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**Networks of opinion leaders and heterogeneous organizations:
The organizational elites of the Quantified Self and
Maker Movements on Twitter**

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Networks of opinion leaders and heterogeneous organizations: The organizational elites of the Quantified Self and Maker Movements on Twitter

1   Introduction

The progression of deep mediatization, that is, the molding of society by digital media and their infrastructures, is not only driven by outstanding 'corporate actors' such as media companies like Apple, Google, and Facebook and state agencies. Just as vital in the process are 'collective actors' characterized by the ways in which they 'act on media' (Hepp, 2020a; Kannengießer & Kubitschko, 2017: 1): These collectivities make media and the infrastructures that undergird them the focus of their engagement, precisely because the latter have become so relevant to society. Social movements such as the Open Source or Indymedia movements that 'act on media' have a long legacy of scholarly attention, however, pioneer communities such as the Quantified Self (QS) and Maker movements have not yet been examined more closely in this respect: While the QS movement is concerned with digital practices of self-measurement and self-optimization through the intensive use of wearables and other tracking technologies, the Maker movement is characterized by the collaborative development of (digital) manufacturing processes based on 3D printers or micro-computers such as the Arduino and the RaspberryPi.

Both pioneer communities share with social movements their open structure and their aim to stimulate societal change. The difference is that pioneer communities – even if they refer to themselves as a movement – share many more traits with the commercial world and established politics and are curated by an organizational elite that can be traced back to the San Francisco Bay Area (Hepp, 2020a: 33-40). In the case of the QS movement, their main curatorial instruments are publications such as *Wired* magazine and the QS Lab Berkeley website "quantifiedself.com", events such as QS conferences, meetups, and prototyping institutions (for example, the Quantified Self Institute in Groningen, the Netherlands). In the case of the Maker movement, these instruments include publications such as *Make:* magazine, or events like Maker Faires and meetings in local makerspaces.

However, besides these particular curatorial forms, online networking operates as a vital function for keeping these pioneer communities together transnationally. In both communities, their organizational elite, that is, their principal organizers and decision makers, connect on Twitter to share the latest information and to make announcements. It is this online networking that will be the focus of this article to deepen our understanding of pioneer communities and their transnational spread. More specifically, we will address the following three research questions:

RQ1: How are the organizational elites of both pioneer communities connected transnationally?

RQ2: What patterns and peculiarities can be identified in terms of account types as well as thematic orientation?

RQ3: What similarities and differences exist for individual countries and between each community?

In addressing these research questions, we aim to reconstruct followee-networks of the organizational elite of both movements as they play out on Twitter. This approach is closely tied to our media ethnography through which we have already been able to determine the central members of the transnational organizational elites (Hepp, 2020b), a prior knowledge from which we define the seed accounts to reconstruct the Twitter networks analyzed here. Starting from these prominent members of the organizational elites, we aim to a) trace the *connections* of these accounts to each other and the patterns within their common followee-networks, b) identify *further transnational key accounts* of the organizational elite on Twitter, and c) describe *similarities and differences* on a transnational and national level as well as between both pioneer communities.

In all, we want to substantiate the thesis that the Twitter network of the QS movement can best be described as a 'network of opinion leaders' and that of the Maker movement as a 'network of heterogeneous organizations'. In both cases, the Twitter analysis underlines the significance of the members of the organizational elite from the San Francisco Bay Area in regard to the pioneer community's transnational figuration. In this sense, Twitter is an instrument that makes it easier for the organizational elite to establish their ideas and ideologies across each community.

In what follows we will briefly summarize the current state of research on the QS and Maker movements' organizational elite and the challenges inherent in an investigation of such figurations based on Twitter data. In a second step, we will introduce our methodology. We will then present a comparative analysis of each community's elite network. To conclude, we will reflect on how our findings offer an insight into the overall figuration of these pioneer communities.[1]

2   State of Research: The QS and Maker organizational elites

In many respects the QS and Maker movements are intimately related: Both date back to the mid–2000s, both were formed in the San Francisco Bay Area, both were 'founded' by former editors and journalists (Gary Wolf and Kevin Kelly from *Wired* in the case of QS, Dale Dougherty from O'Reilly Media in the case of the Maker movement), and both managed to orchestrate the extension of their influence and notoriety from the US to Europe and other parts of the world. However, there are also clear differences between both movements that can be identified through the orientation of their practices (the self vs. manufacturing), their visions of media-related collectivity and societal transformation, their events, and the reach of their published works (e.g. websites, journals, reports) (Hepp, 2020b).

Previous research has shown interest in both pioneer communities, particularly from the point of view of their ordinary members. In the case of the QS movement, this concerns the everyday practices of tracking and self-measurement (Crawford et al., 2015; Didžiokaitė et al., 2018; Lomborg & Frandsen, 2015; Pantzar & Ruckenstein, 2014), the movement's proximity to emerging approaches to personal health (Ajana, 2017; Nafus, 2016; Lupton, 2015; Sharon, 2017; Williamson, 2015) and data security and surveillance issues related to the practice of self-tracking (Abend & Fuchs, 2016; Esmonde, 2019; Fotopoulou, 2018; Lupton, 2014; Sharon & Zandbergen, 2016; Swan, 2013). A number of studies have also investigated the public discourse surrounding the QS movement, be it in the

technology magazine *Wired* (Ruckenstein & Pantzar, 2017), or general media coverage (Hepp, Alpen & Simon, 2018; 2020). While this research is rich in nature and can only be touched upon here in rudimentary form, a study of the QS movement and its organizational elite's engagement does not exist. Apart from obligatory references to the 'founders' of QS in the introduction to various articles and chapters, Gina Neff and Dawn Nafus' book *Self Tracking* (2016) deserves special mention here. However, they neglect to discuss the pioneer community's elite in any real detail.

Perhaps tangential, but still comparable in regard to the lack of emphasis on the organizational elite, is research into the Maker movement. Researched topics include makerspaces as localities of innovation and learning (Barniskis, 2013; Davies, 2017; Lange, 2015; Peppler et al., 2016; Toombs et al., 2014), the relation of the Maker movement to the do-it-yourself and hacker movements (Hunsinger & Schrock, 2016; Ratto & Boler, 2014), new forms of civic participation through the Maker movement and its events (Kostakis et al., 2015; Nascimento & Pólvora, 2016; Richterich, 2017), the engagement of the Maker movement in (industrial) development (Irani, 2015; Ramsauer & Firessnig, 2016), and a general reflection on 'making' as a (countercultural and pedagogic) practice (Gauntlett, 2018). Likewise, studies into reporting on the Maker movement can also be found which either focuses on the pioneer community's publications in *Make:* magazine (Nguyen, 2016; Sivek, 2011) or general discourse on the Maker movement (Hepp, Alpen, Simon 2018). Once again, the role of the organizational elite in the Maker movement is discussed only marginally, even in publications that focus on its historical roots (Turner, 2018).

