Cloth masks and other face-coverings became a focus of much DIY activity and information-sharing. For example, patterns and instructions for DIY creation of cloth face-coverings soon started getting posted online from East Asia, then many other regions. For some time, DIY masks and other face-coverings flourished as an interesting distributed experimental playground for everyday design by all kinds of actors. Simultaneously, face-mask-linked practices, tweaks, design, use and maintenance became something many of us could relate to, albeit within our specific worlds and circumstances.

Our own facet of the phenomenon emerged when infections were detected where we live, in Finland and Denmark. As restrictive measures

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were put in place, face masks were not recommended, and their use was even discouraged (Czypionka et al. 2020). Concerned with our safety and that of loved ones, around mid-March 2020 we started collecting online instructions, how-to video tutorials and early reports on research into mask-wearing and mask-making, with the aid of our combined knowledge of English, Spanish, French, Finnish, Danish and Arabic. As the pandemic unfolded and health authorities imposed various rules and regulations, we began building a repository of DIY face-mask initiatives and started compiling data (examples, sewing instructions and patterns) more deliberately, through desk research and digitally mediated fieldwork in various social-media groups and spaces (Markham 2013). At the same time, we dug out our sewing machines and tested a few of the designs we found online. We crafted initial prototypes and then produced a few masks for ourselves and for friends. Through this personal creation and experimentation, we undertook close-up interrogation of some of the DIY cloth masks we encountered (Jungnickel 2017). Aided by a research assistant, we supplemented this work with semi-structured interviews of people in Denmark who were sewing masks and sharing instructions online ($n = 3$).

A rich picture of everyday design and of the contemporary amateur designer's role holds potential to inform professional design practice and design research alike (Holt and Mackinney-Valentin 2015; Kohtala et al. 2020). We know that professional and everyday design efforts intertwine in intriguing ways, some of which we may not fully understand (de Souza Sierra and Fontana Catapan 2021; Rossi et al. 2020). As artefacts of mundane design engagements with material (cloth and thread) and with knowledge-sharing (related to design, craft and practice), DIY masks as exemplified in Figure 1 highlight the importance of scale as a matter of relations, engagements and freely flowing emergent trajectories, globally and within local networks and communities. For this article, to situate DIY cloth face masks and masking as design artefacts, we apply understandings wherein design is multidimensional, emergent and everyday (e.g. Henderson and Kyng 1991; Holt and Mackinney-Valentin 2015; Wakkary and Maestri 2007), as described below. Such perspectives recognize that continuous creative appropriation of existing resources and exploitation of their affordances are fundaments of everyday design-in-use and encompass awareness that such engagements are widely distributed (Kohtala et al. 2020).

Proceeding from these materials and experiences, we start our journey here by situating the phenomenon of DIY cloth face masks in relation to our main theoretical framework. Our empirical materials, in turn, lead us to ask: what kinds of design engagements and scalar relationships are visible in the various phenomena of DIY design(s) of face masks? Our answers highlight the multiplicity of design artefacts and practices evidenced in DIY mask design across scales, which we bring out through the notion of scalar trajectories. We propose that attending to the movement and contingency present across these multitudinous design engagements allows us to move beyond ontologically fixed and nested approaches to scale and scaling. The discussion below elaborates on these matters. Our endeavour to interweave empirically based exploration with a practice-as-sensemaking approach (Jungnickel 2017) concludes with reflection and discussion of how these examples can assist in identifying and problematizing scale and scalar relationships more broadly in/through design research based on exploring our own practice and that of others.

MASKING PEOPLE

As the pandemic raged, so did debate about the necessity of wearing face masks in day-to-day situations outside medical settings (Escandón et al. 2021; Martin et al. 2020). The media discussion and academic discourse addressing the availability, use and efficacy of various face-coverings (inclusive of DIY ones) have been framed largely in terms of questioning or praising their benefits or harms, while less heed has been given to (1) exploring the implications of masking more broadly as a social practice governed by sociocultural norms (Burgess and Horii 2012; van der Westhuizen et al. 2020) or (2) taking matters of the design of the artefact itself more seriously (Brosseau et al. 2021; Clase et al. 2020), alongside the links of these to everyday practices. Furthermore, little consideration is accorded to the historicity of the practices and regulations involved, experiences of those willing/unwilling to mask, notions of heroism vs. stigmatization and certain utility issues (selection of appropriate materials, proper fit with the various patterns, usability and desirability) – all of which are relevant to design (Kahn 2022; Martin et al. 2020).

At present, research seems to indicate that even simple DIY cloth masks limit the spread of droplets and aerosols somewhat (Howard et al. 2021), although the amount of protection the wearer obtains is still disputed (Brosseau et al. 2021; Bundgaard et al. 2020). Consensus seems to be emerging that use of face masks is among the infrastructural components in strategies for effective collective mitigation and adaptation to the virus, albeit not the only one (e.g. Brosseau et al. 2021; Czypionka et al. 2020; Howard et al. 2021; Martin et



Figure 1: A collage of various styles of DIY cloth masks as we encountered them online in April 2020.

al. 2020). Still, while wearing a mask makes good sense in certain settings, in certain circumstances it could easily raise the spectre of anything from conforming to restrictive measures to making politicized fashion statements (Czypionka et al. 2020; Martin et al. 2020). This situation is not completely new: some of these dynamics were already observed during the Spanish flu pandemic, more than a century ago (Burgess and Horii 2012; Kahn 2022; Tomes 2010).

