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From Hacking Things to Making Things. Rethinking making by supporting non-expert users in a FabLab.

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Abstract. When discussing maker culture, much attention is dedicated to how making can be beneficial for specific fields (e.g. healthcare, education) or various communities of makers (e.g. educators, crafters). The democratic ideal of personal fabrication and the maker culture movement - represented by the growth of open makerspaces (e.g. FabLabs, makerspaces) and online communities (e.g. 'Instructables', 'Thingiverse') worldwide - provides everyone with the opportunity to make (almost) anything. However, structurally engaging non-expert users still remains an important challenge for most open makerspaces. Therefore, this article focuses on the potential of open makerspaces for communities and - more specifically - how to involve non-expert users in these open makerspaces. Framed within the fields of Participatory Design and infrastructuring, this article presents two case studies - 'Hack-a-thing' and 'Making Things' - that are part of a long-term participation process of engaging local non-expert users in FabLab Genk. In these cases, the involved non-expert users entailed teenagers, children and their supervisors (for instance, supervisors involved in participating youth organisations). The case studies show that building relations with existing communities of non-expert users and creating conditions for them to self-organise their activities within open makerspaces are essential starting points for processes of long-term engagement.

Keywords: Maker culture; non-expert users; Participatory Design; infrastructuring; open makerspaces.

1 Introduction

Maker culture can be described as a movement of amateur and professional designers who use a combination of digital fabrication technologies (e.g. laser cutting, 3D printing), open hardware (e.g. RepRap, Arduino) and software (e.g. Blender) and traditional manufacturing methods (e.g. woodworking) to create often personalised objects. It is characterised by a culture of openness and skill sharing [2; 31]. Open makerspaces like FabLabs, Hackerspaces, Makerspaces and TechShops can be considered as the physical representations of this movement. These workplaces provide people with the necessary infrastructures to make things. Although accessibility is increasing through the rise of numerous open makerspaces worldwide and the group of people using the available infrastructure is growing considerably, many non-expert users are often impeded to enter the maker movement. Not only the

lack of skills and experience to design for and to use the technical infrastructure (hardware and software) is an important barrier for these users, but also the enormous variety of different technologies and tools in open makerspaces makes it difficult for them to experiment with. For example, each type of 3D printer has its own properties (size and height of the printable object, layer thickness, etc.), uses a specific technology (FDM technology, polyjet technology, etc.) and type of material (photopolymers, thermoplastics, etc.) influencing the size, sustainability and finishing of the printed object [27; 33]. Furthermore, most digital fabrication and software design tools are not appropriated for this new audience of non-expert users (e.g. interfaces designed for an expert user) and require a lot of knowledge as well as investment in time and energy in learning to use them [3; 9; 36].

Contrary to most recent literature on maker culture, this article does not focus on the practices and outcomes of specific maker communities within certain fields (e.g. healthcare, education) [e.g. 6; 8], the motivations of makers to participate in these maker activities [e.g. 29; 31], technological innovations for maker practices or the economical implications of these practices [e.g. 38]. As it is an underexplored topic in scholarship on making culture, this article focuses on the potential of open makerspaces for communities and - more specifically - how to involve non-expert users in these open makerspaces (and by extent the broader maker movement). In this case, these non-expert users entailed teenagers, children and their supervisors (e.g. involved in the participating youth organisation). As stated by Taylor et al [44] open makerspaces can operate as meeting places that adapt and outreach their activities and facilities to the needs and interests of local communities (e.g. by teaching teenagers specific skills in woodworking that are useful when looking for a job).

By describing two case studies, 'Hack-a-Thing and 'Making Things', taking place within the context of FabLab Genk this article emphasizes the importance of building relationships in stimulating long-term participation processes for engaging non-expert users in a FabLab [5]. Within the Participatory Design (PD) tradition, much attention is given to these ongoing and open processes of *infrastructuring,* characterized by building long-term working relationships with diverse actors over time [20]. This article describes early findings from ongoing research that aims to combine the emerging interest in the broader societal role of open makerspaces for non-expert users with the PD strategy of infrastructuring to set up a long-term participation process with non-expert users within FabLab Genk. In doing so, it particularly focuses on the participation of teenagers and children - of 6 - 20 years old - and their accompanying supervisors.