In our own research, we have compared the organizational elite of the QS and Maker movements in Germany, Great Britain, and the USA in regard to how they curate their transnational reach (Hepp, 2020b). With this article we want to delve deeper into the organizational elite's network of both communities on Twitter. There has, in fact, been little research into the Twitter activities of both movements. One rare exception in the case of the Maker movement is a study by Menichinelli (2016), who looked into the Twitter connections of fab labs, makerspaces and hackerspaces. Menichinelli's analysis provides evidence of a globally spread community on Twitter loosely organized into several sub-communities born out of geographically divergent hubs each with differences in their organizational structures. However, his analysis focuses solely on different kinds of spaces and their networking and not on a reconstruction of the various accounts of the organizational elite.

Twitter as a platform enables three different 'communication modes' (Bruns & Moe, 2013: 16). First, interpersonal communication through the @mention, the @reply function, and direct messages. Second, communication within networks of followers and followees through original tweets. And third, potentially large communication streams that are structured and topic-related using #hashtags (Bruns & Burgess, 2012). These different modes of communication also structure the research of Twitter data to some degree. We find conversation analysis at the level of tweets and retweets (boyd, Golder & Lotan, 2010; Paßmann, Boeschoten & Schäfer, 2014) while another branch of research focuses on the investigation of connections from the created networks of single or multiple accounts and their communication flows (González-Bailón & Wang, 2016; Gruzd, Wellman & Takhteyev, 2011; Xu et al., 2014). Furthermore, research has been carried out that looks into the dynamics of events based on hashtags (Highfield et al., 2013; Gaffney, 2010; Leavitt, 2013; Lotan et al., 2011).

By reconstructing the Twitter networks of both pioneer communities' organizational elites, we consider this study to reside in the tradition of the second line of research mentioned above. Our approach does not focus on 'volatile networks' (Maireder & Schlögl, 2015: 120) of particular events but the analysis of networks on the basis of followee lists,

and seeks to identify more stable networks that can influence and structure observation and patterns of practice on Twitter. Twitter network analyses based on follower and followee lists often concentrate on the structural patterns of these networks as well as particular key accounts as bridges or brokers within them (e.g. González-Bailón & Wang, 2016, Sajuria et al., 2015; Theocharis, Vitoratou & Sajuria, 2017).

While this kind of research reflects the way Twitter structures data, it also poses considerable challenges. First, there is the challenge of its changing architecture and the growing restrictions applied to the Twitter API which results in limitations in research design (Bruns, 2019; Puschmann, 2019). Second, researching social phenomena solely through Twitter data risks falling short in adequately grasping the subject in question, as such data cannot be understood isolated from wider social and cultural contexts. Networks on social media platforms and other kinds of 'digital traces' are always socially and culturally embedded and the challenge is how to link this contextualising information with online data (Hepp, Breiter & Friemel, 2018; Tilson et al., 2010). This means that we not only follow arguments that Twitter data are themselves a product of 'interpretative work' (Bowker, 2013: 170) that should be understood 'by the means used to handle and process it' (Puschmann & Burgess, 2014: 1702) we also want to explore the online activities of the organizational elite in close relation to other ethnographic data we have on their activities.

3   Methodological Approach: Contextualized Twitter network analysis

As already mentioned, our Twitter network analysis is part of a larger project that investigates both movements using a media ethnographic approach. Based on 226 qualitative interviews with members of both pioneer communities, participant observations at eleven major events and 24 local meetups and spaces, we were able to identify the organizational elite. Referring to research on organizational leaders in social movements and scenes (Cammaerts, 2005; Hitzler & Niederbacher, 2010; Nepstad & Bob, 2006), we define such members as those who a) take responsibility for important events, b) publish widely on and in the name of the movement, or c) speak publicly on behalf of the pioneer community (Hepp, 2020b). Typically, the key actors of the organizational elite combine all three criteria.

The entry point for our Twitter analysis are, therefore, 22 manually selected seed accounts of the QS movement from the US, the Netherlands, the United Kingdom and Germany and 19 seed accounts of the Maker movement from the US, Italy, the UK and Germany on Twitter.[2] Our selection includes two account types: personal accounts and organizational accounts. The personal accounts of the QS community include for example the 'founders', Gary Wolf (@agaricus) and Kevin Kelly (@Kevin2Kelly), and organizers of local QS meetups. The organizational accounts of QS are mainly divided into the Twitter appearances of the official website from QS Labs Berkeley (@quantifiedself) and its national and regional offshoots. The corpus for the Maker movement consists of a pool of personal accounts including the founder Dale Dougherty (@dalepd) as well as committed organizers of local makerspaces, a few entrepreneurs, and journalists related to the Maker

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[2] The composition of these countries is based on the fact that the two pioneer communities originated in the US. For the European context, the Netherlands also set the course for the Quantified Self movement, as the first European QS Conference took place in Amsterdam and the QS Institute was established at Hanze University in Groningen. Furthermore, due to the largest European Maker Faire taking place in Rome, Italy also plays a central role in the Maker movement. The comparison of Germany and the United Kingdom is particularly interesting, as these two countries differ significantly in their value orientation towards technology.

movement. The organizational accounts belong mainly to Maker Media, the American company that published the community focused *Make:* magazine (@make) and also organizes and licenses the community's events such as the Maker Faire (@makerfaire) in and to collectives and organizations in other countries. However, it is important to note that Maker Media went bankrupt in the summer of 2019.[3]

In order to generate the Twitter network, we captured our seed accounts by using the Twitter API via R and the rtweet package and crawled their followee lists afterwards. The data was processed and visualized using the open-source software Gephi and the Force Atlas 2 algorithm. In total, we identified 15,162 followee accounts for QS and 18,667 for the Maker movement. However, since the focus of our analysis is trained on connections within the communities' network of our seed accounts, we only labelled accounts within the transnational networks with an in-degree of ≥ 5. Consequently, a followee is only shown by name within the network if the account is followed by at least five seed accounts. The more seed accounts follow the newly identified account, the bigger is the node and label size in the network visualization. Accordingly, the more seed accounts follow a user, the more importance we attribute to the account for the debate on Twitter. This procedure resulted in a transnational followee-network of 82 labelled accounts for QS and 218 labelled accounts for the Maker movement including the seed accounts (see Table 1). However, it must be stressed that this filtering process for the visualization is manually determined by us in order to focus on the organizational elite and new accounts with a connection of as many seed accounts as possible.

