



D2.3 ALTERNATIVE FRAMINGS OF CRITICAL MAKING

About this document

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LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|------|--|
| CMRF | Critical Making Responsibility Framework |
| GIM | Grassroots Innovation Movements |
| RRI | Responsible Research and Innovation |
| TUB | Technische Universität Berlin, Germany |
| VTT | Teknologian Tutkimuskeskus VTT OY, Finland |
| WP | Work Package |
| WP2 | Building the critical making knowledge-base: concept & methods |
| ZSI | Zentrum für Soziale Innovation, Austria |

EXECUTIVE SUMMARY

In this document, the author summarizes the participatory experiences from WP2, specifically in terms of defining and applying a new analytical framework, which we named “Critical Making Responsibility Framework” (CMRF).

The document outlines the iterative approach the consortium took, which reflects the overall work of this project: starting from an academic proposal to combine Responsible Research and Innovation (RRI) principles (Tassone et al. 2018) with Grassroots Innovation Movement (GIM) framework (Smith et al. 2017) as first outlined in the project proposal, and (for now) resulting in an interactive online escape room game.

We documented the winding – but highly collaborative – pathway through academic papers and conference presentations, one of which received a best paper award, or another one that proposed a new RRI key. We also had lengthy reflexive discussions with researchers from different disciplines, and held two workshops with, and got surveys filled out by our non-academic co-researchers, **the critical makers**.

In this report, instead of repeating what we already communicated, the papers and other materials are collected with an overview, including a short reflection on their roles in the process. In the conclusion, the author summarizes this reflexive and participatory experience and offers an outlook for future research.

INTRODUCTION AND OVERVIEW

The original goal of the exercise was, as defined in the proposal and the contract (Annex 1), to 1) develop a Critical Making theoretical-analytical framework, 2) support the reflexive-interventionist approaches of the case actions, and 3) also to engage practitioners (makers). Originally, the framework itself was to be created at the beginning of the project, and further developed and revised mid-term and throughout the interaction with our stakeholders.

From our discussions with makers however, we realized that we had an exceptional opportunity to create something useful *with them and for them*, thus, we continued iterating the framework into a maker-friendly tool for reflection. The idea was that such a tool could truly support grassroots critical makers if it is developed beyond academia.

In Table 1, an overview is offered of the steps taken to iteratively and collaboratively develop the CMRF:

| Steps | Description | Objective | Contributors | Chapter |
|--|---|---|--|--------------|
| Step 1: Proposal & contract | The idea of the conceptual framework and a preliminary figure (Fig. 4., page 14) was included in the proposal, combining RRI and GIM. | The goal was to develop a boundary object between the case actions and ensure coherence in the research activities. | Regina Sipos, Maria Akerman | Chapter 1 |
| Step 2: Introducing the | In a peer reviewed journal paper, the | This version combines RRI and GIM; including | Authors: Regina Sipos, Maria Akerman | Chapter 2 |

| | | | | |
|---|---|--|---|--------------|
| CMRF Submitted December 2021, published April 2023 | CMRF is presented to academic audiences (Sipos and Åkerman 2023) | a 4x4 matrix of the principles, with an elaborating paragraph and examples from field research experiences to support the theory. | Reviewers: Barbara Kieslinger, Hanna Saari and Christian Voigt; anonymous peer reviewers of the journal | |
| Step 3: Conference presentation proposing New RRI Key June 2022 | In a conference presentation and paper, a new RRI key is presented (Akerman et al. 2022) | Based on the CMRF framework, the goal of this presentation was to reshape RRI keys to embrace grassroots innovations, and proposed a new key on community empowerment. | Maria Akerman, Hanna Saari, Regina Sipos | Chapter 3 |
| Workshop with makers September 2022 | Online collaborative workshop with makers from Brazil, Germany, Namibia and Singapore | To support the extension of the framework to makers, the original reflexive questions embedded in theory are transformed with makers. Accessible reflexive questions based on the CMRF and in practice are the outcome. Feedback on useful formats is also gathered. | Organizers: Hanna Saari, Maria Akerman, Regina Sipos, Barbara Kieslinger Participants: Saad Chinoy, Gabi Agustini, Alex Kutschera, Kirstin Wiedow | |
| Step 5: Conference presentation on extending the framework October 2022 | At the MIT's Fab Fest, organized for makers in FabLabs, the paper received Best Paper Award and experts interviewed the first author on stage (Sipos et al. 2022) | This conference paper outlines the process of extending the academic version of the CMRF to makers, and how the questions are developed iteratively. This paper also summarizes the balancing work | Regina Sipos, Maria Akerman, Hanna Saari, Barbara Kieslinger | Chapter 4 |

| | | | | |
|--|--|--|--|-----------|
| | | between reflexive depth a practical tool for makers. | | |
| Step 6: Questionnaire December 2022 – January 2023 | An online questionnaire is distributed to wider maker networks, including the refined questions, asking for their answers to those questions, reflecting whether the questions make sense and proposals to reformulate them. | This step was designed to get feedback about the questions from a bigger group of makers, so that we can see if the questions are understood as intended, and how they resonate with makers. We also asked them for feedback on whether and how they would use the outcomes. | Design: Regina Sipos Feedback: Barbara Kieslinger Participants: 7 makers from around the world | Annex 1 |
| Step 7: CMRF escape room game March – June 2023 | Based on feedback received from makers, an online game is designed with the reflexive questions. | Engaging with a maker-researcher, the reflexive CMRF questions turn into an online escape room game. The goal is to make the process of answering the questions more engaging, provide the makers with tools in areas where they self-evaluated as weak, and to collect their answers for future research. | Game design: Julieta Arancio Feedback: Regina Sipos, Barbara Kieslinger, Hanna Saari, Maria Akerman | Chapter 5 |

This journey was also summarized in the Critical Making Project Zine (Critical Making Consortium, 2023):

1. The BMJ principles stem from Tassone, Valentica, Catherine, Emma McNamee, Harriet J. Eppley, and Tapan K. J. Wals, 2018. "Designing Higher Education Curricula in Times of Systemic Dysfunction: A Responsible Research and Innovation Perspective." *Higher Education* 76 (2): 337-52.
2. The GRI analytical framework can be found in: Sivita, Patricia, U. Fredrick, Birendra K. Bhatt, and Adelle By, 2017. *Grassroots Innovation Networks: Knowledge, EarthScan*

→ Step 3: Approaching UnBoxing

the Story of Part 2:

→ **Step 3: UNBOXING**
- the Critical UnBoxing
Escape Room Game!

Together with Julia Franco, these questions have been used to create a fun game: so that visitors (and unpack their practices and open the "glad box"

Figure 4: Online white Board supporting co-creation in the Critical Making Responsibility Framework workshop with makers.

| GIM/RI | Reflexivity | Anticipation | Inclusiveness | Responsiveness |
|--------------------------------|---|--|---|---|
| Context | What social changes do you promote with your making practices? | How do you future proof your practice? | Who is giving workshops or teaching in your space? Is it managed so that everyone can feel comfortable in the space? | What actions/steps can you take to better address societal needs? How does this shape the actions you intend to take? |
| Franchises | How does the way you speak about your practice affect the decisions you make? | Not applicable | When presenting your narratives/stories that are inclusive? | Not applicable |
| Spaces & Strategies | Have you considered social and ecological sustainability when planning your actions? | Who do you take money and/or resources from and how does that affect your making practices? | What might be particular barriers (like physical ones) for any social groups to participate? How could these be overcome? | How can you work to overcome material scarcities and/or lack of skills in your project? |
| Pathways | How can you create a culture around making that encourages critical sustainability values while also being fun? | Are your actions creating a pathway towards the kind of activities you want to see (even if in a small way)? | Are you building towards a more inclusive future? For whom? | From which public or private societal actors (e.g. companies, politicians, schools) would you need support to realize the future you hope to see? |

Table 2: Initial reflexive questions that were discussed in the co-working workshop.

we managed to refine the reflexive questions:

* from Bati, Gema, Maria and Gema!

We asked makers to help us refine the questions in a collaborative workshop online, to tackle the fundamental dilemma of implementing critical thinking in making without taking the fun out of making. It was a long and exhausting workshop! But



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we will test the game live with dozens of makers early June 2023 and collect their feedback!

Critical Making Responsibility Framework:
Extending an Academic Proposal to Support Reflexivity in Maker Communities

Regina Sipos, Maria Åkerman, Hanna Saar, Barbara Kießlinger

Table 17: Bati, Gema, Maria and Gema, 13 October 2022.

DOI: 10.5281/zenodo.7432145

And an paper, presented at the MIT FabTest in 2022 received the "Best Paper Award"! ↳ check out the video on Youtube

Table 3: Elaborated reflexive questions after the workshop.