2 FabLab: focus on technical infrastructures

Although open makerspaces take on different forms (e.g. Hackerspaces, Makerspaces, TechShops, FabLabs), they can all be considered as open community spaces that offer public, shared access to high-end manufacturing equipment (e.g. 3D-printers, laser cutters). This article will focus on ongoing research within a specific FabLab, namely FabLab Genk.

FabLabs (Fabrication or Fabulous Laboratories) are globally dispersed open workplaces that aim to explore the implications and applications of personal fabrication. The notion of personal fabrication refers to the idea that we can design and make (almost) anything ourselves [24; 38] and is made possible because of recent advances in 'Open Source' electronics and CNC (Computer Numerical Control) technologies such as 3D printing [1; 36; 24; 38]. According to founding father Gershenfeld [24, p.12], a FabLab is "*a collection of commercially available machines and parts linked by software and processes we developed for making things*". Access to the lab and its manufacturing equipment is free – including training to get acquainted with the hard- and software – provided that the FabLab user shares his/her designs (via the internet, through so-called Fabmoments). Documentation and digitally sharing designs places FabLabs in the context of open source: a philosophy, but also a pragmatic method of creation, via which organisations or individuals provide free access to source materials of a thing to a distributed network of people [4].

Inspired by Gershenfeld's initiative, FabLab Genk (www.fablabgenk.be) was set up in 2012 as part of a European project (Interreg IV). In the early days of FabLab Genk, the focus was – like most FabLabs – mainly on the lab as a technical infrastructure offering its visitors (primarily students of local art and design schools) access to the machinery, tools and skills. Over the years, this strategy raised questions regarding (economical) sustainability and how to open up the Lab towards participation of a broader audience (including non-expert users). A survey on FabLabs also concluded that most of "*the labs were primarily offering infrastructures to students, and they were relatively passive in reaching out to other potential users. They had so far created a limited innovation ecosystem, which got used rather rarely*" [46, p. 9]. As a way to overcome these issues of sustainability and participation, an on-going process has been set up in FabLab Genk in which several activities (workshops, exhibitions, demonstrations, information sessions, etc.) are initiated to actively involve non-expert users – and more specifically those from the surrounding neighbourhoods in the city of Genk – in FabLab Genk In this way the emphasis on the FabLab as a technical infrastructure was extended to the FabLab as a community space that offers public, shared access to high-end manufacturing equipment. The Lab more and more became a flexible infrastructure that supports and collaborates with local actors in their (making) activities and changes in function of the communities' needs and wishes. In doing so, FabLab Genk tries to overcome a well-known shortcoming of the traditional FabLab concept, being unable to set up sustainable relationships with local actors [48] and attempts to nurture long-term participation from other and new groups than the traditional makers (i.e. non-expert users like children and teenagers from the surrounding neighbourhoods).

3 Participatory Design (PD) & infrastructuring

The above-mentioned shift from a technical infrastructure to setting up long-term relationships with local actors can be framed within the tradition of Participatory

Design (PD) [19; 25] and more specifically within the approach of *infrastructuring*[1]. In the 1970s, Participatory Design (PD) researchers introduced participatory processes in workspaces as democratic processes to include workers in the design and use of workplace computer applications. In these workspaces, PD researchers organised co-design workshops wherein workers, managers and designers could negotiate about how, for instance, machines entered the workspace, using cardboard mock-ups. Although the democratic goals of PD have not changed, changing work models have altered PD's approaches to work. While in traditional PD co-design is perceived as a 'staged' process, today many PD-researchers (see e.g. [5]) are paying more attention to 'infrastructuring processes' that allow co-design - like work processes in general - to become more interwoven with daily life. This enables engagement in long-term participation processes, extending flexibly throughout time and space. In this sense, infrastructuring is a specific strategy to support (long-term) participation and involve users in the design of systems or objects. It is a process that focuses on long-term commitment and can be described as "*an open-ended design structure without predefined goals or fixed timelines*" [26, p.180]. According to Björgvinsson, Ehn & Hillgren [5], infrastructuring addresses the challenge of design as being 'ongoing' and a process of 'anticipation'. Contrary to most PD projects, in infrastructuring processes the focus is on the setting or surroundings in which the artefacts have a place, instead of on the particular artefact itself [42]. In these processes, the designer's focus is shifted to continuously setting up, enabling and fostering relationships with diverse actors, while flexibly allocating resources [5; 30].