The World Health Organization, or WHO, showed reticence to recommend the general public's use of masks and updated their guidelines only in the interim report of 5 June 2020. This report included recommendations that infected people wear a mask and advice for decision-makers as to situations wherein use of masks by the general public could be encouraged. Mention is made of medical and non-medical masks, with suggestions on the type of fabric to be used, the number of layers, suitable combinations of materials, the shape of the mask, the coating for the fabric and masks' care and maintenance. The WHO's early stance reflects the generally ambiguous global positioning in relation to mask-wearing for the general public. Some countries put draconian universal mask obligations in place, so as to send a strong signal (Kahn 2022), while other nation states let the issue go unattended. The delay on the WHO's part may have contributed to delays in establishing national-level official recommendations, guidelines and regulations in some parts of the world. The latter delays may be related also to efforts at avoiding panic-induced hoarding of masks, which the health-care sector urgently needed. Near the beginning of the pandemic, masks fell into short supply as global supply chains suffered disruption wrought via restrictions on movement and traffic, at least where globalization had resulted in the elimination of local manufacturing capacity (Howard et al. 2021). Researchers have suggested that other factors too were involved in the many official dismissals of masks, however. One is the adoption of a 'throw-away culture' in the health-care sector, which has led to progressive elimination of effective reusable face masks in favour of disposable ones since the 1960s, with subsequent loss of knowledge of the limits and possibilities represented by non-disposable masks (Strasser and Schlich 2020). A different angle on the reluctance to impose mask mandates relates to masks' connotations, such as in their association with facilitating criminality (e.g. they have been worn by social outcasts, the Ku Klux Klan or radical Islamists) or seeing them as enabling anonymity in settings such as civil protests, with widely enforced mask bans sometimes having resulted (Kahn 2022).

A combination of factors led to face-mask design, provisioning and information-sharing taking place mostly at the grassroots levels for some time during the pandemic, through everyday design. The phenomenon was largely mediated by digital media and related knowledge-sharing practices, which linked practices across multiple scales in particular ways. As limitations were imposed on face-to-face social gatherings and other interaction, and with limited availability of masks in the earlier months of COVID-19, many took to the internet, social media and their sewing tables, becoming connected in the phenomenon we witnessed and ourselves engaged in – making masks for oneself and others.

THE THEORETICAL FRAMEWORK

Our theoretical framework is grounded in alternative approaches to understanding scale and design. We unpack these next, before tying them in with our findings.

Scale as relational

Scale, alongside concepts such as environment, space, place and practices, is among the elements from which totalities are built. Human geographer Richard Howitt (1998) reminds us of the ‘naturalization’ of spatial metaphors – that is, of how they have become ‘categorical givens’, losing analytical purpose. Geographical scale, Howitt writes, usually is theoretically handled via two aspects or facets: size and level. The former, as manifested for example in drawing a map to 1:10,000 scale, reduces the geographical space to something more compact. The notion of scale as level, exemplified by deploying geometric nested hierarchies to represent interscalar relationships as small things contained in bigger things, falls short in a different way. Howitt argues that properly tackling the complexities requires a third metaphor, that of scale as relation. By taking inspiration from the domain of music and applying it to geography, he expresses insight that can inform how we think of geographical scale. For Howitt, scale can be understood as the tracing of relations between elements of dynamic geographic complexities. This understanding of scale is dialectical, not hierarchical. In music, scale is ‘a sequence of tones in a specified relationship to each other’ (Howitt 1998: 53), and the composer can choose a specific scale to limit the range of tones in the composition, thereby creating resonances or contrasts. To apply the notion to geography and to a material phenomenon in different scale contexts, with several relationships to the foci of examination, Howitt uses the example of a bauxite mine in Australia. Just as the note C in music can be found in several scales, playing different roles in the musical totality, the mine has different ‘representations’ in the production of social, cultural and environmental change in a locality; of corporate strategies; of international politics related to bauxite or aluminium production. All these various ‘scales’ are real and present, with each relationship with the mine providing one part of the picture, simultaneously with the others. Each is valid and of importance. Hence, scales are not necessarily present in a nested hierarchy, and they are not (only) about size or growth (Larsen-Ledet et al. 2022).

In a similar vein but from an alternative relational angle, feminist science and technology studies scholar Max Liboiron (2021) theorizes on scale as a way to apprehend specific relationalities in context. They argue that understanding relationalities helps us ask vital questions about such matters as differences in power/resources. A relational reading of scale should aid in identifying the relations that matter at different scales and thereby maintain accountability. In Liboiron’s work, scale is recruited to assist in pinpointing which questions go unasked when, for example, research into plastic-based chemical pollution concentrates on identifying harms (e.g. specific, discrete diseases caused by ingesting plastics) without probing the relations created by plastics’ connections to violence (complex structural conditions that grant certain actors permission to pollute indiscriminately). In Liboiron’s view, it is on the latter scale (violence) that interventions in plastics pollution should be mapped if they are to have any effect. For them, the scalar relationships tied to harm or violence are neither hierarchy nor size alone; the issue is more of navigating through those relations that matter the most in specific instances.

Everyday design engagements

Whereas the boundaries between design and craft/making have varied historically (Lees-Maffei and Sandino 2004), contemporary phenomena such as peer-to-peer systems, maker movements and hackerspaces have further

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expanded the space for reflection and for rearticulation of these delineations and of the links between the design engagements of professionals, amateurs and laypersons in more nuanced and interesting ways (see also Hector and Botero 2021; Hirscher 2020; Menichinelli 2020). Additionally, it is important to note that knowledge-sharing plays a crucial role in sustaining everyday design and its relationships with more professional worlds (Botero and Saad-Sulonen 2018) and complex participatory projects (Schoffelen and Huybrechts 2013). Through recognizing peer-to-peer making but also the continuous creative appropriation of existing resources and the exploitation of their affordances as elements of everyday design-in-use, we obtain a solid framework for understanding the constellation of DIY mask-making activities amid the pandemic as design.

Design is no longer regarded as solely the work of design professionals. In addition to invitations for non-professionals to join the design activities, as seen in co-design and participatory design (Simonsen and Robertson 2012), there is increasing recognition of multidimensional everyday design: emergent design that is undertaken in a mundane, everyday fashion, without necessarily involving design professionals. Wakkary and Maestri concretize everyday design in the context of the home when referring to 'home dwellers as a type of everyday designer who remakes or modifies systems, and who uses design artifacts and actions around them as design and creative resources' (2007: 163). Furthermore, everyday design is a site for extended evolutionary design collaboration wherein design-in-use and expert design are intertwined (Botero and Hyysalo 2013).