We repeated this sampling procedure for each national context within our study. Due to a smaller amount of entry points we labelled accounts at an in-degree of ≥ 3 within the national networks.

Pioneer Community	Country	Seed Accounts	Total Followees	Labelled Accounts (in-degree)
Quantified Self	USA	6	2396	**67** (≥ 3)
	The Netherlands	5	8930	**81** (≥ 3)
	United Kingdom	5	3317	**22** (≥ 3)
	Germany	6	1409	**21** (≥ 3)
	US/NL/UK/DE	22	15162	**88** (≥ 5)
Maker	USA	4	5834	**259** (≥ 3)
	Italy	4	8544	**270** (≥ 3)
	United Kingdom	5	2788	**35** (≥ 3)
	Germany	6	3035	**59** (≥ 3)
	US/IT/UK/DE	19	18667	**218** (≥ 5)

Table 1: Data set of both pioneer communities

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[3] An overview of all seed accounts in the dataset accompanied by their description on Twitter can be found in the appendix.

This research design enables us to come to conclusions about how the seed accounts are transnationally connected on Twitter with one another and allows us to discover further accounts with overlaps to the seed accounts and thematic groups within the networks. Moreover, it shows links between each country and points toward potential information brokers. However, it must be clearly stated that the study says nothing about the actual interaction of the organizational elites on Twitter.

Ultimately, the results are then interpreted and contextualized against the background of the transnational and national scale to uncover the dynamics within the overall figuration of the organizational elite.

4   QS movement: A network of opinion leaders

The QS organizational elite's Twitter network can be described as a network of opinion leaders. In adopting this classical term, seminally coined by Elihu Katz and Paul Lazarsfeld (1955), we want to point out the following: In the QS movement, it is primarily the accounts of prominent, individual 'influential' (Katz & Lazarsfeld, 1955: 150) members of the organizational elite that make up the Twitter network. At this point, it is already important to see our Twitter analysis as a contextualizing study: If one were to look purely at the tweets of the QS opinion leaders, their influence would hardly be measurable because it is not necessarily developed in Twitter interactions. In the original sense of Katz's and Lazarsfeld's reflections, the role of the 'opinion leader' mainly unfolds through personal communication, for example, at meetups and conferences. Nevertheless, the accounts of these opinion leaders – even if they rarely tweet – are networked with other accounts in a very specific way.

The transnational network

The 22 seed accounts for QS are divided into 15 personal and 7 organizational accounts. However, the resulting followee-network with 88 labelled nodes shows the same pattern as it is also made up of mostly personal accounts. Only 8 labelled organizational accounts can be found within the network, which are mostly companies for self-tracking wearables like Fitbit or Withings or news platforms for digital healthcare such as MobiHealthnews and Rock Health. The network is, therefore, very homogenous.
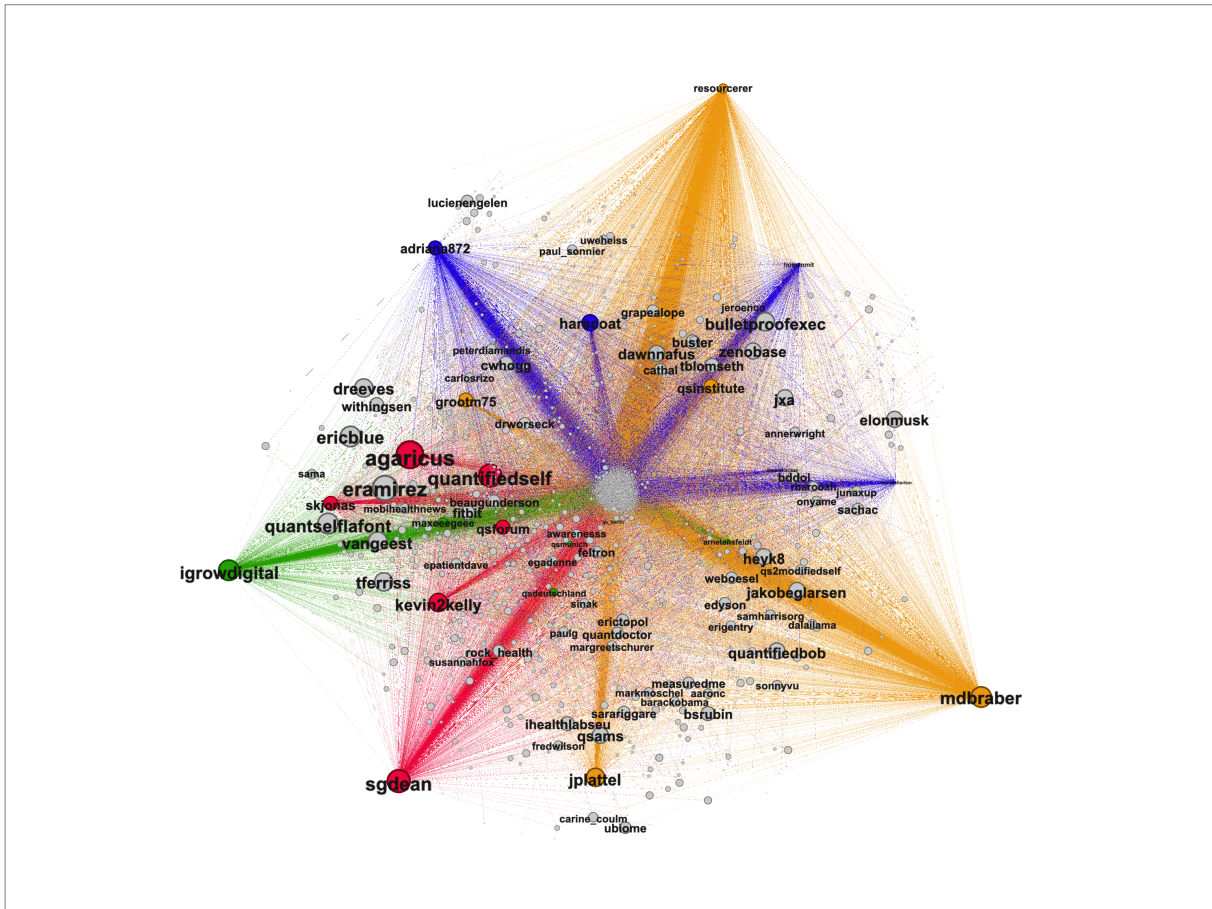
Figure 1: The transnational followee-network of the QS organizational elite based on 22 seed accounts and 88 labelled nodes filtered through an in-degree of ≥ 5. Created via Gephi, Force Atlas 2. Legend for seed accounts: red – USA; orange – the Netherlands; purple – the UK; green – Germany.