The importance of relationships, being inherently part of infrastructuring, is also stressed by Le Dantec and DiSalvo [32]. These authors focus on capacity building and the forming of attachments as two main elements for infrastructuring processes. The first refers to designers developing means to support participants' skills for building communities. The latter involves the social and material dependencies and commitments of participants, being the specific ways to involve participants or keep them engaged. Related to this, Dindler and Iversen [14] also foreground the notion of relational expertise as a core competence of PD practitioners for developing and maintaining relationships with others people through symbiotic agreements (i.e. sustainable connections that are valuable for both parties). To further explain these agreements, Dindler and Iversen [14] refer to Engeström [21] and Stengers [43] to explain how symbiotic agreements do not necessarily strive towards consensus. Instead, symbiosis is understood as a state "*in which every protagonist is interested in the success of the other for its own reasons*" [14, p. 46]. Through collaborative constellations that emerge among heterogeneous participants, with multiple perspectives and agendas and where, rather than a stable center of control, agency is dispersed. According to Dindler and Iversen [14], symbiotic constellations between people allow to appreciate how participants with different agendas maintain working relationships as they are all interested in the success of the process albeit for different reasons.

[1] *Whilst we acknowledge that infrastructuring is not the only adoptable approach to or perspective on (complex, long-term and ongoing) participatory processes, we found this to be the most appropriate for reflecting upon the ways of working of FabLab G.*

Linked to this concept of relational expertise for building relationships is the backstage work (e.g. preparation or building relationships of actors) for setting up these relationships that is considered equally important as the front stage activities (e.g. workshops, co-design sessions) in design processes. Another important aspect that is central to infrastructuring processes involves the creation of conditions for self-organisation to develop or - when already existing - to sustain. Self-organisation is a term used by Luhmann [34] in the context of social theory to refer to self-producing communications (i.e. communication produces further communications) by elements of a social system. In urban development Boonstra and Boelens [7, p. 100] define self-organisation as *"initiatives for spatial interventions that originate in civil society itself, via autonomous community-based networks of citizens, outside government control"*. This definition of self-organisation starts from a rather inwards perspective where the organisation of people serves an internal group of people. But even if these organisational forms have inwards mechanics, they are always dependent on both internal factors (e.g. human capacity, leadership, creativity, etc.) as well external factors (e.g. the government, public opinion, economy, etc) and thus never develop in complete isolation. Taking this into account, Horelli et al [28] redefine self-organization as being part of the more extravert practice of participation, complementing and standing up to formal top-down or staged participatory processes.

Although the literature on infrastructuring is extensive and applied in different subfields of PD (e.g. IT systems for work organisation and societal information infrastructures [30]), this article focuses on infrastructuring within community-based PD [41]. In these complex participatory processes, community building is considered as an important element in which the designer supports collaboration of actors around (the articulation of) a certain issue [13; 15]. Herein, the approach of infrastructuring is seen as a way to form communities and set up, maintain and nurture relationships with non-expert users within the context of FabLab Genk.

4 Case studies: 'Hack-a-Thing' and 'Making Things'

To deepen our theoretical reflections, we describe and compare two specific case studies - being 'Hack-a-thing' and 'Making Things' - that are both part of the infrastructuring process of engaging non-expert users in FabLab Genk. As the description of both case studies will show, 'Hack-a-Thing' provided us with important insights related to involving teenagers, which were later on used to set up the currently ongoing case study of 'Making Things' involving mainly children (of 6 - 10 years old). We will now elucidate the methodology of the case studies and the insights that were gained throughout 'Hack-a-Thing' (4.2) and 'Making Things' (4.3).

4.1 Methodology

For 'Hack-a-Thing' - a workshop series organised over two weekends - 24 teenagers between 16 and 20 years old registered, of which 4 dropped out after the first

weekend. The participants were supported and guided by 5 moderators (with a background in Interaction Design, Product Design or engineering). The teenagers (particularly with an interest in making, programming, hacking and designing) were recruited via an open call for participation: flyers and posters were distributed in different local schools and youth centres, a Facebook event page was setup and e-mails were sent to local youth organisations (e.g. youth movements, the municipal department of youth, youth work services) [17]. During the course of the 'Hack-a-Thing' workshops, two design researchers observed [12] the different activities of the participants and gathered data through using field notes, video recordings and asking questions about the participant's actions and decisions (unstructured interviews). One month after 'Hack-a-Thing', 20 semi-structured interviews (duration of approximately 30 minutes) and a participatory mapping were carried out among the participants (including the ones that dropped out), about their experiences and reflections on the 'Hack-a-Thing' workshops as well as their general ideas on the activities and working of FabLab Genk.