In their conceptual article on amateurs in fashion culture, Holt and Mackinney-Valentin (2015) highlight the role of digital media in the rise of the fashion-design amateur, or everyday (DIY) fashion designers. Activities that occur via social media or such platforms as Threadless or Etsy – where professionals and non-professional designers alike can showcase their creations and sell them – challenge traditional conceptions as to who is a fashion designer and where fashion design takes place. The authors argue that design research must attend to such phenomena because they are transforming the field and cultivating new innovations and forms of creativity.

Looking in more depth at the blurry frontier between design and use, Kohtala et al. (2020) have proposed a taxonomy of active use and design engagement. Their taxonomy, which we have adapted for Figure 2, builds on models for active use and design engagement found in literature from six disciplines: design studies, user innovation, information systems and human-computer interaction, consumption studies, and science and technology studies. The various typologies' differences notwithstanding, the Kohtala team found commonalities in the suggestions offered for distinguishing the intensity of active use. They began their integrative work by developing a minimal framework for discussing active use and design engagement, with a continuum from Use-As-is, through Active Use and User Design, to User Innovation. These intensities can be read with regard to uses, objects, meanings/images and local settings. Noting that such a framework remains overly focused on individuals' engagements in design, Kohtala et al. then explored collective forms of active design engagement and expanded their taxonomy accordingly. Collective forms of design engagement, which have received increasing study especially since the rise of digitalization, are considered to include digital community design and associated supporting design processes undertaken by design professionals and/or others and to cover efforts of

USES	Routine use	Adjustment workarounds	New local uses repurposing	New-to-the world uses, technique, innovation
	<i>Wear a DIY mask made by someone else</i>	<i>Make a DIY mask fit better (tie a knot in the straps)</i>	<i>Combine other elements to improve fit (e.g. add nylon sock) or filtering (e.g. vacuum cleaner filter)</i>	<i>Use a rubber band to wear mask with hijab or turban</i>
OBJECTS	Reproducing an object	Adjustments, tweaks	Altered objects, new objects	User innovation
	<i>Sew a DIY mask (at home)</i>	<i>Make changes while sewing the DIY mask (e.g. create a pocket to insert filter)</i>	<i>Create a device to adapt DIY masks (e.g. a customisable extender)</i>	<i>Create a new DIY mask pattern with instructions</i>
MEANINGS, IMAGES	Reproducing a meaning	Re-signifying, re-sensing	New meanings, resignification	Radically new meanings
	<i>Repurpose other textile items (e.g. T-shirts or socks) as DIY face masks</i>		<i>Create an origami DIY mask pattern</i>	<i>Crochet a DIY statement mask</i>
LOCAL SETTINGS	Routine use of given equipment	Repair and maintenance, troubleshooting, diagnosing, bricolage	Altered protocols, altered equipment	New-to-the world local equipment and integration
	<i>Use accessible sewing equipment (e.g. from library or a local sewing studio)</i>	<i>Test best fit (e.g. use pipe cleaners for nose piece) and sealing (e.g. e-cigarette vapor)</i>	<i>Assemble DIY mask otherwise (e.g. use stapler instead of sewing machine)</i>	<i>Set up local distribution of DIY masks or patterns</i>
USE AS-IS		ACTIVE USE	USER DESIGN	USER INNOVATION
ORGANIZATIONS COMMUNITIES	Normal community activity, peer help	Subverting rules, coordinating, organizing	Renewal of rules, changing community procedures	Formation of new rules, procedures for counter contexts
	<i>Join a DIY mask collective (e.g. FB group)</i>	<i>Create a DIY mask collective (e.g. FB group)</i>	<i>Transform rules of the collective</i>	<i>Create new rules for the collective</i>
IMAGINARIES, IDEOLOGIES	Re-enactment of imaginaries, proletizing	Recreating aspect of imaginary, performance, display	New partial realization of imaginary, reconstitution	Creating new to the world infrastructures, platforms
	<i>Share info on how masks work and their benefits</i>	<i>Create and share a repository (e.g. a list) of existing DIY face mask pattern</i>	<i>Make and share instruction videos of how to make DIY masks</i>	<i>Set up (a) distribution channel(s) for DIY mask patterns</i>
INTERACTION ARENAS, GLOBAL PLATFORMS	Use of content as-is, bridging, brokering	Contributing content, feeding to platforms	Contributing to infrastructure	Creating new-to-the-world infrastructural platforms
	<i>Copy or download a DIY design/pattern from an existing platform</i>	<i>Provide own DIY pattern or design adaptations back to the platform</i>	<i>Create an open editable repository of DIY mask designs/patterns</i>	<i>Create a new infrastructural platform for DIY mask designs</i>

INDIVIDUAL

COLLECTIVE

Figure 2: Kohtala et al.'s matrix of design engagements (2020) populated with examples, denoted in italics, from our empirical material (adapted from Saad-Sulonen et al. [2020]).

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open design, Open Source and ‘DIY maker’ peer social groups in peer-to-peer spaces such as fablabs, makerspaces and hackerspaces too. The engagements may focus on co-creation by organizations/communities, imaginaries/ideologies or interaction arenas/global platforms.

Accordingly, Kohtala et al.’s final proposal takes the form of a matrix, with the *x*-axis consisting of the intensity continuum for active use and design engagements and the *y*-axis addressing the individual-oriented aspects and the collective ones both (see Figure 2). The authors populated their matrix with empirical insight from a long-term study of design engagements in fablab settings in Europe, providing empirical examples for each cell in the matrix. These examples attest to the many possible outcomes or objects of the engagements, far beyond the 3D-printed objects in their study. Files, printers, procedures, services, documentation, activities and events, governance or economic models, platforms, etc. all emerge and flow from sites of everyday design, where so-called users are occupied with design engagements. While the taxonomy and matrix in Figure 2 may appear at odds with our criticism of nested hierarchies as simplistic representations, such rich and multifaceted pictures speak to the framework’s utility – not in its own right but as a canvas to be ‘animated’ and ‘stirred up’, in keeping up with our critique of narrow conceptualizations of scale.