• we also asked the makers:
- What format?
- What's the game?
- Physical, playing cards?
- What is this useful?
- Makers: For reflection, building, and creativity

Conclusion

We are curious to see: Makers are very practice - oriented. What happens if they are given for give themselves the tool, think, and permission to stop, think, anticipate and reflect together? ↳ CRITICAL MAKING?

I made a question in the online questionnaire to reflect on the question, reflective whether the question is useful and how they would reformulate the question, based on an example to present

Step 3

CHAPTERS

CHAPTER 1: DESCRIPTION AND FIGURE FROM PROPOSAL

We will consider these principles of responsible making in our analysis of the social responsibility of the maker community. The main theoretical framework, which will guide us during our work is inspired by the interdisciplinary work proposed by Smith et al. (2017) in the book *Grassroots Innovation Movements* (GIM). The novel approach of this framework lies in the realization that in order to understand and analyse grassroots innovation movements today, social movement literature (mobilization of resources and political strategies) needs to be linked to science and technology studies and innovation studies (concepts about learning, knowledge creation and technological innovation) (ibid, p. 18). The GIM framework suggests analysing **4 interrelated concepts** to understand grassroots innovation movements: broader contexts, framings, spaces and strategies and pathways.

1. **Context:** historical, political, economic, cultural, religious contexts and other circumstances, issues and situations, as well as opportunities that were available within those contexts that had a generative effect on the movement. An important example is the need to examine distinct characteristics of such movements in the global South, as so far social movement literature has deemed the availability of resources a prerequisite for social movements, yet, extensive movements can be seen in resource-constrained communities (ibid, p. 21). Socio-technical landscapes that open “windows of opportunities” can be seen nowadays in grassroots’ reactions to Covid-19 and create and exchange necessary innovations.
2. **Framings:** the process of “meaning production” that enables movements to identify and organize their experiences, connect to powerful narratives and do this beyond shared grievances. This includes technological frames as well as a broader set of concerns (social, economic, political, etc). Their critique on mainstream innovation, their motivations and how they problematize mainstream models (ibid, p. 23) are important parts of their approach to RRI. Their collective identities, shared meanings, interpretations and narratives are important factors in the way they design their practices.
3. **Spaces and strategies:** analysing their locations and actions/activities that enable them to do experimentation and innovation differently, e.g. by enrolling audiences, alliances and users to improve their own performance (in a user-centred way, creating public engagement) and making alternative spaces of engagement, hereby mobilizing resources while considering the costs and benefits, risks and rewards of strategies, shaped by the conditions attached by resource holders that influence the outcome of their activities (ibid, p. 26). These all contribute to the development of such arenas, where norms and expectations towards innovation can be different from the mainstream.
4. **Pathways:** explaining how they contribute to developments in different settings over time, including a future perspective. These alternative pathways and their plurality shows that there is not just one self-evidently best pathway, and the political nature of grassroots movements might contribute to new pathways created with greater attention to issues of social inclusion, diversity and difference and social justice, playing a key role in their RRI practices (ibid, p. 28). How do they develop, respond to changes over time, what consequences does this have for the pathways?

The conceptual framework (Fig. 4) will act as a boundary object between the different activities in the work packages (Leigh Star 2010) and ensure coherence in our activities, together with our leading research questions. For its creation and refinement, we will invite leading scholars in the field of social and intellectual history of science and society to engage with us. Throughout the project the conceptual framework will be updated and refined based on lessons learned from the explorative scientific work and the dialogue with RRI stakeholders and makers on future implications.

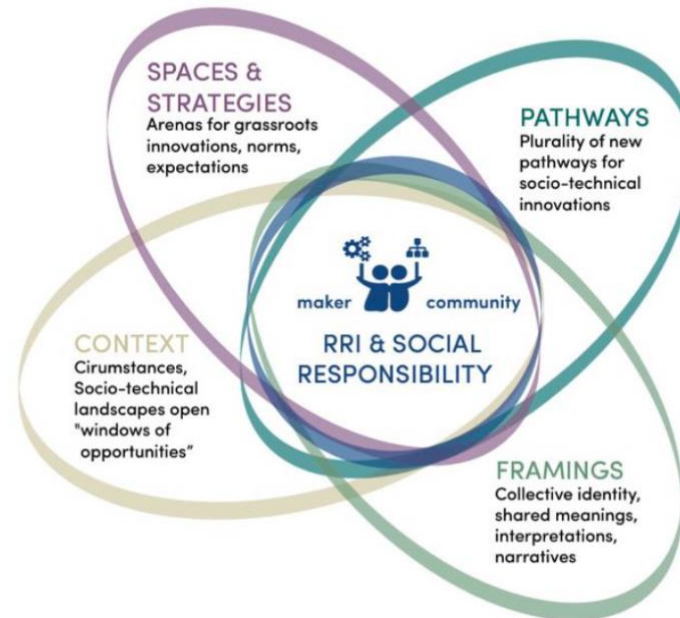


Fig. 4: Conceptual framework

The framework allows us to look at the status quo, to include a historical view and a future vision. When building the knowledge base for Critical Making (in WP2) **the four analytical areas will be amended with the RRI and responsible making perspective**. They will serve as instruments to systematically analyse how far responsible critical making is supported and practiced and which contexts, strategies, framings and pathways foster responsible innovation processes. The framework will help us identifying aspects in the four areas that are specifically supportive for RRI in the maker community. This will allow a critically reflexive transdisciplinary look at how things developed. It will also be facilitating the look back at the end of the project's participatory interventions to reflect on what changed and e.g. which of the four analytical areas we specifically addressed by our interventions in the different cases.

In addition, the framework shares a cross-sectional idea of looking out for different future possibilities. In the sphere of context, circumstances are mapped by utilizing a multi-level perspective (Geels & Schot 2007), where "windows of opportunities" for a particular maker space are identified in a larger modelling consisting of niche level innovations, variables of sociotechnical regime and socio-technical landscape developments. In framings, future possibilities are negotiated collectively, including establishment of e.g. shared vision. In the pathways section, various opportunity pathways are constructed and assessed from multiple perspectives. Spaces and strategies compress the work of all other sections by crystallizing novel strategies and co-operative forms.

The three core RRI aspects, 'gender', 'young talents', 'openness' are taken into consideration in the theoretical framework as well as in the three dedicated case actions in distinct work packages. Social responsibility, ethics and other relevant aspects related to responsible innovation are considered across the three case actions. In the following the three case actions are presented in more detail.

CHAPTER 2: INTRODUCING THE CRITICAL MAKING FRAMEWORK



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Introducing the Critical Making Responsibility framework for analyzing responsible innovation processes in grassroots practices

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Introducing the Critical Making Responsibility framework for analyzing responsible innovation processes in grassroots practices

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This paper introduces the Critical Making Responsibility Framework. The framework has been developed by the Critical Making consortium in order to analyze responsible innovation processes in grassroots innovation, specifically in the practice of making. The paper builds on a literature review to highlight the shortcomings of current Responsible Research and Innovation (RRI) frameworks' relevance towards grassroots innovation practices, and conversely, the lack of scientific understanding on ethics and responsibility in making. To fill the gap, this paper proposes a combination of the dimensions of the Grassroots Innovation Movements (GIM) analytical framework and the RRI capacity dimensions. Finally, the outlook reflects upon how the framework will be utilized in hands-on ways to support the work of academic and non-academic co-researchers of reflexive maker practices.

Keywords: literature review; critical making; grassroots innovation; Responsible Research and Innovation; participatory action research

Introduction

Academic interest in makerspaces has been growing, as these nurture an approach different from traditional methods of innovation: participatory grassroots innovation. Makerspaces are known for supporting the practice of making, which is a term for the subculture that constitutes a technology-based extension of DIY culture (Doyle 2013). This support consists of access to infrastructure and tools, but also to community members, their shared knowledge and skills.

Grand narratives around the possibilities the so-called maker movement represents have been formulated, and expectations towards these innovation spaces have been high, including bringing about a new industrial revolution (Anderson 2012) or democratizing innovation (Tanenbaum et al. 2013) through the prosumer's empowerment (Paltrinieri and Esposti 2013). Maker communities have also been celebrated for their potential impacts, including social (Unterfrauner et al. 2020; Bosse et al. 2019), political (Maxigas 2012) and environmental (Lange 2017; Kohtala 2016) impacts. A recent example of the capacity of the maker movement to address societal needs in a responsive manner was witnessed during the COVID-19 pandemic when grassroots communities were rapidly prototyping, testing, documenting and reproducing necessary products (Kieslinger et al. 2021) as global supply chains broke down.