In 'Making Things', 60 local children from Moroccan and Turkish descent and 8 supervisors of youth organisation 'Gigos' are involved in the process. On six occasions, we observed [12] over 60 children (boys and girls) of 6 - 10 years old as they engaged in diverse activities organised by the youth organisation (e.g. partaking in games, free playing or crafting) or by FabLab Genk. (e.g. 'making' workshops). The field notes and audiovisual material of these observations provided us with insights in the lifeworlds and interests of the children. Based on the output of the observations, 20 children received a sensitizing package containing assignments in order to express their personal experiences and ideas related to 'making' workshops. Through drawing, writing or crafting, the children were 'warmed up' for the topic [47]. In total, 20 children completed the first assignment; the second one was completed by 18 children. Afterwards, two informal making sessions were organised which setups were directly inspired by the findings from the observations and sensitizing packages (thus, fitting the children's interests). First, 10 teenage girls (10 - 16 years old) of 'Gigos' were introduced to the FabLab and its ways of working through making and customizing wooden necklaces, jewelry stands and graffiti templates that were (partly) prepared in FabLab Genk for them to use during the workshop. Second, 33 children (boys and girls, 6 - 10 years old) participated in a more low-tech workshop in which they made and customized paper ornaments, dolls and necklaces that were also (partly) prepared beforehand in FabLab Genk. Additionally, informal brainstorms with the children and semi-structured interviews with the supervisors of Gigos were carried during which they discussed their experiences and expectations of the past and future workshops.

The research presented in this paper derives from an ongoing study conducted by two design researchers and is based on insights from observations, sensitizing packages, semi-structured and unstructured interviews as well as mappings with participants, moderators and supervisors of both 'Hack-a-Thing' and 'Making Things'. The two case studies were documented and the gathered data - such as the sensitizing packages, videos, images, field notes, interviews and mappings - was analysed at regular moments in time. The two main participating design researchers independently conducted qualitative analyses of the process documentation (logged field notes and audiovisual material of the observations, transcribed interviews and

mappings) and continuously carried out an open coding of the different data to look for patterns. These analyses were brought together on a regular basis to conduct a more selective coding of the different interpretations of the workshops. The following categories were identified based on the (clustering of the) codes:

(1) *actors*, including participants, moderators, organisers, etc. and their expertise (in making), goals, level of involvement, etc.
(2) *activities*, such as the front stage and backstage activities that took place during, before and/or after the workshops.
(3) *objects*, being the artefacts - and other results - that emerged from the workshops including their importance for the actors, their openness for debate and change, their delicateness, etc.
(4) *time*, entailing the duration of the workshops, whether they were recurring or not, etc.

These four categories offered important handlebars to investigate the involvement of the non-expert users in the two case studies of 'Hack-a-Thing' and 'Making Things'.

The two case studies can be framed in a PD approach. First, through 'Hack-a-Thing', we aimed for empowering local youth in the city of Genk (in which FabLab Genk is located). Today, the city especially knows many unemployment among low-educated (mostly, technically schooled) youth. In this context, the 'Hack-a-Thing' workshops explored how introducing local youth to Fablab Genk could allow them to imagine new relationships between themselves and their surrounding objects, triggered by informally teaching them new, particular skills (e.g. in hacking old appliances or used objects such as a printer, toaster, etc.). Through involving the teenagers in a PD process of hacking and designing old appliances together, we hoped their opportunities in searching jobs and further developing their abilities would increase. In this way, the 'Hack-a-Thing' workshops actively tried to create opportunities for the teenagers to feel empowered, cf. more genuine forms of participation. In the case of 'Making Things', rather than defining the variables of the workshop beforehand (e.g. the content, format and methods of the workshops are selected and designed by adult researchers beforehand), ways to design the workshops in a participatory manner are explored. This means that, via e.g. co-design methods, the children are asked to *design* the workshops themselves before effectively *participatin*g in them. In this way, 'Making Things' attempts to create opportunities for children to have a greater share in defining PD processes instead of merely participating in them.