Looking more closely at the network (see Fig. 1), the nodes with the highest in-degree from our seed accounts belong to US-accounts: Gary Wolf (in-degree of 13), followed by the official QS account (in-degree of 11) and Steven Dean (@sgdean, in-degree of 11), a QS meetup organizer in the US. The Dutch seed accounts of Maarten den Braber (@mdbraber, in-degree of 10) and Joost Plattel (@jplattel, in-degree of 9), both Dutch meetup organizers, also have noteworthy amounts of followers among the seed accounts.

Moreover, the network uncovers further key actors within the followee-network who have not previously appeared in our media ethnography but are followed by the majority of our seed accounts and thus seem to be relevant connections on Twitter. In this regard we identify Ernesto Ramirez (@eramirez, in-degree of 12), who leads the San Diego QS meetup, as well as Paul LaFontaine (@quantselflafont, in-degree of 10) who is the QS meetup organizer in Denver.

Other "new" accounts, which stand out in the network due to their overlaps within the organizational elite can be clustered into a thematic group of eleven male (tech and/or health) entrepreneurs who are located in the US. Of these, Eric Blue (@ericblue), founder and CEO of activeOS has the highest in-degree of 10 and David Asprey (@bulletproofexec) founder of Bulletproof, and David Reeves (@dreeves), co-founder of LegUp, have nine followers among the seed accounts.

Another, albeit smaller, thematic group of 8 accounts can be identified around Dawn Nafus, (@dawnnafus, in-degree of 8), Thomas Blomseth (@tblomseth, in-degree of 7), Jakob Eg Larsen (@Jakobeglarsen, in-degree of 8), Sara Riggare (@sarariggare, in-degree of 6) and 4 other accounts, who research topics related to QS or health. Blomseth, Larsen and Riggare are even official collaboration partners with QS Labs Berkeley.

Authors of books or journalists related to QS can be grouped into a third group, including Tim Ferriss (@Tferris, in-degree of 9), Kate Farnady (@heyk8, in-degree of 8), Buster Bensson (@Buster, in-degree of 7) and 6 other accounts.

If we look at the labelled followee-network of QS as a whole, it becomes clear that it is heavily influenced by personal accounts in the US – both in terms of high in-degrees of the seed accounts, as well as the large amount of overlapping followees which can be traced back to the US. Dutch accounts seem to demonstrate moderate importance, represented through the overlaps of the seed accounts to Joost Plattel, Maarten den Braber as well as a number of other accounts such as Yuri van Geest (@vangeest) and Lucien Engelen. By contrast, neither the seed accounts from Germany and the UK seem to play a major role in the transnational Twitter network, nor are there any significant new accounts from both countries with an in-degree of ≥ 5. Rare exceptions are Florian Schumacher's seed account (@igrowdigital, in-degree of 10), a German meetup organizer, and Denis Harscoat's, (@harscoat, in-degree of 8) and Adriana Lukas (@adriana872, in-degree of 7), both QS London meetup organizers.

The national context

This resonates with the national followee-networks of the QS movements' organizational elite, as demonstrated by the QS Twitter networks in their respective national contexts.
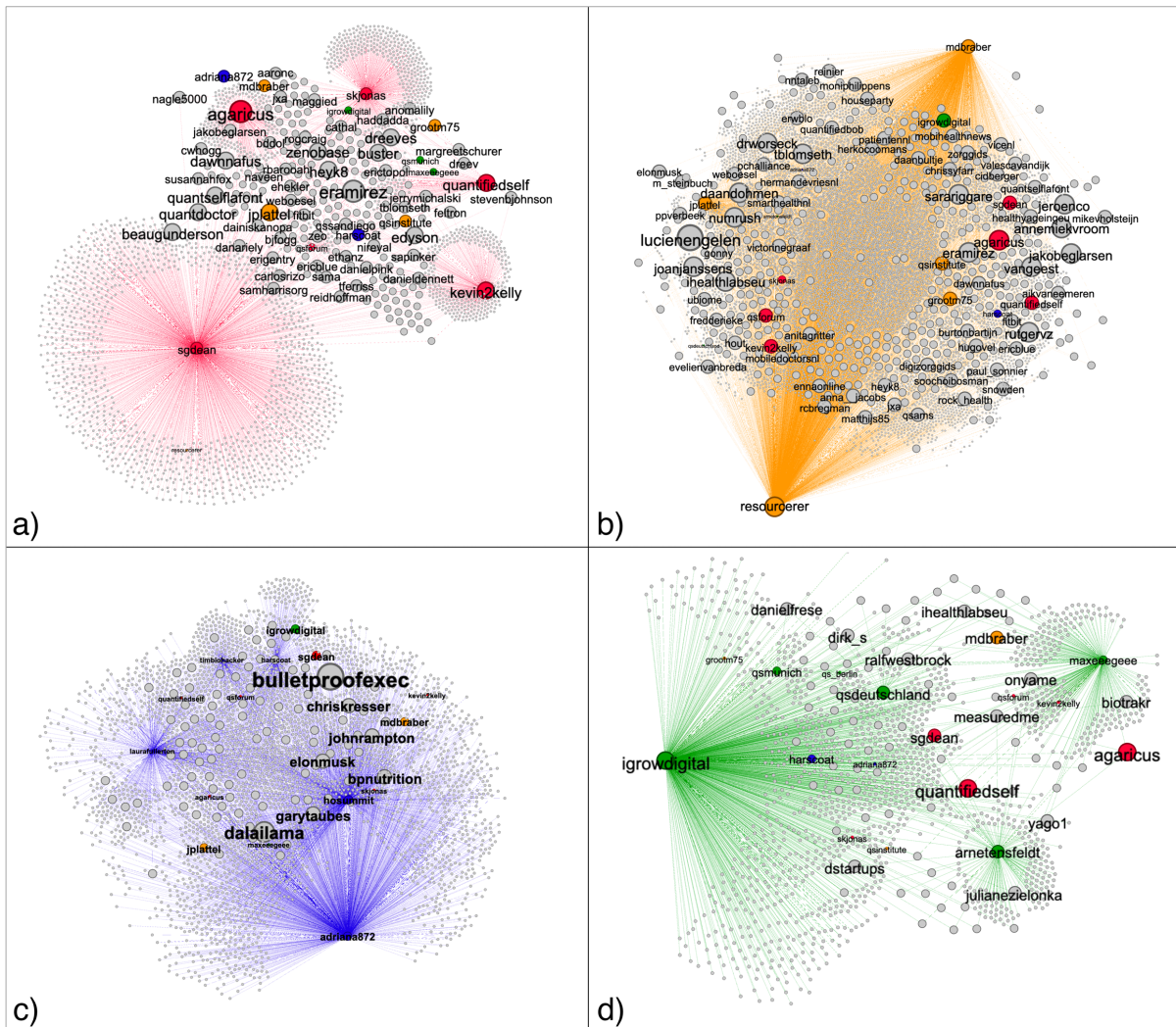
Figure 2: The national followee-networks of the QS organizational elite from the USA, the Nether-lands, the UK and Germany. a) The US network is based on 6 seed accounts, resulting in 67 la-belled nodes (in-degree of ≥ 3); b) the Dutch network is based on 5 seed accounts resulting in 81 labelled nodes (in-degree ≥3); c) the UK network is based on 5 seed accounts resulting in 22 la-belled nodes (in-degree of ≥3); d) The German network is based on 6 seed accounts resulting in 21 labelled nodes (in-degree of ≥3). The network is created via Gephi, Force Atlas 2.