MULTIPLE DESIGNED ARTEFACTS IN RELATIONS THAT SPAN SCALES

Our entry points into design engagements around DIY design and making of masks in the earlier phases of the pandemic involve specific sewing patterns but also the landscape of collectives and spaces where the design engagements that we followed took place (e.g. the home, the collective studio, Facebook groups and YouTube channels), sometimes jumping between sites and connecting to each other (amidst social restrictions). Our first move in the analytical interrogation of our practice and empirical materials was to follow Kohtala et al.’s example in looking closely at concrete doings. We drew inspiration from their detailed design-engagement inventory informed by observations from peer-to-peer open design and making activities at fablabs, by identifying resonating examples in our own empirical material. We found value in their analysis also for the set of categories and the matrix proposed, which we believe shed light on the emergent relationships between design activities with not only individual-oriented but also collective aspects and on how they connect with a continuum of routine, adjustment and novelty, ultimately speaking to local uses and sometimes even global interactions. We populated our adapted matrix with examples from DIY mask-making that we had collected from our practice, observed in our repository and pinpointed from the interviews (see Figure 2).

In the upper part of Figure 2, which refers to individual-oriented design engagements, we note particular types of uses related to DIY masks: one might wear a mask, adjust it to fit better by tying a knot in the straps, combine other elements with it (such as a nylon sock) to improve the fit and protection or use a rubber band to afford wearing it with a hijab or turban. As for the objects involved, one can sew masks but also tweak them, create devices to tweak masks and also create patterns for making masks. In relation to meanings and images, one can craft a mask by repurposing everyday clothes, create an origami mask or even devise a crocheted mask as a statement. Finally, specific local settings may allow for the use of local sewing equipment, testing

the fit by using pipe-cleaners or e-cigarette vapour, assembling a mask by means of equipment other than sewing equipment and setting up local distribution of masks or patterns.

The lower part of Figure 2 presents collective design engagements. These are not limited to producing/refining DIY masks or patterns; in contrast, they started bringing in collectives (as entities) as objects of design, along with the platforms needed for the collective organizational and communication needs. The engagements in this portion of the matrix – joining or setting up a DIY collective, transforming or creating new rules for the collective, etc. – are related to formations of people (organizations or communities) that cohere or emerge around DIY mask-making. Here, for imaginaries and ideologies we find design engagements related to contemporary visions of desired futures or imaginaries, such as sharing pre-existing information on how masks work and how they counter airborne viruses' spread, creating repositories of patterns for DIY masks, making and sharing one's own patterns and instructions and setting up some distribution channel(s) for those patterns. Finally, collectives rely on arenas and global platforms for knowledge-sharing. In our case, some used existing ones to view, copy and/or download mask-sewing instructions/patterns or to upload new/adapted patterns. More intense design engagements, in contrast, could also entail creating altogether new platforms.

Examining everyday design as represented by DIY face masks in light of Kohtala et al.'s taxonomy of design engagements allowed us to highlight how such design covers a host of activities, associated with various interactions with quite different artefacts. One kind of interaction identified takes place with the body of the wearer (specifically involving the fit of the mask on the wearer's face or in relation to one's headdress). Another involves the material of the mask and its filtering capacities. Yet another emerged in relation to the genre of sewing patterns or instructional videos as means for sharing design knowledge. Design engagements can also extend to the design of rules for online community engagements (Kohtala et al. 2019) and for working with information-technology platforms (e.g. the Just One Giant Lab platform and the OpenCovid19 Initiative there). If we regard these design engagements as taking place at different scales – in the sense of Howitt and Liboiron – and around various temporalities, we can trace back to the relations that matter, as we attempt next.

What this first analysis confirms, it is the multiplicity of related design artefacts that are outcomes of everyday design. They encompass new masks, tweaks and adaptation of existing masks, sewing patterns, tweaks and adaptations to those, devices, documentation and instructions, guides, repositories of resources, rules for online collectives, new online platforms, etc. Where Bødker et al. (2016) saw artefact ecologies as composed of the artefacts a person or a community owns, adapts and interacts with, we witnessed what one could call a design-artefact ecology emerging: individuals and collectives engaging with multiple design artefacts, across a variety of physical and online spaces supported by infrastructure of various sorts, through a range of intensities covering use to innovation.

Whilst Kohtala et al.'s taxonomy and matrix clearly helped us map the multitude of design engagements at play in DIY mask-making, employing this mapping in isolation proves problematic. Where the Kohtala team's mapping work was centred on identifying and naming design engagements concentrated in specific localized spaces (the fablabs), the settings we dealt with are of a more distributed nature and might seem less organized. This factor led

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us beyond locating the engagements, to tracing trajectories (Hyysalo 2010). That process, explained below, adds relational, temporal and gestural layers (Agid and Akama 2018) to what initially appears to be a frozen matrix (i.e. we moved from Figure 2 to Figures 4 and 6). Thereby, we explored some of the patterns and conditions that render certain relations and engagements possible, across multiple scales.

SCALAR TRAJECTORIES ACROSS MULTIPLE DESIGN ENGAGEMENTS

Our second analytical move was to overlay another set of empirical findings on the matrix of design engagements, in the shape of specific trajectories. This superimposes 'flight paths' in Figure 2 that acknowledge mutual influences and contingency in how design engagements accumulate, emerge and move (Hyysalo 2010) – in this case, between the elements of the matrix.

To compile the trajectories, we worked from two jumping-off points in our research on DIY mask-making. The first came from our search for instructions and mask-sewing patterns to guide our own DIY creation of cloth face masks. A recommended pattern we recurrently encountered was the so-called Hong Kong mask, or HK mask, pattern (see Figure 3), which we used in our own practice. After embarking on more rigorous research and data collection, we found that the HK design and another pattern for a surgical-type cloth mask with filter pocket, from Taiwan, were among the very first to be shared online, in early 2020. The second entry point came about through our encounters with online mask-sewing collectives in Denmark and our further interviews with some of their members (see Figure 5). With the following discussion, we report on two trajectories, each grounded in one of these entry points to DIY mask-making (many other trajectories can be identified, but we do not present them here). The first trajectory follows some of the relationalities associated with HK-mask-based patterns, and the second is woven in with those from Danish makers of DIY cloth face masks. The trajectories, as living narratives, find anchor points in the design engagements expressed via Figure 2, but at the same time they are attempts to relay the dynamism at play in movements