4.2 'Hack-a-Thing'

In the summer of 2012, FabLab Genk organised 'Hack-a-Thing': a series of workshops aimed at introducing and involving local youth (16-20 years old) in the activities of the FabLab (Fig. 1). This was done by informally teaching them particular skills through the creation of new, creative objects from parts of old appliances (e.g. printers, toasters), by enhancing them and finding new ways to

operate and program them [16; 18]. The workshops resulted in several interesting outcomes, such as a coffee grinder (made from old hair dryers, a vacuum cleaner and popcorn machine) and the 'Persistence of Vision Robot' (Fig. 2). The latter entailed a moving robot that could write messages in light when photographed using the long-exposure of a photo camera. During the workshops, taking place in FabLab Genk, the teenagers were introduced to programming with Arduino (www.arduino.cc/) and experimented with the available machines (e.g. laser cutter, 3D printer, etc.), while departing from their own existing skills. For instance, interviews later showed that the participants who were involved in hacking a vacuum-cleaning robot into the 'Persistence of Vision Robot' all had some notions of programming software, making the step to include Arduino in their project rather easy [17].

Fig. 1. Youngsters participating in the 'Hack-a-Thing' workshops

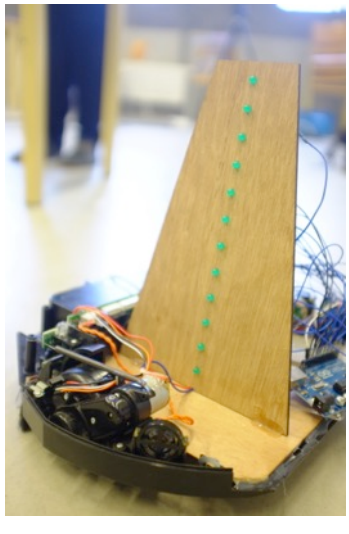

Fig. 2. The 'Persistence of Vision Robot', created during the 'Hack-a-Thing'

Concerning the *actors*, it became clear that although the intention of the 'Hack-a-Thing' workshops was to take first steps in building relationships with local actors, the focus was almost entirely on the front stage design activities (the workshops) and the involved artefacts (old appliances and the newly created objects). Little effort was invested in the backstage work (before and after the workshops) and developing meaningful relationships with the local youth. Furthermore, the format of these workshops was set up by the team of FabLab Genk and did not originate from the everyday practices of the participating local teenagers. Although the workshops were considered to be successful by the organising team and the participants, since it generated several interesting objects, it failed to function as an important stimulant for the development of long-term relationships with local youth. Four of the participants dropped out of the workshops, only three participants returned regularly to the FabLab for making activities and - afterwards - members of local youth organisations brought forward that the content of the workshops was not sufficiently linked to the interests and practices of local youth. After the workshops, interviews with local organisations and teenagers who did not participate (anymore) were carried out, pinpointing several reasons for not participating - or dropping out - in 'Hack-a-Thing'. For instance, the FabLab was unknown territory for most of the youth, entailing a big threshold for them to participate in the workshops, the 'Hack-a-Thing' workshops appeared to be too tech-savy and the theme of hacking did not directly relate to their own interests.

On the level of *activities*, the 'Hack-a-Thing' workshops made clear that the act of hacking felt uncomfortable to some of the participants who were more used to making things from scratch or who were not acquainted with programming or digital fabrication. The interviews also indicated that the emphasis on the technical infrastructure of the FabLab (i.e. machines and software) in the 'Hack-a-Thing' workshops appeared to be an important threshold for many participants who were not familiar with the available technologies. Furthermore, the 'Hack-a-Thing' workshops were not integrated in already existing activities of local organisations, making it more difficult to attract participants and create long-term attachments to (the workings of) the FabLab.

Regarding the *objects*, 'Hack-a-Thing' intentionally kept the hacking of surrounding objects or appliances as open as possible (e.g. the FabLab team provided assistance in the hacking activities but let the participants define the activities themselves). However, the objects that were brought by the participants already defined the outcome of the workshops to some extent. For example, the group that worked on the 'Persistence of Vision robot' started with a vague idea of moving robots and therefore immediately recognized the potential of the vacuum-cleaning robot. Interviews with the participants also showed that their contribution of bringing objects was perceived as highly valuable in giving people a feeling of control over the uncertain activity they were engaging in. Besides the objects of the workshops, also the technical infrastructure of the FabLab, the input from the moderators and the introduction course (to Arduino and using the FabLab infrastructure) greatly determined the results of the workshops.