The network of the organizational elite in the US (Fig. 2a) is based on 6 seed accounts – 4 personal and 2 organizational accounts – resulting in a followee-network of 67 labelled nodes with an in-degree of ≥ 3. Once more Gary Wolf's dominant position (in-degree of 5) becomes clear through this national perspective, who has even more followers (among the seed accounts) than the official QS account (in-degree of 4). Furthermore, the presence of 4 Dutch seed accounts in the US network, especially Joost Plattel's with an in-degree of 4, is particularly striking. This indicates that these accounts might serve as bridges and po-tential information brokers between the two countries. In an attenuated form this can also be said for Adriana Lukas and Denis Harscoat, both with an in-degree of 3.

The national network of the Netherlands (see Fig. 2b) is built up on 5 Dutch seed accounts and spans over 81 labelled nodes with an in-degree of ≥ 3. That means that the number of users with a higher in-degree in the network is comparatively high and that many accounts are followed by at least 3 seed accounts. Within the network Lucien Engelen, author of

the book "Augmented Health Care", represents the account with the highest in-degree of 5. The seed account with the greatest number of followers belongs to Martijn Aslander (@resourcerer, QS Amsterdam) with an in-degree of 4. The impact of the US seed accounts– especially through Gary Wolf with an in-degree of 4 – can also be seen in the Dutch network. Besides the accounts, which already appeared in the transnational network, 2 entrepreneurs from the Netherlands, Rutger van Zuidam (@rutgervz, founder of odysseyhack) and Daan Dohmen (@daandohmen, founder of FocusCura), are of relative importance in this national network. The presence of researchers in this network is also particularly strong (@sarariggare, @jakobeglarsen, @tblomseth, @drworseck and @Anne-MiekVroom). This might be explained by the fact that the first (now closed) QS Institute for research on QS was located in the Netherlands.

The UK network (see Fig. 2c) is different in some ways. It comprises only 22 labelled nodes, based on 5 seed accounts. So, in contrast to the networks described above, we see a relatively small number of accounts followed by more than 3 seed accounts. Instead, the network is structured around a few accounts with large overlaps, most notably from the already mentioned David Asprey, founder of Bulletproof, a company selling nutrition supplements, as well as the account of the current Dalailama (@dalailama). Slightly less prominent are the organizational account of Bulletproof (@bpnutrition) itself, as well as the personal accounts of Chris Kresser (@chriskresser), a health blogger and Paleo diet enthusiast, John Ramption (@johnramption) founder of naturebox, a health-focused foodbox and Gary Taubes (@garytaubes), author of "The Case Against Sugar" – all with an in-degree of three. This suggests that the UK network tends to have a thematic focus on topics around nutrition, well-being and biohacking rather than self-tracking. By contrast, the classic QS accounts play a rather subordinate role within this network. Accordingly, the connections to foreign QS seed accounts are also weak.

The German network (see Fig. 2d) is based on 6 seed accounts and includes 21 labelled nodes, with an in-degree of ≥ 3 and is, therefore, also quite small. Within the network the German seed account of Florian Schumacher stands out (in-degree of 4), who has led all QS meetup activities in Germany in the past years. Parallel to the national networks of the Netherlands, the accounts of Gary Wolf (in-degree of 4) and QS (in-degree of 4) prominently appear. This allows us to assume that the German QS accounts are also co-oriented toward the American QS Twitter community. Maarten den Braber seems to be another broker connecting the German and Dutch communities. The network also reveals other key actors in the German context. These are mostly German-based accounts from (tech) business-related actors such as Daniel Frese (@Danielfrese, entrepreneur), Dirk Spannau (@dirk_s, founder of TwentyZen), Ralf Westbrock (@RalfWestbrock, consultant and coach for innovation), Andreas Schreiber (@onyame, former QS cologne meetup organizer, co-founder of Medando) and, in a rare exception, a female entrepreneur and speaker on digital transformation and health, Juliane Zielonka (@JulianeZielonka) – all have an in-degree of 3. Consequently, what we can see is again a connection of the organizational elite to the startup and entrepreneur scene, represented here by mostly middle-aged German business men.

Ultimately, the comparison of national contexts does well to demonstrate that the QS organizational elite is also mainly connected to individual 'opinion leaders' with different thematic foci, but still maintains a strong connection to founders or researchers. The national UK network distinguishes itself through a slightly shifted focus to nutrition and biohacking, but is still represented by individual accounts.

5   Maker: A network of heterogeneous organizations

The Twitter networks of the QS movement described so far clearly contrasts with that of the Maker movement. To put it more emphatically, the latter can be described as a network of 'heterogeneous organizations'. In defining them as such, we mean to say that while individual opinion leaders also appear in this network, it is dominated by various kinds of organizational accounts.