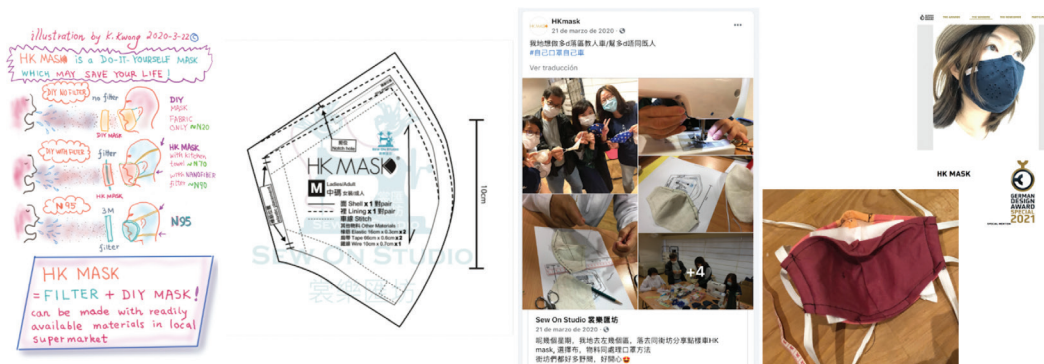


Figure 3: From left to right, the rationale for the HK mask as an illustration that Dr Kenneth Kwong created and shared via social media; a downloadable HK-mask pattern (in size M) for women, refined on the basis of his work and contributions from the Sew On Studio collective in Hong Kong; the HK-mask collective sharing a connection to a Sew On Studio community event through a social-media post in March 2020; the second author's HK-mask prototype made in Helsinki in the following month; a screenshot of the German Design Awards special mention from December 2021.

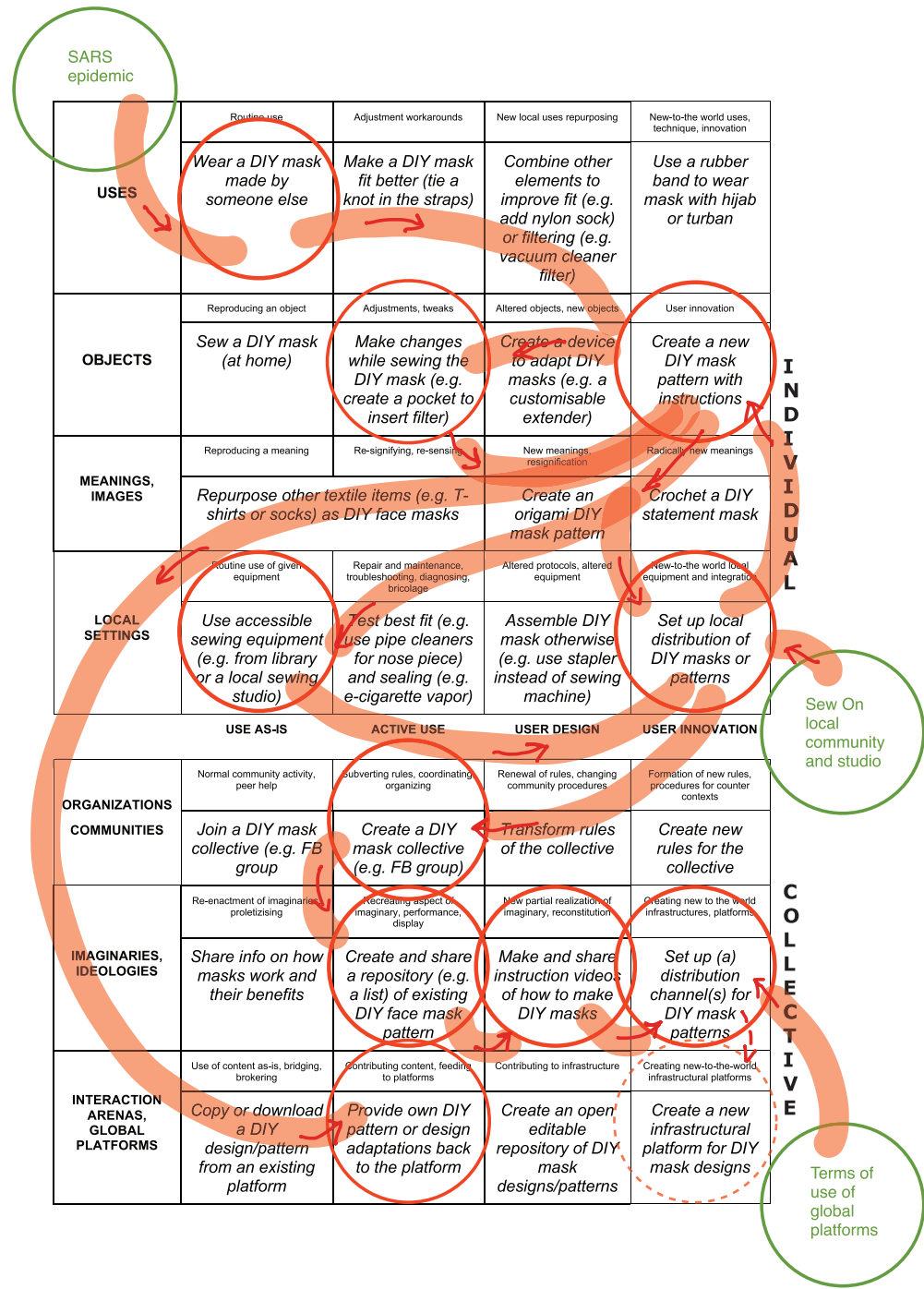


Figure 4: Trajectory 1 – sharing the HK-mask patterns.

and connections made across the whole range and full spectrum of intensity of those engagements. The analysis culminated in Figures 4 and 6, representing the picture with trajectories 1 and 2, respectively.