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Alongside the positive examples, academia has been debating whether the promises of positive societal, economic and environmental impacts are truly delivered. Moreover, some researchers have criticized the maker movement for technosolutionism and ideological colonialism (Lindtner, Bardzell, and Bardzell 2016). The American Make: magazine was criticized for their involvement with the US military (Finley 2012) or the MakerBot for becoming a closed-source project after it was built by a community of open hardware enthusiasts (Benchoff 2016).

When discussing the making, it is important to note that it is not a uniform activity that follows one central blueprint and should be reproduced anywhere in the world exactly as prescribed. Following Ong and Collier's definition (Ong and Collier 2004) it is rather a 'global assemblage' (Lindtner, Bardzell, and Bardzell 2016) of hacker- and makerspaces, spaces of collaborative design and grassroots innovation, brought to life by offline and online communities that make use of the tools found in these spaces (Smith et al. 2017). Hacker- and makerspaces are localities that attract inquisitive people, early adopters and creators of innovative artifacts. Following from this heterogeneity, there are also different interpretations within the maker movement of the main societal goals of making and the meaning of some, supposedly key principles of maker movement, such as openness (Saari et al. 2021). However heterogeneous, these spaces of grassroots technology innovation practices (Smith et al. 2017) provide researchers with opportunities to observe processes of collaborative, collective or community-based design (Bonvoisin et al. 2018). Makers and maker communities often engage in grassroots innovation, act as litmus tests to measure the (dis)contentedness of society, and pinpoint emerging societal needs and propose change (Sipos and Wenzelmann 2021).

As indicated by the response of makers to the Covid-19 pandemic, the potential of responsible innovation in the maker movement is interesting for research. The pandemic has shown the risks and limits of relying solely on global supply chains, centralized large corporations and governments, and therefore has set off an unprecedented interest in local, distributed, and openly accessible design and manufacturing to solve the massive unmet needs that have surfaced during the crisis. This disastrous period presented itself as a unique opportunity for makers to prove their skills. Such a shift, from niche to broader society impact, needs a critical view on social responsibility and ethics.

This paper suggests an integrated interdisciplinary approach to address responsibility in making which draws from the analytical framework proposed for research grassroots innovation movements (GIM, Smith et al. 2017) to understand the social embeddedness of maker movement and puts that into dialogue with the concept of Responsible Research and Innovation (RRI) capabilities developed within the academic debates on the responsibility of innovations (e.g. Stilgoe, Owen, and Macnaghten 2013).

Based on this dialogue, we introduce a first version of a Critical Making Responsibility Framework. To briefly summarize its background, the framework has been designed in the EU-funded *Critical Making* project to support the participatory research interventions of the project. The interventions aim at co-creating socially responsible and sustainable maker practices, increasing diversity and inclusion with regard to age and gender, and to support the idea of openness, while highlighting best practices both from the Global North (Germany, France) and the Global South (Brazil, South Sudan or Indonesia). The framework discussed in this paper will support this work to provide insight on the different dimensions of responsibility in the particular context of making, hereby illuminating the complexity of the topic. The authors believe that the analytical framework might support inquiry in other similar participatory interventions, especially those that allow

for the cooperation between academic and non-academic co-researchers, e.g. in participatory action research.

A related academic discussion on critical making, which also influenced the framework presented here, stresses the advantage of combining reflexivity (and consequently also responsibility) with the particular opportunities that material practice, or making provides (Ratto and Hockema 2009). This approach inspired researchers to ask questions about communities that follow the underlying principles of responsible making, which are significantly less visible in the mainstream narrative of makerspaces compared to the corporatized version in which ‘everyone just buys the kit’ (Hertz 2012). The term critical making, coined by Matt Ratto, originally described participatory scholarly design practices that combine critical thinking and making (Hertz 2012). This unique practice, although it is a niche approach, is applied in academic work in ways that are relevant for the endeavor described in this paper, as critical making is extended towards real-world interventions. E.g. environmental research is transformed through citizen participation and technoscience (Wylie et al. 2014), interdisciplinary learning supports the combination of art, science and engineering studies with social interventions (Ratto and Hertz 2019) and Ratto’s Critical Making Lab continues to extend the practice ‘from scholastic humanistic work and into the realm of public intervention’ (314, Ratto 2019) asking questions about reflexivity and practice. Moreover, the concept has also been used to describe a responsible and critical way of making as we can see in some forms of activism or GIM (Sipos and Wenzelmann 2021).¹ The Critical Making consortium refers to the concept of critical making for the first time as an approach for describing RRI practices in maker-innovator communities. Grounded in grassroots innovation processes, critical makers have been repetitiously highlighting values such as inclusion, ethics, responsibility, reflexivity, or openness (Sipos and Wenzelmann 2021). We find this discussion useful in identifying how critical thinking, which is an essential part of responsibility, is enacted and can be enacted in the existing practices of making.

While the framework is preliminarily aimed at supporting the work of the researchers within the project, in the future, it will be further developed to help researchers in participatory action research projects to better understand the criticality, reflexivity and responsible practices of innovation within grassroots, involving the points of view of grassroots practitioners. The current version presented in this paper is thus considered a starting point, aimed to inspire conversations and collect experiences from its practical application.

Analytical-conceptual background

Responsibility and criticality in making

The aim of the Critical Making consortium is to co-create a new responsibility framework that is particularly tailored to capture the responsibility issues that are relevant in making and grassroots innovations and respect their character. We know from observation and participation that grassroots innovators do engage in responsibility practices, as they advocate for openness, sharing, co-creation and user-centered and community-based design. The potential for responsible innovation inherent in a specific subset of grassroots innovators identified as maker communities is to be researched. This potential comes from the cumulative and shared knowledge of its members, and the technical possibilities that the democratization of innovation and access to technology through rapid prototyping offers, especially when combined with critical thinking and reflexivity. This is so far

understudied and needs more research (Ratto and Boler 2014; Sipos and Wenzelmann 2021). However, we should not forget that innovating for the benefits of society is not the goal of a widely disseminated rhetoric of makers, who use standard engineering practices to solve issues with often limited societal impact. Furthermore, when we tried to find ready-to-use or easy-to-elaborate responsibility frameworks to be applied in the context of making, we realized that the recent debates of RRI largely neglect the questions of grassroots innovations, which means that they fail to address the particularities of citizen and community-driven innovations (see also Bhaduri and Talat 2020). In the following, we will describe how we attempt to overcome this failure by integrating the in-depth understanding of grassroots innovations studies (GIM) of how making is embedded in society and can provide a particular source of reflexivity with existing conceptualizations of responsible innovations developed in RRI literature. We start the description of our analytical-conceptual framework with RRI conceptualizations and then move on to introduce the GIM approach.

RRI capacities in grassroots innovations

The concept of RRI was developed a decade ago as a response to the need to deliberate the values embedded in the process of science and technology development and to provide a responsibility framework for research particularly in the context of European Union research and innovation funding (e.g. Gianni et al. 2019). It has been understood as primarily a tool to govern the socio-ethical aspects (Scholten and Blok 2015) of research and innovation and as such a continuation of broader debates in science and technology studies (STS) emphasizing the need to increase the sensitivity of researchers and scientific institutions on the needs, wishes and fears of citizens and communities (e.g. Irwin 1995). Particularly, there is a need to recognize that although science and technology development have enhanced well-being, they have also created unintended consequences, including climate change for example. In addition, many of the outcomes of science and technology development are controversial and have become matters of social concern as public discussions around issues such as genetically modified organisms and data economy show. Therefore, it has been claimed that a closer connection between science and society is needed (Gibbons 1999).

RRI as a concept is thus originally created to provide a responsibility approach for institutionalized research and refers to strategies and practices which enable researchers and a variety of stakeholders to become mutually responsive to each other and to anticipate the societal impacts of the outcomes of research. It is understood as ‘a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the acceptability, sustainability and societal desirability of the innovation process and its marketable products’ (Von Schomberg 2011) What is to be noted is the importance put in the continuous engagement of citizens and civil society during the innovation process to negotiate the value of its outcomes. Following from that, RRI discussions are closely connected to and draw from the long-term tradition of STS studies in exploring means and practices of public engagement in science and innovations (e.g. Stilgoe, Lock, and Wilsdon 2014) and furthermore are also interested in finding ways to support the capacities of both citizens and other stakeholders and scientist and innovators to engage in fruitful communication (e.g. Selin et al. 2017; Tassone et al. 2018).

In addition to putting emphasis of engaging stakeholders and public into dialogue with researchers and innovators, the RRI principles also highlight the need to integrate the

practices of anticipatory governance into the innovation process (Felt 2018). According to (Stilgoe, Owen, and Macnaghten 2013), anticipation and forward-looking thinking together with collective stewardship are key factors of responsible innovation. Furthermore, they identify four particular RRI dimensions critical for responsibility in research: anticipation, reflexivity, inclusion and responsiveness, which according to Tassone et al. (2018) form the RRI capacity framework (see Figure 1.) that can be supported through education.