On the level of *time*, 'Hack-a-Thing' showed that a longer process was needed in order for meaningful relationships to be formed. As the workshops took place on two days spread over two months, they failed to function as an important stimulant for the

development of *long-term* relationships between the FabLab and local youth. Some teenagers dropped out of the workshops and although new relationships were formed through participating in the workshops, they did not appear to be sufficient for enabling long-term participation in the lab. The participatory mapping showed that the short time span of 'Hack-a-Thing' did not convince the participants of the possibilities or opportunities of (the activities of) FabLab Genk for their own practices. Moreover, the interviews showed that the local youth organisations were not convinced as well about the integration of FabLab Genk's ways of working into their own activities. Therefore, no further attempts in self-organizing were made following 'Hack-a-Thing'.

4.3 'Making Things'

'Making Things' is a long-term PD process in which a collaboration with local youth work organisation 'Gigos' is set up to design workshops together with children of 6 – 16 years old and youth workers. 'Making Things' answers to the need of 'Gigos' to offer accessible STEM (Science, Technology, Engineering and Mathematics) workshops to children during leisure time. As research [39] shows that activities reflecting the daily lives of the children motivate them more to bring new ideas to the table, the youth organisation wanted to enthuse the children through better fitting their personal interests. Therefore, as mentioned, 'Making Things' explores ways to design the workshops in a participatory manner.
In doing so, 'Making Things' is part of a strategy to actively involve non-expert users – and more specifically teenagers from the surrounding neighbourhoods – in FabLab Genk striving for long-term participation. Learning from the previous experiences (i.e. 'Hack-a-Thing'), 'Making Things' builds further on the idea of setting up workshops that fit and even originate from the personal interests of the participating children and teenagers (Fig. 3 & 4). As the actual workshops and making sessions are preceded by a PD process of participant observations and sensitizing packages, the FabLab team wants to design the final workshop collaboratively with the children and youngsters, in a way that better suits their needs and wishes.

In contrast to 'Hack-a-Thing' - that worked with an open call for participation - 'Making Things' focused on a pre-defined community or group of *actors*: the children and the youth workers of the youth organisation. Moreover, before the 'Making Things' process was set up, an informal relationship between some youth workers and members of the FabLab team already existed. Building further on this existing relationship, 'Making Things' can be seen as a symbiotic agreement between both parties: for FabLab Genk, it implies intensifying the relationship with the local youth and 'Gigos' by engaging them in its activities and for the youth organisation it means creating specific STEM workshops for their target group. Also the workshops themselves (i.e. the front stage activities) are embedded in a long-term process of backstage activities (such as partaking in events organised by 'Gigos' and informal meetings). These backstage activities allowed the members of the FabLab team to already build meaningful relationships with the children and youth workers involved (departing from existing ones), before the workshops and making sessions effectively took place.

Fig. 3. Teenaged girls participating in a ‘Making Things’ making session

Fig. 4. Several 6 - 10 year olds participating in a ‘Making Things’ making session

On the level of *activitie*s, in ‘Making Things’ more emphasis is put on gradually getting the participants acquainted with the possibilities and machines of FabLab Genk, its ways of working and (the topics of) the workshops that will be organised. Informal brainstorms with both the children and youth workers involved showed that this approach is more likely to take away some of the uncertainty and discomfort that the participants of ‘Hack-a-Thing’ experienced with the making activities in the FabLab. Furthermore, the activities carried out in ‘Making Things’ are all embedded in the daily operations of youth organisation ‘Gigos’, making these activities

accessible for all children (and youth workers) and corresponding to their life worlds. This approach of 'Making Things' differed greatly from 'Hack-a-Thing', in which the technical infrastructure and possibilities of the FabLab and not the interests of the participants formed the starting point. Furthermore, the 'Hack-a-Thing' workshops were not integrated in already existing activities of local organisations, making it more difficult to attract participants and create long-term attachments to (the workings of) the FabLab. Moreover, the FabLab team will look into how the workshops can be translated into open, adaptable and workable formats for the youth organisation (for them to carry out the workshops alone without the assistance of the FabLab team). In this way, through self-organisation in the future, 'Making Things' aims to form attachments to FabLab Genk that can change, depending on the needs and interests of the youth organisation.

Concerning *objects,* as 'Making Things' is only in the preparative phase (meaning that (most of) the actual workshops and making sessions have yet to take place), there is no clear view on the final artefacts yet. However, the preparative making sessions did show that the extent of openness that was integrated into 'Hack-a-Thing' could not be achieved in 'Making Things'. Particularly the 6 - 10 year old participants relied heavily on the input of the moderators both before as well as during their making activities. For instance, while making a laser-cut paper doll the children imitated and attached great importance to the prefabricated example of one doll which the FabLab team made beforehand, despite regular remarks on how this example should only function as mere inspiration. Here, the exemplary doll appeared to give the children some form of control in their making activity but also steered the end-results significantly.