Trajectory 1: Sharing DIY mask patterns

In sewing and fashion design, a pattern is a designed artefact that allows the reproduction of a design by others, providing conventions and basic instructions for a future maker. The pattern functions as a template from which the constituent parts of a cloth artefact can be traced onto fabric before being cut out and assembled (by sewing or other means) into a wearable artefact. The first trajectory we worked on conveys a path of design engagements around the creation of sewing patterns for DIY cloth face masks in Hong Kong, very early on in the pandemic. This trajectory's starting point in East Asia, a region that holds fresh memories from a similar respiratory virus (SARS), may explain its early onset, as might the positive positioning of face masks in general as symbols of freedom (e.g. during pro-democracy protests) in Hong Kong. One of the first patterns we catalogued was created by Taiwanese anaesthesiologist Dr Chen Xiaoting, who shared a model for a DIY surgical face mask made from cloth on 6 February 2020 in a Facebook post in Mandarin and English. Another early pattern is the HK-mask pattern, which was based on the work of Hong Kongese retired chemistry lecturer Kenneth Kwong, apparently the first to share a pattern for a DIY cloth face mask with an in-built pocket for a filter. He shared his drawings in a bilingual social-media post (a public post from his personal Facebook account). Both February 2020 posts – from Dr Xiaoting and Dr Kwong – exemplify a move from individual-initiated design engagement beyond simple use-as-is to user innovation, in the form of providing knowledge necessary for making a specific mask. The two posts address aspects of material selection (types of fabric and qualities to look for), filtering possibilities (the best materials, home replacements and ways of testing them), fit (patterns for multiple sizes, tips for making better knots and notes on the importance of the fit around the nose) and adherence (economic arguments for cloth masks, advice on how best to arrange their production and opportunities for making a fashion statement). The trajectory of the pattern based on cloth surgical masks did not evolve as greatly, since the scalar relations at play did not proliferate as much as the HK-mask pattern did.

The knowledge-sharing that took place via Dr Kwong's social-media account later spilled over to other collective forms of innovation through relations. In a few posts associated with the launch of refined patterns on 21 February 2020, he stated that 'some people online question whether I'm qualified to pull off this project. I am no face mask expert but I know a lot of the experts' (Kwong 2020), referring to the many former students of his acquaintance who helped out and completed various tasks. People not part of his direct circle took part too, notably Winsome Lok, a local fashion designer who runs the community sewing studio Sew On, for elderly people in Hong Kong. She contacted him, finding his post to resonate with the values of the sewing studio and the two started collaborating. In the space of a few weeks, nearly 40 volunteers joined together to hone the design and the pattern, produce printed and video instructions for sewing and wearing the mask and also organize a distributed production line to make masks for those unable to sew their own. The network included retired master tailors, textile and fashion graduates, expert seamstresses working from home and other volunteers.

Other relations led also to the formation of a collective that administered and hosted a Facebook page (masksbymhongkongers) dedicated to collecting the information and links. The page had amassed 30,000 followers by March 2020. Also, a spin-off site compiling the materials emerged (DIYmask.site, whose hosting has not been continued). This showcased the original illustrations by Dr Kwong, a collection of the patterns and videos with sewing and wearing instructions created by the Sew On studio, all translated by volunteers into ten distinct languages already by 27 March. For a while, the spin-off effort involved a GitHub account to share this site's code, thus hinting at possible further user innovation through the creation of new infrastructural platforms.

In addition, the various relations and collective efforts yielded instructions for hosting (socially distanced) sewing workshops and assembling kits for DIY mask-sewing. The associated Facebook community and distributed production line was bustling with activity – sales included – for about a year before engagement started waning. The last posts document the patterns' recognition in several quarters, including a mention at the German Design Awards ceremony and a design exhibition. A 'pinned' post reiterates a commitment to not closing down the shared downloadable file repository even though volunteers would no longer be updating the site content or arranging collective activities: the HK mask would 'keep on living' there, despite the imminent wrapping up of the community efforts.

Trajectory 2: Sewing together DIY cloth face masks

DIY sewing takes place in the solitude of the domestic sphere or through social events held for both practical and leisure reasons. It is important to acknowledge also that sewing is a feminized practice in many parts of the western world. Sewing has allowed women (particularly of the middle class) to sit 'while not wasting any time' (Gelber 1999: 162); this setting affords discussing current affairs and learning from and taking care of each other – a phenomenon that manifested itself in the sewing efforts begun by many, including us, amid the pandemic. Moreover, the arrival of digital platforms has added new dimensions to the practice of DIY sewing (e.g. Lindström and Ståhl 2014; Russum 2016), such as bringing various media formats and digitally mediated peer support to bear for disseminating practical knowledge.



Figure 5: From left to right, a post acknowledging (our) lurking around one of the Facebook groups for DIY sewing of face masks; display of a video shared in one of those groups that clarifies a part of the sewing strategy for a particular pattern; a photograph of someone's stash of completed DIY cloth face masks (these photos were shared with us by the makers in the DIY sewing group).