The transnational network

The 19 seed accounts of the organizational elite are divided into 11 personal accounts and 8 organizational accounts and are, therefore, quite balanced. However, within the transnational followee-network of 218 labelled accounts (in-degree of ≥ 5), we uncovered a variety of organizational account types next to our seed accounts which were mainly related to Maker Media. These additional organizational accounts belong mainly to technology companies, community platforms or journalistic outlets. Moreover, with almost the same number of entry points, the resulting followee-network is more than twice as large as the transnational QS followee-network. Consequently, we see a much greater overlap of the seed account in regards to their followees.
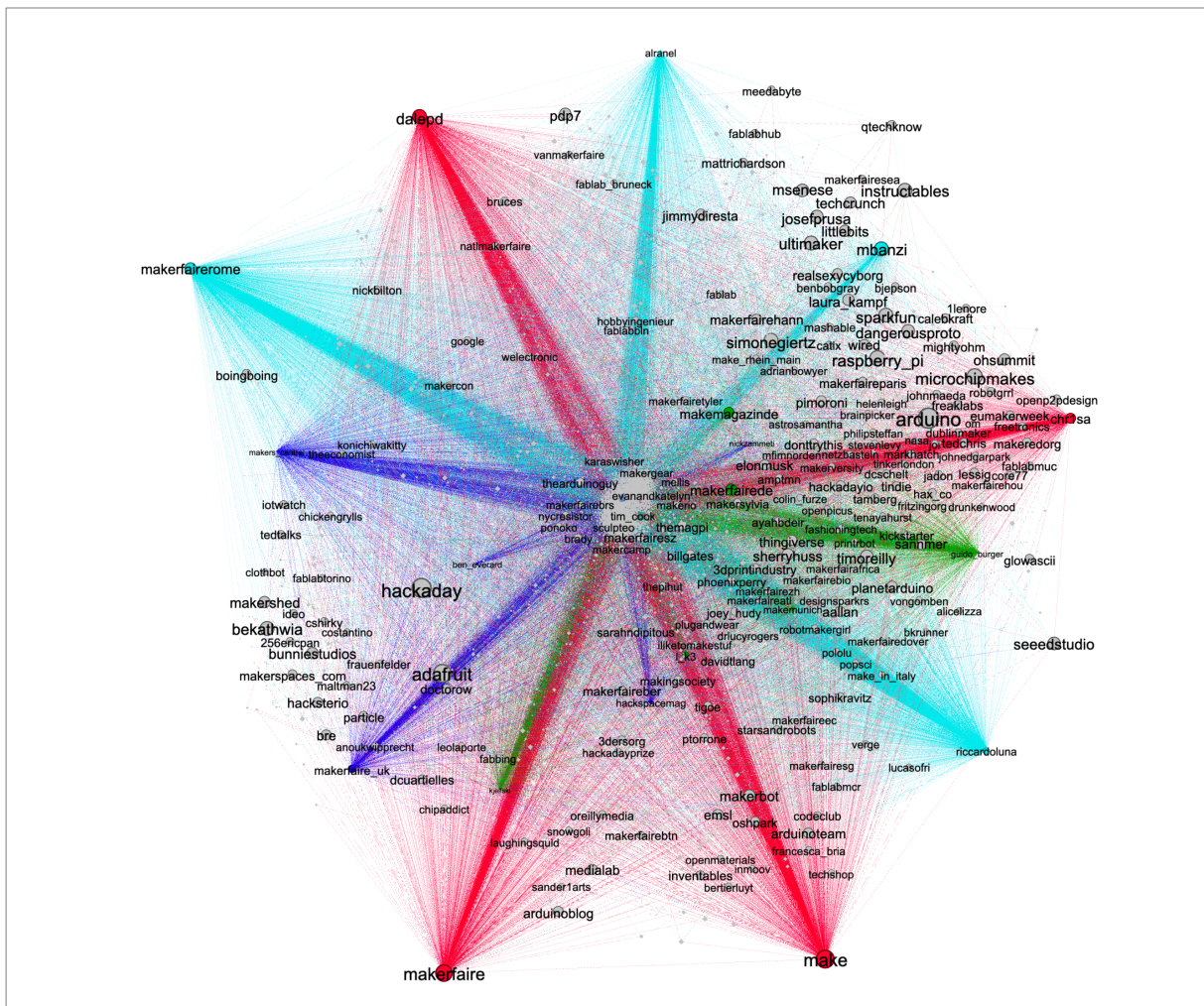

Figure 3: The transnational followee-network of the Maker organizational elite is based on 19 seed accounts and 218 labelled nodes filtered through an in-degree of ≥ 5. Created via Gephi, Force Atlas 2. Legend for seed accounts: red – USA; blue – Italy; purple – the UK; green – Germany.

Looking at the transnational Maker network more in detail it becomes clear that the US-based seed accounts are again the most prominent seed accounts in the transnational network: the seed accounts with the highest in-degree belong to *Make:* Magazine (in-degree of 14), Maker Faire (in-degree of 13) and Dale Dougherty (in-degree of 11). The Italian founder of the micro-controller Arduino, Massimo Banzi (@mbanzi), is another seed account which reaches an in-degree of 11. The most prominent seed accounts for the UK and Germany show thematic similarity within this network. For the UK these are accounts for the UK Maker Faire (@makerfaire_uk) and Hackspace Magazine (@hackspacemag). Similarly, for Germany it is the accounts for the German Maker Faire (makerfairede) and the German edition of *Make:* Magazine (@makemagazinde) that represent the most prominent seed accounts.

The highest in-degree, however, is not held by a seed account, but Arduino's organizational account (@arduino, in-degree of 16), followed by Hackaday (@hackaday, in-degree of 15), a community platform, which have the most overlapping followers among the seed accounts.

In strong contrast to the transnational QS network, in this Maker network the 10 accounts which are most followed by the seed accounts are organizational accounts, and thus seem to be of higher importance for the Maker than QS debate on Twitter. Besides to the organizational accounts related to Maker Media (18 accounts of Maker Faires), the organizational accounts can be clustered into thematic groups around technology companies manufacturing, for example, microcontrollers such as @arduino, @raspberry_pi, 3D-printers (@Ultimakers) or other soft- and hardware (e.g. @adafruit, @microship_makes, @sparkfun), community platforms such as Hackaday, Thingiverse (@thingiverse) or Instructables (@instructables), journalistic outlets (e.g. @Techcrunch, @oreillymedia, @wired) and regular maker festivals and projects (e.g. @littlebits, @dangerousprototype, @makershed) as well as a few local spaces (e.g. @fablabbln, @fablabmcr, @gablab_bruneck).

Among the few personal accounts which exist within this network, another thematic group can be identified around popular Youtubers and influencers such as, Simone Giertz (@SimoneGiertz, in-degree of 11), Becky Stern (@bekathwia, in-degree of 11), Laura Kampf (@laura_kampf, in-degree of 9), Jimmy Diresta (@JimmyDiResta, in-degree of 8), Naomi Wu (@RealSexyCyborg, in-degree 8) and Colin Furze (colin_furze). Connections to entrepreneurs can only be seen sporadically in this network (@elonmusk, @josefprusa).

Altogether, the transnational followee-network of the Maker's organizational elite appears as a heterogenous structure, with several thematic groups within the pool of organizational accounts and just a few influential personal accounts. Interestingly, Elon Musk's account is the only labelled account, which appears in both the transnational Maker network and the QS network.