For the purposes of evaluation and monitoring the responsibility of research and innovation activities of research funding and performing organizations, RRI has been operationalized to six separate policy keys (gender, governance, ethics, stakeholder and public engagement, science education) and related indicators to be used in evaluation.² In addition, different RRI tools targeting the design and implementation of research process and to increase the sensitivity of research teams along the on-going work towards ethical issues and social responsibility have been developed.³ As mentioned before, these tools have been so far mostly designed for institutionalized research and innovation. Following from that, it has been claimed that despite reflecting similar goals with both citizen and industry-driven pro-social innovation movements, the RRI discourse has remained mainly isolated from it. Furthermore, it has also been criticized of being fundamentally Euro-centric (Bhaduri and Talat 2020) designed for the societies and innovation systems of the Global North. Moreover, several scholars have claimed that the concept of RRI fails to recognize such conceptualizations of innovation which arise and are addressed towards the Global South including for example frugal and grassroots innovations (Mamidipudi and Frahm 2020). Such a distinction is relevant as the contexts in which those innovations are developed differ significantly from R&I practices of established research institutions and companies which means that the concept of RRI is not adoptable as such. As the sites of frugal and grassroots innovations are diverse, ranging from social collectives to informal enterprises, also the understanding of dynamics of innovations and their social embeddedness needs to be revised and enriched with context-specific knowledge. For example, Bhaduri and Talat (2020) claim that frugal innovations are by definition responsive to societal needs and values as they are directly

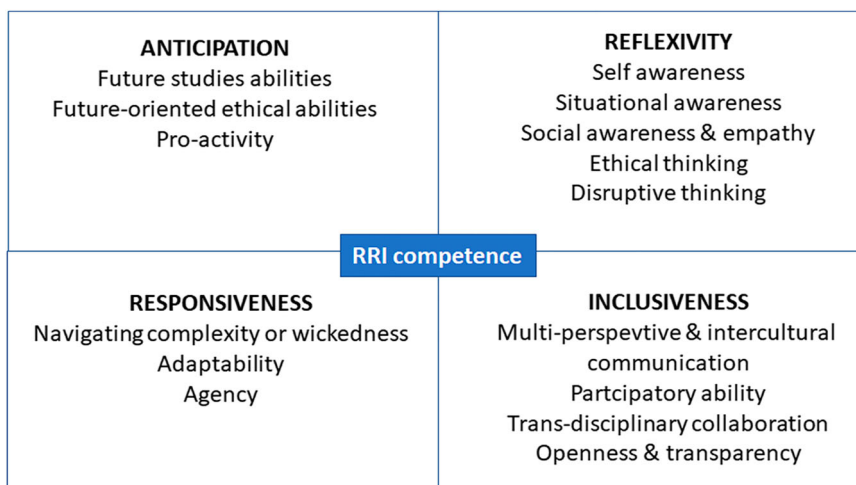


Figure 1. RRI competences. (Source: Tassone et al. 2018).

developed by the people and communities for the purposes of these same communities. In addition, the need for extensive foresight processes related to the potential outcomes of innovations is rarely needed as small-scale grassroots innovations mostly do not have broad social or ecological impacts.

Despite the criticism raised, and the failures of existing RRI frameworks to grasp the dynamics of grassroots innovations, the on-going debates on the definition, essence and different uses of RRI indicate that it is a flexible concept and framework open to interpretations and context-specific tailoring. We find it useful to explore how the four anticipatory and forward-looking capacities identified in the RRI literature can be used as resource in creating a responsibility framework for citizen and community-driven innovations. We believe that these principles can be adopted in a meaningful way for these purposes when enriched with an in-depth understanding of how the present state and future pathways of community-driven innovations are shaped by various societal processes. We introduce the GIM framework in the next section, which has been developed for exactly this purpose.

Grassroots innovation movements framework

Practical grassroots innovations committed to values of social justice or environmentally sustainable developments have existed for decades and caught the attention of researchers (see for example Schumacher 1973; Hess 2009; Smith 2005). The GIM framework that is guiding us during our work in this project is inspired by such previous work. The novelty of the GIM framework is that it proposes a multidisciplinary approach to provide researchers with a tool that sheds light on the particularities of grassroots from different viewpoints. Firstly, to analyze how GIM co-create alternative visions and practices of development, GIM uses insights of social movement literature on the mobilization of resources and political strategies for example. In addition, it draws analytical approaches from science and technology studies (STS) to direct the analytical gaze on the collective action frames for alternative science, (see Hess 2009) and from innovation studies to focus on concepts about knowledge creation, (see, e.g. decolonial scholars such as Escobar 2004), and technological innovation leading to alternative types of technological change. (Escobar 2004, 17–18).

Making can be considered as an integral part of grass roots innovation movement. As Smith et al. summarize, ‘we conceive hackerspaces, fablabs and makerspaces as a grassroots innovation movement because there is considerable activity outside formal institutions and because their networks are committed to exploring the social possibilities of bringing tools to people’ (100, Smith et al. 2017).

Grassroots innovation communities, networks and movements create solutions to (hyper)local issues. This is mainly done in bottom-up, self-initiated processes, with a focus on and embedded in local communities and their problems, needs and values. Moreover, open-source documentation and sharing help solutions become more sustainable than universalist and closed-source approaches (Arancio 2021). Innovations are developed cooperatively, through collaborative deliberation, negotiation and while building trust. The solutions might be born out of necessity, to raise awareness around societal questions concerning marginalized groups of people, or, as Smith et al. point out, address issues neglected by conventional innovators, because developing such solutions is rarely profitable. Communities, discourse, knowledge, prototypes and innovations are emerging through the process, producing knowledge, appropriate technology and coordinating social organization (6, Smith et al. 2017).

Another relevant approach to grassroots innovation research which adds a layer of societal discourse to the technological discourse can be found in the anticipatory design of Human–Computer Interaction (Lindtner, Bardzell, and Bardzell 2016), an approach that resonates with RRI practices. This reflexive-interventionist approach has been used e.g. to study the aforementioned frugal and grassroots practices in the Global South, specifically to understand how so-called e.g. an Indonesian DIYbio collective contribute to citizen science by developing a water sampling protocol and a digital map of water data gathering, hereby challenging traditional beliefs about sites of technology innovation (Lindtner and Lin 2017). Research combining critical thinking, reflexivity or anticipatory practices with making, participatory design, or grassroots innovation is thus becoming more and more present in academia.

As mentioned earlier, Smith and his colleagues combined insights from the different disciplinary approaches and developed an analytical framework to better understand the pathways of development that different GIMs have walked. The framework is designed for researchers to analyze already established GIM retrospectively, i.e. to gain better understanding of the pathways developed autonomously over time, without the intervention of researchers. Smith et al. (2017) argue that pathways to sustainable development are plural, and they want to know more about how groups and networks address questions of development, how they express relevant values in the innovation activity and what shapes their pathway through that activity. The authors also claim that broader social visions and implications of developments are made richer by analyzing GIM (Smith et al. 2017, 5): it is a matter for analysis to understand how GIM provide ‘a source of reflexivity in society, by pointing to the contention and plurality involved in sustainable developments and opening up more spaces for doing the politics of alternative sustainabilities’. It is this question of reflexivity within the communities and its extension that becomes a source of reflexivity in society that makes this endeavor interesting for RRI. In our Critical Making Responsibility Framework, we aim to strengthen the potential of this reflexivity by combining the retrospective analytical framework of GIM with the forward-looking RRI capacity framework.

The GIM framework suggests analyzing 4 interrelated concepts to understand GIM: broader contexts, framings, spaces and strategies and pathways (see Figure 2). We use these four dimensions in the Critical Making Responsibility Framework to identify which factors and processes are important when targeting the particularities of social responsibility and RRI in making.

Critical Making Responsibility framework

Method for developing the framework

In parallel with scholars, grassroots practitioners themselves also started developing strategies to help others achieve more sustainability when developing new technologies in makerspaces. One example is the set of ‘Sustainable Making Principles’ (Nuesse and Wanalo 2019). The Critical Making consortium has tailored a working definition for responsibility in making and grassroots innovations that guides the development of the Critical Making Responsibility framework. This is based on three sources: first, the aforementioned set of strategies, which was co-developed by a consortium member and grassroots practitioners, second, the RRI and GIM literature reviews and third, insight provided by critical making scholarship.