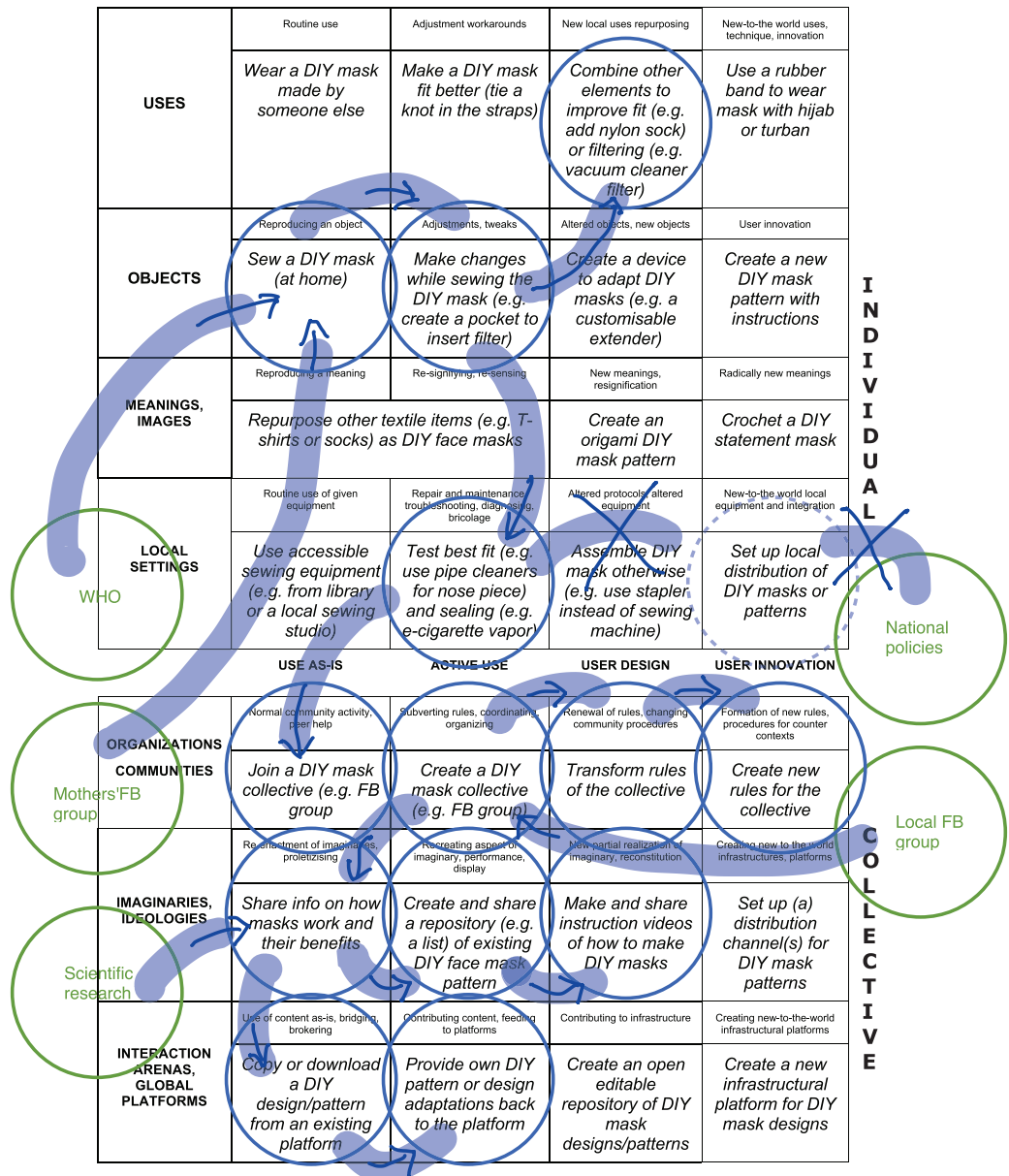


Figure 6: Trajectory 2 – sewing DIY cloth face masks together in Denmark.

An initial online search for Denmark-based DIY face-mask-related groups alerted Mille, who was assisting us with the research, to two on Facebook that were actively sharing sewing tips and advice. After posting a message about our interest in DIY face masks and asking group members to get in touch, Mille interviewed two members of one group. One of them was a Danish lady

in her 40s who had grown interested in sewing face masks in June 2020 upon encountering a post to a mothers' Facebook group she belonged to, asking where one could buy a cloth mask. The informant, a seamstress at hobbyist level, started making some face masks, at first to provide them to others in the group and later for other friends and her extended family. That process's enquiry stages saw her join a Facebook group focused on DIY cloth face masks and making extensive use of the information shared there, such as recommendations on filter materials. In turn, she shared some aspects of her experience and journey. However, she came to notice that she was uncomfortable sharing further, outside the group. Hence, for example, she removed a video in which she documents and explains how she and her husband tested the fit of masks by means of his exhaled e-cigarette vapour. She did not wish the video to circulate more widely.

She had searched the internet (YouTube) for mask-making videos that could offer inspiration, consulted information from the Danish National Board of Health and relied on her husband's skills in the English language to translate the WHO guidelines' recommendations for fabric types. Her first masks were based on a free pattern she downloaded from a Danish textiles website known for providing many DIY guides. She adjusted this pattern for better fit by making it bigger, adjusting the side stitches and iterating over several ways of adding a pipe-cleaner to achieve a better fit around the nose. In crafting her face masks, she paid special attention also to the feel of the layer touching the face and to the moisture-absorbency quality of various fabrics. Having a nickel allergy herself, she shared with us how she had tested pipe-cleaners for nickel.

Mille's second interviewee was one of the founders of the Facebook group, a woman in her 50s who had started sewing masks early on, before there was any official discussion in Denmark about wearing them. She was annoyed by the government's lack of recommendations and their statements that masks create a false sense of security. The first pattern she used was one linked to in an e-mail message she received near the end of February 2020. Initially, she deemed this design, which featured pockets for interchangeable filters, too complicated for her to sew, so she adapted the pattern while preserving its core concept. She was aware of Taiwan's experiences with DIY face masks and thought highly of the results – as she pointed out, people in Taiwan had gone through the first SARS epidemic, some years before. When the COVID-19 pandemic erupted, she was active in a local Facebook group where many members were writing negatively about face masks. As a small subgroup emerged who thought differently, she and another member were spurred to create a separate group dedicated to making face masks. As the administrators of the new Facebook group, they aimed to support the activities of mask-sewers by finding and highlighting research-based recommendations grounded in scientific evidence. For example, they shared the discovery by Israeli researchers that HEPA vacuum-cleaner filters are good at filtering out the tiny virus behind COVID-19.

The group thrived, and members were supportive of each other. Then, as autumn 2020 rolled around, the group, its administrators and several members started receiving negative messages on Facebook, both public and private. Some of these claimed that DIY masks are ineffective and that their use would increase the spread COVID-19. In the wake of this negativity, the administrators announced the group's imminent shutdown, but an outpouring of support led them to reconsider. Instead, the interviewee and her co-founder kicked some members out and supplemented the group's rules with a section

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articulating zero tolerance for hateful rhetoric and bullying of any kind. When asked her opinion on the usefulness of DIY cloth face masks, she replied that she agrees with science, which now has clarified that disposable surgical masks are better, but she also noted that ‘a good cloth mask is a whole lot better than nothing’.