The national context

Once again, we look at each country separately. We observe that the national networks are also mostly dominated by organizational accounts.
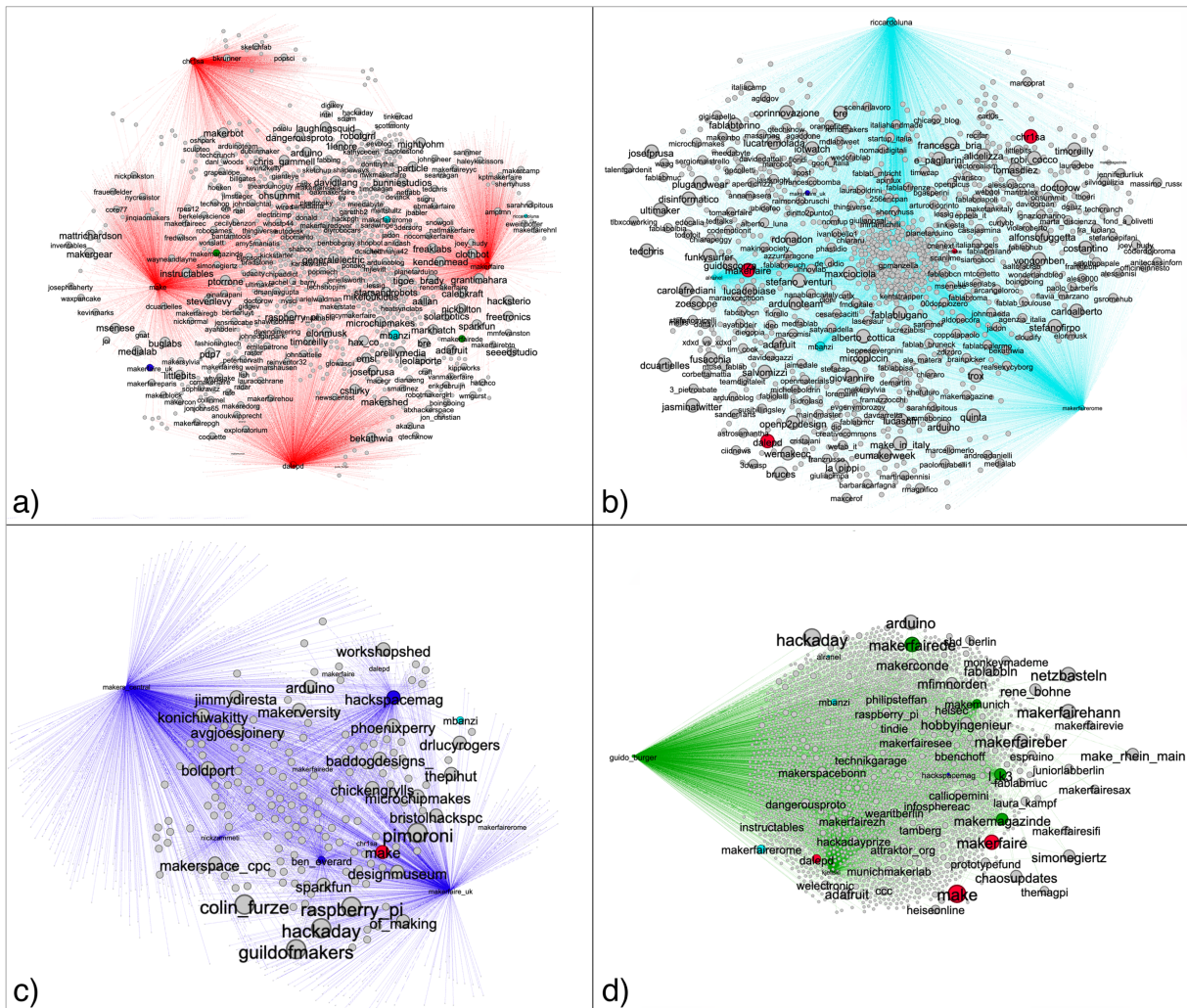
Figure 4: The national followee-networks of the Maker organizational elite from the USA, Italy, the UK and Germany. a) The US network is based on 4 seed accounts, resulting in 259 labelled nodes (in-degree of ≥3); b) the Italian network is based on 4 seed accounts resulting in 270 labelled nodes (in-degree of ≥3); c) The UK network is based on 5 seed ac-counts resulting in 35 labelled nodes (in-degree of ≥3); d) The German network is based on 6 seed accounts resulting in 59 labelled nodes (in-degree ≥3). The network is created via Gephi, Force Atlas 2.

The US network (Fig. 4a) is the second largest network in our sample in terms of labelled accounts. It stretches from our 4 seed accounts over 259 labelled nodes with an in-degree of ≥ 3. All 4 seed accounts from the US have the same in-degree of 3 and are, thus, follow one another. Interestingly, Massimo Banzi's account has an in-degree of 4 within the American network, which means that all seed accounts follow him. This indicates that he might be an influential information broker for the American context on Twitter. The accounts from the UK and Germany have nearly no visibility within the US-network. Congru-ent with the transnational network, there are more organizational account types than per-sonal account types. Taking all accounts with an in-degree of 4 together, we find 30 or-ganizational accounts which can be grouped to more or less the same thematic groups as in the previous network.

The network of the organizational elite of the Italian Maker movement (Fig. 4b) is the largest network in our sample. It spans from four seed accounts over 270 labelled nodes with an in-degree of ≥ 3. The users with the highest in-degree are the American seed accounts of Chris Anderson (@chr1sa, CEO of 3Drobotis, journalist and author), Dale Dougherty and the organizational account of the Maker Faire. On this basis, the Italian network also seems to be oriented toward the Maker movement's US origins. Massimo Banzi, as well as Riccardo Luna (@riccardoluna), former *Wired* author and curator of the Maker Faire Rome, share an in-degree of 3, whereas the other seed accounts are almost invisible within the network. Nonetheless, we see various "new" accounts. In contrast to the two previous networks the Italian network is dominated by personal account types. Only six organizational accounts with an in-degree of four can be identified among the labelled accounts. In regard to the personal accounts with an in-degree of 4, 2 thematic group stand out: (mostly male) Italian authors and journalists (e.g. @lucadebiase, @lucatremolada, @alicelizza) or (mostly male) Italian entrepreneurs related to (maker-) technology (e.g. @giovannire, @Rdonadon, @Maxciociola).