The consortium’s working definition is as follows: Responsible innovation and making in grassroots practices means that those who tinker with existing technologies

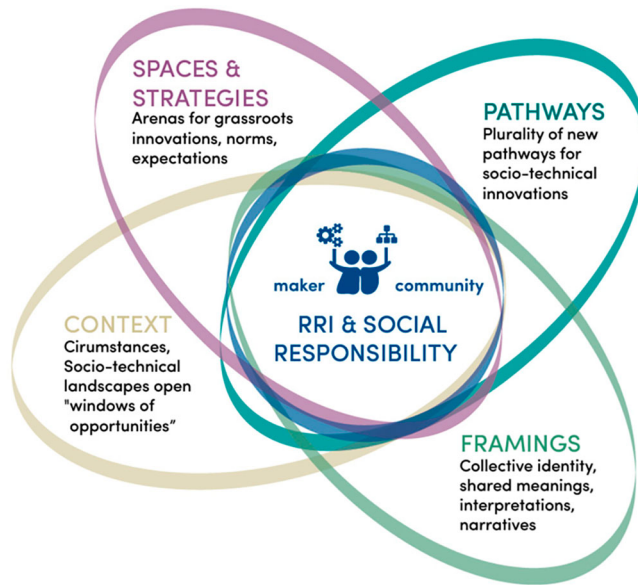


Figure 2. Critical Making Responsibility framework. Illustration by the Critical Making consortium.

and develop new solutions do this critically. This criticality reflects on their responsibility to ensure that the solutions are locally situated and community-based; responsible, ethically correct and addressing societal needs; based on critical thoughts and reflections about power structures; aim to have positive impact and change structures; and the practice itself is joyful and meaningful to the makers.⁴

To further develop these tailored approaches to responsibility, the Critical Making consortium started to create a dialogue between the chosen two analytical frameworks, i.e. the RRI capacities and the GIM framework during the first phase of the Critical Making project from January to June 2021. The first step was to create a matrix that explores how the forward-looking and reflexive RRI principles and retrospective GIM framework enrich each other. We have particularly wanted to understand and explore which dimensions align with each other and which might not.

An important initial step has been the alignment of different disciplinary terminologies to a common understanding as we intend to combine concepts stemming from distinct disciplinary backgrounds. Previous experiences have shown that terminology is crucial when defining a cross-disciplinary approach. While terms and concepts driven from the GIM and RRI frameworks like 'context' and 'framings' or 'anticipation' and 'reflexivity' might be termed researchers of a particular discipline immediately understand, such terminology is not necessarily accessible for researchers of other disciplines and other non-academic actors who might be interested in using the methodological tools developed in the project.

A first 4×4 matrix has been created by the authors of this manuscript in an attempt to combine each of the dimensions, based on thorough literature review. Eight multidisciplinary researchers with backgrounds in social sciences and STS, experience with maker communities, GIM and/or RRI, as well as disciplinary foci on gender, education and specializations in open source technology and development shared experiences. They explored the feasibility and opportunities of developing the matrix and engaged

in discussions on its usefulness and practicalities of implementation. The aim of these reflexive exchanges has been to create a preliminary framework of short descriptions of anonymized examples from our research experience⁵, which will support the understanding and the thought process of the future users of the framework. The exchanges also helped identify elements which we currently see as not applicable.

RRI meets GIM

As described in the previous section, the definition of the four RRI capacities is developed for institutionalized actors engaged in funding and performing research and innovation activities and basically for the socio-technical systems of the Global North. Therefore, although we take these RRI dimensions as a starting point to develop the Critical Making Responsibility Framework, we need to reconsider the meanings of the dimensions when applied for making and grassroots innovations. For example, as mentioned earlier, according to (Bhaduri and Talat 2020) grassroots innovations are usually incremental with little risks which means that broad foresight processes are not relevant and often too heavy in these contexts; although anticipation is still a meaningful activity. We must also take into account that grassroots innovation – especially in the Global South – happens with very limited resources, and with hacked, tinkered, pirated technologies but in return (and opposed to conventional innovation) with a very high involvement of local communities and everyday people in the co-design process. In addition, also reflexive processes need to be designed in different ways and question of inclusiveness gets different meanings at the grassroots level compared to institutional research contexts. For this adoption, we have put the RRI dimensions into dialogue with the GIM conceptualizations and created a 4×4 dimensional analytical framework (see Table 1).

Elaborating the axes of the framework

Vertical axis: the four GIM dimensions

The **context** helps outline the conditions in which the movement is developing. Historical, political, economic, cultural, religious contexts that could be generative or constraining, and other circumstances, issues and situations, including opportunities available within those contexts that had a generative effect on the movement are considered here.

In **framings**, future possibilities are negotiated collectively, including establishment of shared vision(s). Framing is the process of meaning production that helps communities connect to powerful narratives beyond shared grievances which can be expressed in critique towards mainstream practices. Framings are shaped by underlying assumptions, and can include problems, strategies, requirements, theories, knowledge, design criteria, exemplary artifacts, testing procedures and user practices that emerge through social interaction. While it can include technological frames (free/open source software, free/open source hardware, peer production, personalized manufacturing, mass customization and a new industrial revolution, the democratizing power of technological citizenship), it can also include or exclude a broader set of framings, such as social, economic, or political questions and can be important factors in how they design their practices.

Spaces and strategies crystallize novel strategies and co-operative forms. What actions communities take, and how those actions are influenced by the availability of resources is explored here, considering that spaces can not only be physical, but also social, discursive and institutional (makerspaces are spaces for grassroots digital

Table 1. GIM-RRI matrix: the Critical Making Responsibility framework. Table created by the Critical Making consortium.

| | | RRI competence | | | |
|------------------|-----------------------|---|---|--|--|
| | | Anticipation | Reflexivity | Inclusiveness | Responsiveness |
| GIM Dimension | Context | Ability to understand and act upon the ongoing changes in social, historical, political, economic, cultural, religious contexts (trends & weak signals) and other circumstances and what kind of opportunities, restrictions and requirements they may provide in the future. | To become aware of how social, historical, political, economic, cultural and religious context have affected on ones activities (innovations, projects etc.) and what kinds of contexts their reactions & innovations might create, (e.g. vicious circles or hope, and for whom?) | To become aware of exclusive, contextual patterns - to understand that you don't by accident exclude others (like women, elderly, etc) - understanding how exclusion works and supporting people based on the contextual patterns of exclusion | To understand the particular societal needs arising from the context and to respond to them through making & innovations and in addition knowing 'how to react and whom to contact to influence the societal rules of the game'. |
| | Framings | not applicable | To become aware of how used language and terminology shapes the taken actions and what kinds of values and interests are mobilized, maintained or challenged with the language used. Shared framings can help and hinder dialogues and once that is recognized, something new can be learned. | To reflect upon and become aware of the wordings that are used, or the setup of the space, and whether they create inclusion or exclusion? Does the shared umbrella of interpretation lead to missing any perspectives? | not applicable |
| | Spaces/ Strategies | To become aware of one's own strategies to act, to learn to deliberately build strategies towards desired futures and to be able to anticipate what kinds of futures (and future spaces of action) the applied strategies create. | To become aware of how chosen strategies influence other people or environment - what are the risks and rewards for the surrounding community and environment of the chosen strategies | To become aware of the norms and conventions that 'made the space' of making & innovations: if excludes someone, become aware of these norms and conventions, physical structures and language. | To explore how available resources will influence what you do (skills in the team; tools available) and how to act to expand them. |

(Continued)

Table 1. Continued.

| | RRI competence | | | |
|----------|--|---|---|--|
| | Anticipation | Reflexivity | Inclusiveness | Responsiveness |
| Pathways | <p>To become more aware of what sort of pathways are supported: what future pathways are made while doing concrete projects, and reflect upon the potential plurality of it, to anticipate the impact of the ethical pathways.</p> <p>To recognize the path dependencies, become aware of what one can change with the created pathway and what not.</p> | <p>To become aware of one’s own role and the situatedness of the activities carried out: how those impact/influence the environment. By recognizing the various pathways (anticipation), the potential social and ecological impacts can be reflected upon.</p> | <p>To reflect upon whether the developed or imagined pathways maintain existing exclusive structures, do they create new exclusions, new divisions between people? How can they be made more inclusive?</p> | <p>To investigate what kind of support the desired pathways would need in the broader social context (knowledge, funding, policy changes etc.) and/ or whether they may face resistance and to consider how this support can be gained and resistance addressed.</p> |

fabrication, maker movements and grassroots groups, activities include educational outreach and skills provision, etc.). Locations and activities that enable them to do experimentation and innovation differently are analyzed, actions done by enrolling audiences, alliances and users to improve their own performance (in a user-centered way, creating public engagement) and making alternative spaces of engagement. It is hereby that resources are mobilized while grassroots consider the costs and benefits, risks and rewards of strategies, shaped by the conditions attached by resource holders that influence the outcome of their activities (Smith et al. 2017, 26).