If we return to the notion of scale as relations, the trajectories that we have outlined above suggest that alternative readings of scale that do not focus merely on nested scales are important. Our example trajectories suggest that movement and temporal gestures (Agid and Akama 2018) between widely distributed design capacities (Kohtala et al. 2020), whether of sewing hobbyists or retired tailors, and their specific design engagements (denoted via the red circles in Figure 4 and the blue ones in Figure 6) occur through creation of relations (see the thick connectors and narrow arrows in the two figures). Importantly, the emerging movements and gestures flow in all directions, whether at individuals’ or collective level. Also, concerns travel between locations, contexts and situations in many, quite different ways, with distinct but related design objects getting addressed. Thereby, ‘scalar trajectories’ provide insight as to some of the resonances, compositions and temporalities involved in many design decisions (Howitt 1998; Hyysalo 2010). For such conditions, the ‘chair in a room [...] an environment in a city plan’ (Hill 2012: 35) paradigm no longer appears sufficient. The case before us seems to mesh better with Howitt’s and Liboiron’s invitations to understand relationalities, differences, power and the resources at play. The latter way of thinking offers tools for a nuanced understanding of the building of alliances among a retired chemistry lecturer, a fashion designer and a retired expert seamstress, or of how imbalances in information access between citizens and health-care workers play out. All of these elements influence a host of design engagements that, while at least initially appearing to differ in importance, all link together into the full picture. The two trajectories examined, connected to the humble DIY mask, reveal how the paths of ‘amateurs’ (in Holt and Mackinney-Valentin’s conceptualization) in their various design engagements cross the paths of others (experts of whatever kind, collectives and other groups) while also uncovering the paths of materials (cloth, filters, pipe-cleaners, hoover filters, digital platforms, etc.) and their related global supply chains. Thinking about trajectories highlights some of the motion at play, unfreezing what was locked into the matrix: the fixed instances of design engagements, in various intensities in the individual-level and collective domains, are now animated in choreographies of sorts (Agid and Akama 2018). The trajectories are unique to each story yet also interwoven with fixed and common elements – touchpoints to a momentarily recognized taxonomy of contemporary design engagements, which hints at shared patterns that might need to be in place for engagements to flourish or wither (Hyysalo 2010).

Our exploration of trajectories challenges the borders of the matrix too. The two sample trajectories bring in elements such as previous epidemics, primarily SARS in East Asia; communities outside the most obvious domain of the design engagements under direct study (e.g. a local sewing community not initially centred on sewing of masks or a mothers’ group on Facebook); the terms of engagement of global platforms; scientific research; the doings and policies of global bodies such as the WHO – which we have tentatively marked with green circles outside the current matrix in Figures 4 and 6. As a lens informing the understanding of scalar relationships in design, the DIY mask also sharpens focus on the more and more crucial role of governing

bodies and their shaping of policies (at local, national, regional and global level) and on issues of scientific evidence and misinformation. The scalar relationships of the design engagements involved are also intertwined with platform capitalism and its hold on infrastructure for producing/sharing content and for people's communication and self-organization.

DISCUSSION AND CONCLUSIONS

The phenomenon of DIY cloth masks' design supplied us with a window for starting to map relationships in design engagements and suggested the concept of scalar trajectories. The DIY face mask belies designers' common perception of scale as a thing to tame, limited to concerns of size and growth only and to conceptions of nested hierarchies of contexts for situating a given design artefact. Though we were inspired to broaden our gaze by Hill's expanded view of design contexts, which accentuates the need to acknowledge the dark matter of policy, regulations and organizations along with how design swings between the meta (or the dark matter) and the matter of the artefact, the combined lenses of everyday design engagements and scale as relational took us even further. In examining the masks and their making fairly early in the pandemic, we found that a seemingly banal creative exercise in amateur crafting of cloth-based protection against a respiratory virus entails more complex entanglements than expected, not only between matter and dark matter but also between individuals and collectives as they engage in diverse emergent distributed activities.

Returning to Howitt's way of thinking (1998), if we carry the analogy of the musical notes' or scale's relationalities/differences further, to the world of design, we can view the face mask as a note, whose role and relations can be viewed, and attended to, differently through several analysis scales – e.g. materials, ergonomics, scientific research, misinformation, local and global politics and policy. The most promising route for practice-based design researchers might be to consider material interventions not within an onion model of nested concerns (à la Saarinen) but via enquiry that moves across relations to identify all the elements that matter or come to matter.

The kind of design we have identified and followed with the face masks thus invites us to reflect further on what design is and how it can be understood. First, it allows us to expand understanding of the everyday design behind specific places such as the home or workplace. This kind of design is not 'packaged' to exist in specific local spaces (such as fablabs), and there are no established networks of such places globally (though similar initiatives may exist in multiple locations, such as local Facebook-based mask-sewing groups). Neither do the activities form a 'brand'. They are grassroots and emergent, and they may exist simultaneously in very different locations, around the world. We cannot necessarily speak of a collective design either, of the sort usually conceptualized under the distributed co-design rubric or even as 'co-sewing' in a shared location (Hirscher 2020). The kind of design we witnessed with DIY face-mask-making is emergent and continuously evolving, at the same time individual-level and collective, distributed in time (synchronous and asynchronous) and space (across localities), and diffused. Its dynamics and our ways of exploring them may inform ways of understanding the shapes a collective design body (Angelon and Van Amstel 2021) can take and how professional and 'amateur' ones may intersect.

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Challenges remain when such design stays confined to the sphere of ‘amateur design’ at least as currently shaped. No recognized constructs permit design of this nature to address such factors as requirements for formal regulation and compliance markings (for instance, face masks marketed in Europe must have a CE marking), especially with regard to design for health. Directions forward might be shown by solutions now being experimented with in such domains as application-based delivery services connecting home cooks with customers, which include health checks for the home kitchens. This is one of many possible avenues for design research.

Our research has but scratched the surface in understanding the DIY making of cloth face masks as a set of ‘scaled’ design engagements. We envision further work at the empirical level and in forging conceptual and theoretical connections between scale as relation and, for instance, an understanding of design as infrastructuring (see Karasti 2014). Such connections would consolidate a framework for understanding design that extends the usual temporal and scalar boundaries associated with single artefacts, projects and size/growth, to begin fully addressing the distributed sets of practices and temporalities at play in and around design.

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way civic participation intersects with participation in the design of digital technology and services, thus emphasizing a democratic approach to digital design.

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