On the level of *time*, as the 'Hack-a-Thing' workshops showed that a longer process was needed in order for meaningful relationships to be formed, 'Making Things' is set up as a long-term participatory process with the ambition to build meaningful relationships that last longer. Also, as mentioned, the FabLab team aims to create transferable and adaptable formats based on the 'Making Things' process for the youth organisation, FabLab Genk and other organisations. By extending the timeframe of the PD activities in such a self-organising way it is foreseen that the relationship between FabLab Genk and the youth organisation 'Gigos' will last over longer periods of time, since the workshop formats can be adapted continuously to fit the changing needs and interests of the youth workers and children.

5 Discussion

This article departs from the premise that, often, FabLabs are mainly considered as technical infrastructures, providing access to the available machinery, tools and skills. FabLab Genk was no exception to this, with the workshop series 'Hack-a-Thing' clearly departing from the Lab's technical infrastructure. However, since then, questions were raised about how FabLabs can be opened up for participation of a broader audience and more specifically to non-expert users. After all, through the 'Hack-a-Thing' workshops, it became clear that considering a FabLab as a mere technical infrastructure hindered the formation of sustainable, long-term relationships

with local actors (i.e. 16 - 20 year olds from the city of Genk). As mentioned earlier, four participants dropped out of the workshops, the content of the workshops was not sufficiently linked to the interests and practices of the youth and the FabLab was unknown territory for most of them. Attempts were then made, in the form of an ongoing infrastructuring process (of which 'Making Things' is one case study), to transform FabLab Genk from a place of technical infrastructure to a community space that still offers public, shared access to high-end manufacturing equipment but that changes its activities and focus according to the needs of the specific communities. In doing so, FabLab Genk aims for nurturing long-term participation from non-expert users from the surrounding neighbourhoods within the FabLab[2].

The analysis of 'Hack-a-Thing' and 'Making Things' activities led to interesting insights on how this participation for children and teenagers can be achieved. First, it showed that a key element of infrastructuring processes is creating conditions for self-organisation so that communities can sustain, self-organise and (re)form themselves around issues or alter existing formations or approaches. As mentioned, self-organisation can be seen as a way to complement and stand up to formal top-down or staged participatory processes [28]. In the case of 'Making Things', self-organisation through adaptable templates makes it possible for youth organisation 'Gigos' as well as others to create a long-term relationship with the FabLab, but without being dependent on the FabLab team for setting up and organising the STEM workshops. Here, we touch upon the discourse of transferability in PD research, stating that knowledge constructed in PD processes can be relevant for contexts other than the ones in which it was created [10; 11; 22]. In this line of through, Marshall & Rossman [35] suggest the concept of transferability as a possible alternative to positivist terms such as validity (internal and external), reliability, generalization and objectivity. For 'Making Things' transferability could thus offer a way to transfer workshop templates created within the FabLab Genk context into the context of a youth organisation. However, it must be acknowledged that focussing on transferability and looking into how the workshops can be translated into open, adaptable and workable formats (as is the case in 'Making Things') can present some points of concern. For instance, as different participants in different trajectories - such as future case studies - have different interests, needs and life worlds, it might not be possible to properly transfer such formats from one context/community to another. Moreover, every community might have different ideas on what a FabLab means to it and what it can expect from such an open makerspace. Therefore, it might not be evident or even possible to transfer a format resulting from one participatory process to another. This, of course, raises questions about how transferable formats such as those aimed for in 'Making Things' truly are. To deal with this concern, we refer to Travis [45] who clarifies that transferability does not imply a clear prediction about the *applicability* of the findings to a different context but rather enables the *utilisation* of the findings in that context. She claims that, in order to achieve transferability, a thick description is needed of the

[2] *As 'Making Things' only started half a year ago, this paper results from the first phase of its process. Therefore, at this early point in the process, we do not yet have a clear vision on whether the infrastructuring process brought about any long-term changes (as it is still ongoing). However, based on our findings from 'Hack-a-Thing' and the first phase of 'Making Things' we hereby opt some points for further discussion.*

context: "*If the thick descriptions demonstrate an essential similarity between two contexts, then it is reasonable to suppose that tentative findings of Context A are also likely to hold in Context B*" [40, p. 1189]. As Frauenberger et al [22] emphasize, understanding how knowledge depends on the context is a pre-requisite of being able to transfer it to other contexts. Therefore, before looking into transferring the formats to other contexts, we need to come to thick descriptions [23] of both the context of Making Things as the new ones.