In the **pathways** section, various opportunity pathways are constructed and assessed from multiple perspectives. How does the plurality of pathways contribute to alternative developments over time? Ideas and aims are continuously developed and dismissed; objects and practices and their materiality also contribute to developments in different and changing settings over time, including a future perspective. These alternative pathways and their plurality show that there is not just one self-evidently best pathway, and the political nature of grassroots movements might contribute to new pathways created with greater attention to issues of social inclusion, diversity and difference and social justice, playing a key role in their RRI practices (Smith et al. 2017, 28).

Horizontal axis: the four RRI procedural responsibility dimensions

Anticipation refers to systematic thinking which aims to increase resilience of communities and helps to recognize and create opportunities for challenging the existing state of the art with novel social and technical innovations. Anticipation can be fostered with various participatory and deliberative foresight tools including horizon scanning, scenario building and road mapping. The aim is also to make people aware of existing social imaginaries.

Reflexivity refers to deliberate rethinking of how one's activities encounter and reflect the social norms and conventions and potentially challenge or strengthen existing social power relations, division of labor and costs and benefits or whether it causes potential risks for other people or ecological environment. Reflexivity is a process of questioning one's own activities and looking at them from the perspective of other people and natural beings.

Inclusiveness, which is the third RRI dimension refers to the need to include multiple voices and stakeholders in the innovation and making to bring in legitimacy and to provide an opportunity for stakeholders to express their concerns and opinions about the direction of activities. Several engagement methods to achieve inclusion in research have been introduced including for example citizen juries and panels or more light consultation through surveys and polls. In grassroots innovations the context is different as innovations are driven by citizens. In this case also, there is the need to carefully consider that people with multiple background feel welcome and get their voices heard in making activities and to make sure that also often underrepresented citizens (e.g. elderly people, young people, people with lower socio-economic status, etc.) are invited to participate.

Responsiveness is the ultimate aim of the three previous RRI principles: to increase the capacity of researchers and science and innovation system to be responsive for social challenges related to their research. In institutionalized research, this kind of responsiveness is shown for example in the direction of research efforts towards recognized societal challenges. In addition, research actors can actively influence the rules of the game in society by promoting changes in regulation and standards and contributing to on-going policy debates and programs.

Prompts for using the framework

To reiterate, we understand that not all researchers, and especially non-academic co-researchers in participatory projects might be familiar with all the terms used in the matrix. To support their practice-based work without overburdening them with additional readings, the Critical Making consortium made a first attempt in translating academic terms into a short, succinct description and real-world examples that might bring those high-level ideas closer to their practice. Below follows the matrix converted into a list of accessible prompts which are informed by the field research experiences of the Critical Making consortium.

Context × Anticipation

- Explanation: Anticipation here is the ability to understand and act upon the ongoing changes in social, historical, political, economic, cultural and religious contexts (including trends & weak signals) and other circumstances. It also refers to what kind of opportunities, restrictions and requirements these may provide in the future.
- Example: One could explore community-based innovation processes that reflect upcoming societal changes: grassroots innovators being first sensitive to societal change and reacting by kickstarting innovation, because innovative capabilities are based in community. Viewing trends in making from the industry's point of view, the spread of makerspaces could be a sign of distributed manufacturing becoming more prevalent.

Context × Reflexivity

- Explanation: Reflexivity refers to becoming aware of how social, historical, political, economic, cultural and religious contexts have affected one's activities (including innovations, projects, programs) and what kinds of contexts their reactions and innovations might cause (e.g. vicious circles or hope, and for whom?)
- Example: While designing a participatory project, a responsible researcher or maker needs to ensure that visibility does not cause harm to its participants, for example in projects that tackle human rights issues or might generate knowledge uncomfortable for decision-makers. A case of this was the negative, unintended impact in a grassroots innovation project trying to help homeless people by developing water filtration tools, but as newspapers started reporting about them, people in the settlements, who were considered illegal, got evicted.

Context × Inclusiveness

- Explanation: To become aware of exclusive, contextual patterns. It is necessary to understand these in order to not (even if by 'accident') exclude others. This is especially applicable to women, elderly, and other, traditionally underrepresented groups. It is crucial to understand how exclusion works and support people based on the contextual patterns of exclusion.
- Example: Projects proactively designed to include underrepresented communities and develop frameworks that support their inclusion based on the context. An example is a capacity-building project that develops the self-esteem of minorities

and allows them to become part of a ‘time share bank’ for participating in incubation programs, instead of having them pay, thus, building an alternative economy.

Context × Responsiveness

- Explanation: To understand the particular societal needs arising from the context and to respond to them through making and other types of innovations. In addition to this, knowing how to react and whom to contact to address the societal needs and risks related to novel innovations or identified during making.
- Example: Responsive makers and grassroots innovators are those who directly address the needs of community. Responsiveness could also mean having the networks and ability to reach e.g. local politicians to generate influence on higher levels and achieving the goal through policy change or other types of support.

Framings × Anticipation

- Anticipation relates to forward-looking activities and deliberate actions aiming to affect future pathways whereas framing as an academic term refers to existing shared meanings and cultural structures that shape these meanings. A small group of actors often only has an impact on broader cultural discourses and assumptions once the community has grown into a movement. In addition, it is also difficult to anticipate the changes in these structures within which they need to carry out their work.

Framings × Reflexivity

- Explanation: To become aware of how the language and terminology used shapes the actions taken, and what kinds of values and interests are mobilized, maintained or challenged with the language used. Shared framings can help and hinder dialogues. Once this is recognized, a learning process can begin and change might occur.
- Examples: Reflecting upon the framings we work with might reveal how different people understand the terms free, open source, open innovation and how different community members’ experiences might clash in these wordings. Framings of different concepts, such as nationalist, leftist/socialist or capitalist framings of social innovation are influenced by the country where it takes place and its history. Another example could be framings of beneficiaries in fundraising processes: for this purpose, they are often described as passive, ‘in need of help’, downplaying their abilities to contrast with the abilities of those who will be funded to deliver that necessary help.

Framings × Inclusiveness

- Explanation: To reflect upon and become aware of the wordings that are used in verbal or written communication, or the setup of the space one creates for the community. Does a specific setup lead to inclusion or exclusion? Does the shared umbrella of interpretation within the existing community lead to missing any perspectives?
- Examples: Creating shared interpretations is necessarily a collective, discussion-based process. When a member of the community argues for a particular idea,

other perspectives are automatically downplayed. This collective production of ideas and meanings creates bonds but might also exclude others. Does the term 'maker' exclude 'makeuses' and vice versa?

- Framings × Responsiveness
- Not applicable: Similarly to the Anticipation × Framings, we find that the intersection of Framings × Responsiveness is not an applicable category. The reason is that framings cannot be influenced through policies, standards and public action but are rather changed slowly over time, through collective reflection.

Spaces/Strategies × Anticipation

- Explanation: To become aware of one's own strategies to act, to learn to deliberately build strategies towards desired futures and to be able to anticipate what kinds of futures (and future spaces of action) the applied strategies create.
- Examples: Strategies are always forward-looking in themselves, with an explicitly or automatically embedded idea of which directions to take and why. By asking the participants what their goal is for the next years, or what kind of world do they want to see then and how does their project help them reach this, such strategies of anticipation can be mapped.

Spaces/Strategies × Reflexivity

- Explanation: To become aware of how chosen spaces and strategies influence other people, including what the risks and rewards for the surrounding community and environment of the chosen strategies are. After deliberating the strategy itself (as it might be something that was not consciously planned), one might ask themselves: What are then the 'side effects' of the strategies communities have chosen?
- Examples: By saying no to taking money from a big company, an already underfunded community remains low on financial resources, however, their practice stays uninfluenced. Instead, they decide to use limited but non-attached resources to avoid outside powers impact their values and practices in ways they deem as negative. Another example is when a community receives particular machines free of charge. If this is a 3D printer, they might move away from paper prototyping and create more plastic waste than previously in the process, which becomes an unintended impact caused by the resources they have.

Spaces/Strategies × Inclusiveness

- Explanation: To become aware of the norms and conventions that 'made the space' in terms of making or grassroots innovations. What has contributed to it including particular people, and if someone is excluded, there is a need to become aware of those norms and conventions, physical structures and language that contributed to the exclusion. There is a need to become aware of what capabilities and skills are expected from people to be allowed to participate.
- Examples: In addition to physical inclusiveness (accessibility or safety of space, tools, website), cultural, and other influences might also play a role. In some countries, cultural issues might play a role, such as it being inappropriate for women to leave their homes in the evening. This has led to only men meeting in

the spaces created for the whole community in a project. The issue was reflected upon, and additional activities were planned from then on during the daytime hours.