The UK network (Fig. 4c) is the smallest network within our sample of the Maker movement regarding the labelled networks: Here the network of our 5 seed accounts stretches over 35 nodes with an in-degree of ≥ 3. The most followed British seed account belongs to the Hackspace Magazine, whereas the German personal seed account of Guido Burger (@guidofmakers), an influential maker and speaker, even reaches an in-degree of 4, and can be considered as bridge to the German Maker community. Another seed account with at least an in-degree of 3 is the American *Make:* magazine. Remarkable in this network is that there is no user in the network that is followed by all 5 seed accounts and just 4 accounts with an in-degree of 4: Colin Furze, a British Youtuber and-maker with nine million subscribers is the only personal account type while there are 3 organizational account types: Pimoroni (@pimoroni), a re-seller of maker hardware, particularly in relation to RaspberryPi, Hackaday and the RaspberryPi account itself. The stronger prominence of RaspberryPi compared to the Italian Arduino, can be explained through RaspberryPi's origins in Cambridge. Among the accounts with an in-degree of 3 there are mostly organizational accounts related to tech companies and only 3 personal accounts, 2 of them are also Youtuber-Makers (@jimmydiresta, @avgjoesjoinery).

The network of the organizational elite of the German Maker movement (Fig. 4d) spans from the 6 seed accounts over 56 labelled nodes with an in-degree of ≥ 3. The seed user Guido Burger stands out in the network as he follows more users that any of the other seed account, but he himself is only followed one other seed account (in-degree of 1). Also isolated is Kjell Otto's seed account (@kjellski) with an in-degree of 0, which seems to indicate that he is less relevant and connected within the German Twitter debate than the other seed accounts. The highest in-degree among the German seed accounts is held by the Maker Faire Germany, but *Make:* Magazine US (in-degree of 6) reaches the highest value among all seed accounts, followed by Maker Faire US. This suggests that the German maker scene also orientates itself toward the origins of the Maker movement in the US.

If we look at the followees, Hackaday shows the highest overlap of all 6 seed accounts. An overlap of five accounts can be achieved by the organizational accounts of the biggest maker events and projects in Germany: Maker Faire Berlin (@makerfaireber) and Maker Faire Hannover (makerfairehann), as well as Netzbasteln (@netzbasteln), a German DIY-radio show and, once again, the Arduino account. From this it can be concluded that organizational accounts predominate here as well. Furthermore, the accounts with an in-degree of 3 confirm this: This includes other German maker events (e.g. @mfimnorden, makerconde,), a makerspace (@fablabbln), the Chaos Computer Club's account (@chaosupdates) and Adafruit, in contrast to only three personal accounts belonging to makers (@hobbyingenier, @rene_bohne, simonegiertz).

In summary, we gain a deeper insight into the Twitter network of the Maker movement if we consider it as being made up of mostly heterogeneous organizations. However, those accounts bridging the national contexts are accounts belong either to Maker Media or to individuals and organizations that cooperate closely with them. We argue, therefore, that accounts related to Maker Media comprise an organizational core in the pioneer community and its representation on Twitter. However, around this core, further accounts are grouped together such as technologies, projects and local spaces, which are seen in national contexts as well as in the transnational networks.

6 Conclusion

The transnational followee-networks of the organizational elite and their national contexts on Twitter show similarities yet, the composition of the networks of both movements is fundamentally different. With reference to our research questions, we can summarize that the transnational networks of both communities differ in size, as the Maker network is more than twice the size of the QS network (218 vs. 88 labelled nodes). However, they are quite similar in that the seed accounts as well as newly identified accounts in the US dominate in both transnational networks, which speaks for an orientation by both pioneer communities toward the origins of the movement in the San Francisco Bay Area. The presence and impact of the German and UK-based accounts seem to be rather low. Specific accounts from the Netherlands for QS and Italy for the Maker movement are relatively present in the transnational Twitter networks, which indicates their potential functionality as bridges.

In regards to our second research question we can state that the QS organizational elite on Twitter is represented as a network of opinion leaders as indicated by the vast majority of personal accounts which belong, on the one hand, to QS meetup organizers, who are heavily involved in the core activities of arranging and organizing QS events and, on the other, through the connections of QS seed accounts to influential entrepreneurs and founders. The many Twitter connections to founders of tech startups found here could serve as an indication of financing and stabilization attempts by community leaders. By contrast, the organizational elite of the Maker movement is represented on Twitter as a network of heterogeneous organizations which range thematically from Maker Media related accounts to tech companies, community platforms, journalistic outlets, and specific maker events. This indicates, on the one hand, already established collaboration partners and ways to spread the Maker ideology through various channels (platforms and journalistic outlets) and underlines the importance of digital maker technologies for the movement on the other. In both Twitter communities, significantly more male accounts are visible when looking at the personal account types.

For our third research question we can summarize that the QS organizational elite's Twitter network is not only smaller in regard to the number of accounts but also less intensely overlapped compared to the Maker network. This also applies to the national contexts, as the transnational thematic groups are also reflected at national level. The national networks of the QS movement are also more individualized and seem to be more fragile in their overall institutional structure. The national Twitter networks of the Maker movement's organizational elites are larger in size, more tightly meshed, and consist of various account types (with Italy being a notable exception) in comparison to QS. Moreover, the connections to established companies reflect a potentially more solid structure of the movement even in the national contexts. In regard to national particularities, the QS community has a thematic proximity to dietary and biohacking concerns as represented by the British network. In the Maker community, the Italian network stands out for its many

personal accounts instead of the dominance of organizational accounts found in other Maker networks. In both pioneer communities it is noticeable that the German and British national networks have much less overlaps.

The results can be related to our previous media ethnography. As our research shows, both differ in the way they are curated by their respective organizational elite (Hepp, 2020b): The QS movement is based on the model of an 'unenforced trademark', that is, the legally incomplete trademark protection of the term 'quantified self' which prevents others from securing the copyright. Such a strategy allows the movement's founders to facilitate a discourse of belonging and exclusion around the movements' principal ideas. In the case of the Maker movement, curating is carried out through a 'franchise model', specifically the development of the concept and the corporate identity of *Make:* magazine or the Maker Faires by Maker Media (and since 2019, the *Make:* Community), which are both licensed in different forms. The Twitter networks of each community correspond in structure and character to these two models: The 'unenforced trademark' model relies much more on looser forms of organization and the commitment of individuals who hold the pioneer community together through conferences and meetings. In the franchise model, established organizations have a much higher priority, alongside Maker Media and its successor, the *Make:* Community, other publishing organizations, companies, and local spaces.

In both cases, however, Twitter is an important connective tool: Twitter – together with other platforms such as Instagram – allows their organizational elites to stay in touch with one another beyond single, showcase events, to refer to each other in their ongoing curatorial practices, and to stimulate and develop a shared discourse. That said, we cannot understand these pioneer communities simply as figurations that constitute themselves solely online. They become vivid through their local events, groups and practices. But platforms such as Twitter are important in that they facilitate the keeping together of these pioneer communities at a transnational level and work to stabilize a shared horizon for their collective action.

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