Second, the analysis indicated the importance of backstage activities [14] for community building [13; 41]. As mentioned earlier, the backstage activities in 'Making Things' - such as attending informal gatherings at the youth organisation - allowed for building meaningful relationships with both the children and youth workers involved, before the workshops and making sessions effectively take place. As Dindler & Iversen [14] indeed indicate, these backstage activities were not only essential in gaining trust from the children and youth workers but were - and still are - important in getting to know them and their interests in a more informal way, complementing the insights gained from the front stage activities (i.e. observations, workshops and brainstorms) in meaningful ways.

Third, 'Making Things' specifically departs from the idea of setting up workshops that fit and originate from the personal interests of the children. This is crucial for setting up long-term participation processes of engaging local non-expert users in FabLab Genk On the one hand, asking the involved children to *design* the workshops themselves before effectively *participatin*g in them was crucial here. On the other, an important aspect of this was the choice to organise the workshops not within the space of the FabLab itself but rather in the context of the youth organisation. It also pinpointed the importance of giving form to a process that allows the involved actors to gradually get acquainted with the FabLab (and its ways of working), gain necessary skills and knowhow and steadily get used to making activities. However, this does require insight into (the skills, knowhow and eagerness of) the teenagers and how to approach them.

Next, the case studies showed that departing from existing relationships - as was the case in 'Making Things' - facilitates the further nurturing of those symbiotic agreements. To better enable collaborative constellations that emerge among heterogeneous participants [14], 'Making Thing' - in contrast to 'Hack-a-Thing' - departed from a much clearer view on the life worlds of the involved participants, allowing for its activities to better fit the wishes and needs of the specific community. However, departing from existing relationships can present pitfalls, for instance when different expectations arise between the partners in a symbiotic agreement. As 'Hack-a-Thing' made clear, different expectations or agendas [14] - among other things - can lead to participants dropping out of the participatory process.

However, it must be acknowledged that the described case studies are not beatific and are open to critique. For instance, since both 'Hack-a-Thing' and 'Making Things' target a specific group of participants (i.e. children and teenagers) it is not evident to formulate general concluding remarks that can be transferred to other non-expert users (such as adults). The findings should thus be interpreted in this light. Moreover, as the 'Making Things' process is still on-going (with activities planned until December 2017) it is not yet evident to draw definitive conclusions on whether or not the workshops were successful and achieved their goals. The gained and

described insights are thus preliminary findings, merely reflecting tendencies that became clear over the course of the ongoing infrastructuring process. However, the findings and methods of this unique, local process can be transferred as knowledge sources to inspire other projects and contexts dealing with similar issues [10; 11; 22].

6 Conclusion

For a long time, literature on maker culture [e.g. 6; 8; 29; 31; 38] focussed on specific communities of makers and their contributions to specific fields. In this respect, open makerspaces were mostly defined as technical infrastructures that provide makers with access to machines, tools and knowledge. Recently, more attention is dedicated to these open makerspaces as community spaces that try to engage non-expert users in their operations [44]. By describing two specific case studies – 'Hack-a-Thing' and 'Making Things' – that are part of FabLab Genk's on-going strategy to set up long-term participatory processes of engaging non-expert users, this article aims to frame this debate within the literature of PD and infrastructuring.

The article showed that 'Hack-a-Thing' and 'Making Things' proved to be useful initiatives for investigating attempts to structurally engage non-expert users (i.e. children and teenagers) in an open makerspace such as FabLab Genk. By analysing the actors, activities, objects and aspects of time involved in both case studies, we gained a deeper understanding of how building meaningful relationships with communities can enable processes of long-term engagement. In this context, the article pinpointed the importance of creating conditions for self-organisation in infrastructuring processes so that communities can sustain and self-organise around issues or alter existing formations or approaches. It also made clear that setting up and nurturing long-term, meaningful relationships with (local) non-expert users takes time and effort. Continuously engaging in both front stage and backstage activities in order to collaborate with these actors requires investments of different kinds. However, as this article made clear, it is exactly this relational expertise [14] that lies at the core of developing and maintaining meaningful relationships between an open makerspace such as FabLab Genk and local non-expert users.

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