Spaces/Strategies × Responsiveness

- **Explanation:** To explore how available resources will influence what you do and if the resources or chosen strategies limit the scope of social goals you address? How to act to expand the resources and whom to engage in commenting and reflecting the chosen strategies?
- **Examples:** It might be explored what skills are available within the team and which tools they have access to. Was there a case when they wanted to do something but their skills, tools, space, resources didn't let them, so they pivoted and did it differently? Did this modification still develop a suitable solution? How was this possible?

Pathways × Anticipation

- **Explanation:** To become more aware of what sort of pathways are supported. What future pathways are consciously or subconsciously made while doing concrete projects? These need to be reflected upon, including their potential plurality to anticipate the impact of the ethical pathways. The goal is to recognize the path dependencies, become aware of what one can change with the created pathway and what not, for example through envisioning: what is the future the project is aiming at, and what are the different pathways to get there?
- **Examples:** Acknowledging that prerequisites need to be achieved before efficient change is done is crucial. While change might be blocked by existing structures, but with long-term planning of a pathway, one can have an impact. An example of such long-term planning of hidden agendas includes community network projects that at first glance are about physical infrastructures, however, their ultimate goal is empowering and protection of the rights of indigenous communities.

Pathways × Reflexivity

- **Explanation:** To become aware of one's own role and the situatedness of the activities carried out, including how those impact/influence the environment. By recognizing the various pathways (anticipation), the potential social and ecological impacts can be reflected upon.
- **Examples:** If a maker community decides to opt for distributed manufacturing, they ought to recognize their own role in making various pathways happen. These pathways can be based on business and start-up culture, or can be more environmentally or socially just, representing changes the maker movement significantly contributed/can significantly contribute to.

Pathways × Inclusiveness

- **Explanation:** To reflect upon whether the developed or imagined pathways maintain existing exclusive structures, do they create new exclusions, new divisions between people? How can they be made more inclusive?

- Examples: The long-term work of a social innovator and activist lobbying for internet laws to be more open in the late 1990s to turn his country into a knowledge-based society combined with the completely separate work of another social innovator bringing micro-hydro plants for sustainable electricity to remote areas combined enable remote communities today to have their own community-maintained electricity and internet without being hindered to do so by the market or complicated laws.

Pathways × Responsiveness

- Explanation: To investigate which societal actors and resources need to be engaged to support the realization of desired future pathways and whether there is a need of policy or regulatory changes.
- Example: For open hardware in healthcare, a project has explored pathways which, depending on the cultural context, needed legal changes, e.g. in the medical device legislation, to be adapted in order to become available. Makers might strategically engage with academia to receive new ideas, cooperate on interdisciplinary projects, or visibility through scientific articles, leading to more impact to change future pathways. Some also engage with governments on different levels, or the United Nations, not only to receive funding, but also to influence e.g. the political support of creative economy and so shape a desired future pathway.

The benefits of cross-fertilizing GIM & RRI frameworks

The cross-fertilization of the GIM and RRI frameworks benefits both discussions. The analytical conceptualizations of GIM are originally developed for researchers to understand the dynamics of social movements. In that sense, it provides an outsider's perspective to grassroots innovations. Currently, it is not used to support grassroots processes or as part of participatory action research. While combining it with the RRI capacities, we want to elaborate this framework towards a reflexive tool that is useful for both researchers interested in multiple dimensions of social responsibility in grassroots innovation but also for practitioners to support their reflexive processes. Following that the combining of the general RRI principles with the GIM insight on grassroots innovations as a social movement will also enrich both theories. For the RRI discussion, the dialogue with GIM broadens the concept of innovation which has so far been restricted to institutional innovation settings. For the GIM community, it provides new approaches for future-oriented participatory action research.

Summary and outlook

Although the Critical Making Responsibility Framework has been developed only recently and still needs to prove its validity in practical and analytical contexts, first feedback from actors in the field is very encouraging.

On the one hand, the Critical Making consortium has already made use of the framework to create awareness about criticality and responsibility in maker settings and the framework has contributed to shaping the co-design of interventions. The outcomes of these participatory and co-creative sessions were summarized in parallel with the peer review process of this paper and were shared at the FAB17 conference to inform wider audiences

about those first experiences in applying the framework, including concrete questions developed by the co-designers based on the Framework and pertinent to the cases (Sipos et al. 2022a).

In the next phase, the consortium will further validate and elaborate the descriptions within the case actions, and then with field actors to get their insights on the relevancy of suggested responsibility dimensions. Once the general framework is ready, we move on to develop specific toolsets (including concrete guiding questions) for:

1. researchers that engage makers in participatory action and for
2. grassroots innovators in the field (e.g. makers).

This is done to create a self-reflective tool for people and communities who ask themselves whether their practice is sustainable, responsible, etc. and also to provide a tool for researchers and policymakers who want to assess the responsibility of particular actions. The Critical Making Responsibility Framework is thus to be further developed into hands-on tools, tested and iteratively developed in a variety of co-designed case actions within the Critical Making project.

While developing a questionnaire for self-evaluation and planning is relatively straightforward, it is not necessarily fun or engaging. Overburdening people with seemingly theoretical or rhetorical questions who would rather be tinkering cannot lead to useful outcomes. Thus, we will explore the possibility of accessible, easy-to-use, hands-on, visual tools that allow the process to be gamified, with reflexive questions as prompts. The medium will be decided upon together with the practitioners and tested and iterated together with them, and the language will go through further ‘translation’ processes to make the tool accessible in non-academic language and to be made hands-on and practical to be used before (for planning), during (for reflection) and after (for self-evaluation) any grassroots community and project. As maker communities often work, develop and think together, grassroots making is a non-linear and very creative process. We are curious to see: while grassroots often act in very hands-on ways, what happens if maker communities are given or give themselves the tools, time and permission to think, anticipate, reflect together?

Notes

1. A more detailed literature review of the term can be found in the Critical Making Baseline report, developed to support the work of the Consortium (Sipos, Åkerman, and Wenzelmann 2022b). This report includes the analysis of various relevant practices, including its roots in critical technical practice, critical design, adversarial design, critical engineering, tactical media, etc.
2. See for example MoRRi or SuperMoRRi.
3. See for example the RRI-tools portal <https://rri-tools.eu/> or the NewHoRRizon societal readiness thinking tool <https://newhorizon.eu/thinking-tool/>.
4. The working definition has been outlined in the Critical Making Baseline Report, which is yet to be published. At the same time, to “give back” to makers, a methodological toolbox translating the principles back to the everyday practice is being developed and tested in a participatory manner. See <https://zenodo.org/record/5948298#.YoIx8C-23BI>
5. The cases are anonymized to protect the identities of those who could be negatively affected by having their names or projects revealed, as they work in complicated political contexts. However, as a reviewer pointed out, referencing the projects adds relevance to their theoretization. The project highlights best practice cases – whenever safe and appropriate – on the <https://criticalmaking.eu> website and on social media.

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CHAPTER 3: EXTENDED ABSTRACT OF THE PRESENTATION ON “RESHAPING RRI KEYS TO EMBRACE GRASSROOTS INNOVATIONS: FOCUS ON COMMUNITY EMPOWERMENT” AT EU-SPRI 2022

[142] Maria Åkerman (VTT Technical Research Centre of Finland), Hanna Saari (VTT Technical Research Centre of Finland) and Regina Sipos (TU Berlin). *Reshaping RRI keys to embrace grassroots innovations: focus on community empowerment.*

Abstract. Recent research has shown the potential of grassroots innovations and maker communities to shape socially relevant, problem-driven innovations. To ensure that these citizen-driven innovation processes ultimately lead to more sustainable and inclusive outcomes, there is a need to increase and support the reflexivity and responsibility of key grassroots innovation actors, including communities active in makerspaces and fablabs. Currently the concept of Responsible Research and Innovation (RRI), which is originally developed for the purposes of institutionalised research and innovation funding and performing organisations fails to address the particularities of these kinds of citizen-driven processes taking place outside research organizations. As the sites of frugal and grassroots innovations are diverse ranging from social collectives to informal enterprises, also the understanding of dynamics of innovations and their social embeddedness needs to be revised and enriched with context specific knowledge to make the concept of RRI meaningful for these communities.

To address the need to support responsible citizen- and community-driven innovations, the EU funded Critical Making project has co-created a Critical Making Responsibility Framework to better understand how social responsibility can be understood, practiced, and evaluated at the level of grassroots innovations. The Critical Making Responsibility Framework draws from the existing conceptualisations of RRI capacities, including anticipation, reflexivity, inclusion and responsiveness (Tassone et al. 2018) and reinterprets them with an in-depth substance understanding of social embeddedness of maker-driven grassroots innovations provided by grassroots innovation movement (GIM) studies (Smith et al. 201). The GIM framework guides researchers to focus on the context, framings, pathways and spaces and strategies shaping the development of grassroots innovation communities. The core of the Critical Making Responsibility framework is to put the analytical, retrospective four-dimensional GIM framework into dialogue with the forward looking and reflexive RRI capacities approach.

This presentation introduces the Critical Making Responsibility framework and presents the experiences related to its participatory development and application while evaluating different types of responsibility interventions in maker spaces. Based on these learnings, we will also introduce and justify a suggestion to include community empowerment as a novel RRI key when evaluating grassroots innovations. Our preliminary results indicate, in line with the existing research on grass roots innovations, that a functioning community with committed members is one of the most important corner stones of grassroots innovation movements, and therefore projects working with these communities should also take community empowerment seriously. Empowered grass-roots communities have a feeling of capability when it comes to creating changes in the society and they hold the keys to maintaining their functionality in the long term. These kinds of community empowerment aspects are not covered by the existing RRI monitoring and indicator frameworks.

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Keywords: Grassroots innovations, Maker movement, RRI capacity, Responsibility framework, Community empowerment

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CHAPTER 4: FAB17 CONFERENCE PAPER AND PRESENTATION ON EXTENDING THE ACADEMIC FRAMEWORK TOWARDS MAKERS

Critical Making Responsibility Framework. Extending an Academic Proposal to Support Reflexivity in Maker Communities

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Abstract

Bottom-up initiatives from maker networks across the globe, such as the first aid response during the outbreak of the Coronavirus, are currently showing how responsible innovation is happening outside the constraints of profit-driven large industries. We are witnessing the development of alternatives to DIY and making as a hobby. In this process, critical, socially responsible making and a professionalization of the maker-driven open hardware movement resembles how open source software became a widespread alternative to proprietary software. However, the positive societal, economic, and environmental impacts of the maker movement are still researched. The Critical Making project aims to gain scientific insights into the potentials of the maker movement for critical, socially responsible making in a participatory way. With both an academic and a practice-oriented audience in mind the project develops the Critical Making Responsibility Framework and a corresponding practical toolset to help reflect on core principles of critical making, such as social responsibility, sustainability, openness, inclusiveness. In this paper we present the emergence of the Critical Making Responsibility Framework and its current state. Also, we reflect on the experiences of makers having contributed to the development of the reflective toolset and discuss some of the challenges encountered along the way.

Keywords

Critical making, responsibility, reflexivity, criticality, grassroots innovation, social innovation

1 Introduction

Over the last decades a large and continuously growing ecosystem of DIY, makers, hackers, and innovators has emerged that produce innovations across all fields of applications. This development has shaken up the research and innovation system in many ways, from its culture of openness and collaboration to the democratization of production and personalized manufacturing. The maker community has become important for industry, who seek collaboration, but also for academic research, as a way to encourage

students to become more interested in science, technology, and engineering. Since making and makerspaces represent a distinct approach from conventional ways of innovation, academic interest in the practice has been on the rise.

Alongside the positive examples however, academia has been debating whether the promises of positive societal, economic, and environmental impacts of the maker movement are truly delivered. The Critical Making project, which is funded by the European Union's Horizon 2020 Research Funding Programme, aims to explore this question, and has been engaging in participatory action research for the past year and a half, aligned with an integrated interdisciplinary approach to explore responsibility in making.

In this contribution, we present the current version of the Critical Making Responsibility Framework, embedded in a wider analysis of the current state-of-the-art on critical, responsible making and innovation practices. The Critical Making consortium has made use of the framework to create awareness about criticality and responsibility in maker settings and the framework has contributed to shaping the co-design of interventions. First experiences in co-developing specific toolsets, including concrete guiding questions, for researchers who engage makers in participatory action and for grassroots innovators in the field, e.g. makers, have gained positive feedback. In this paper we dive deeper into the applicability and usefulness of a self-reflection tool that allows the reflection process to be gamified, with reflexive questions as prompts. We hope that through this iterative process, the framework can become more practical, and useful for any grassroots community and project at different creative stages.

2 Current Approaches Towards Critical Making

There has been growing academic interest in the maker movement as researchers started to explore its innovation potential. The literature base on making is growing. Research interests span from educational opportunities (e.g. Halverson & Sheridan 2014, Vuorikari et al. 2019, Stilz 2021) to economic aspects (e.g. Anderson 2012, Fasoli 2017 & Tassinari 2017, Langley et al. 2017) and societal implications of maker communities (e.g. Millard et al. 2018, Menichinelli & Smith 2019, Kieslinger et al. 2021). In the following we concentrate our state-of-the-art analysis on the democratization potential, and potentials for social and responsible innovation.

2.1 Open, social and responsible innovation practice in making

Openness seems to be an inherent characteristic of maker practice. It appears as one of the central values of the global movement (e.g. Dreessen, Sheepers & Leen 2016). Many makerspaces explicitly state openness and sharing as one of their core values, and it is outlined in the Fab Charter that every branded FabLab commits to (Johns & Hall 2020). Open-source software and hardware are central to the practical everyday lives of makerspaces (e.g. Haldrup, Hoby & Padfield 2018; Tanenbaum et al. 2013). Sharing designs openly online is also a major factor behind the global expansion of the movement. The effect that the expiration of closed licenses of 3D printers had on the global maker scene showcases this. As the designs of previously only commercially available 3D printing technology became available, makers around the world embraced the new possibilities and open-source 3D printers were immediately developed, with some becoming closed-sourced again (Benchoff 2016).

However, there is a need to critically reflect the contested understandings of openness as it may also lead to tension within the maker movement (Saari et al. 2021). Openness is a multifaceted concept and has many meanings depending on the situation and community. Beyond the most obvious definition of open-source software and hardware, openness can also refer to inclusion of different groups of people as well as the openness of economic structures and spaces of entrepreneurship. As the maker movement, when understood as a global network of makers and different spaces for making, innovation and tinkering, is very diverse, it also comes with its tensions. These include tensions that arise from different imaginaries and scenarios as well as tensions that derive from balancing between individual and collective aims and needs (Saari et al. 2021).

The maker movement has been praised for its democratization potential, of the production process as well as of skills acquisition. Making empowers people to be creative and autonomous in solving any relevant local problem themselves, using machinery and materials at hand, adapting existing open designs, and sharing their innovations with a global community which does not discriminate between perceived experts and non-experts (Brady et al 2014; Bilandzic & Foth 2013, Keulartz & van den Belt 2016).

The democratizing power of makerspaces can also be seen in its results in making technology and its outcomes accessible for everyone. Makerspaces are supporting the creation of citizen science or social innovation projects, such as 3D-printed prosthetics, cheap sensor-based solutions for agriculture, and making technological solutions affordable for low-income people. There are a lot of makerspaces that create communities for their members, contribute to the improvement of the lives of people, or help them understand that technology does not need to be an inaccessible black box. At the same time, we also see modes of social critique in hacker- and makerspaces. Media art, fine art and other interactive artists have e.g. adopted maker practices and technologies to highlight critical stances within their work, using making as a mode of revealing a critical approach to embedded technological systems (Stoyanova 2017).

Narratives celebrating the maker movement even speak about a new industrial revolution (Anderson 2012), and the democratization of innovation and technology design by empowering the consumer (Tanenbaum et al. 2013) to make their own products through prosumerism (Paltrinieri and Esposti 2013). Maker communities have been celebrated for their potential for far-reaching social (Unterfrauner et al. 2019; Bosse et al. 2019), political (Maxigas 2012), and environmental (Lange 2017; Kohtala 2016) impacts. Makerspaces don't necessarily self-identify as spaces of social innovation, but some specialize in solving societal issues by engaging in certain activities.

At the same time, with the increasing popularity of the maker movement, criticisms have surfaced. Expectations have been high, but even with tens of thousands of workshops around the world, making remains a fringe phenomenon and the above mentioned new industrial revolution (Anderson 2012) has been difficult to prove (Troxler and Maxigas 2014). Similarly, concerns about unquestioned technosolutionism, namely the belief that technology can unilaterally solve all of society's problems have surfaced (Lindtner et al. 2016).

The social impact of makers in Western countries may be limited by the mainstream rhetoric of the entrepreneur maker and the standard engineering practices of their educational backgrounds. Thus, we need to ask: if innovating for society is a main goal of maker communities, who does it and how do practitioners innovate and engage in multidisciplinary processes that include critical thinking, reflexivity, and co-creation with others? One potential answer we see is *critical making*, a practice that was developed to unite critical thinking and the material practice of making (Ratto and Hockema 2009).

2.2 Critical Making

The Critical Making project¹³ emerged from the gap that research on the potential democratization power of the maker movement has still been scarce until recently. Thus, a transdisciplinary team of researchers and makers jointly launched a participatory research agenda at the start of 2021 to study grassroots innovation processes encountered in the maker community.

The project was inspired by the concept of *critical making*. Albeit still a niche approach, it has had a major impact on the design of the project. As briefly highlighted above, the term *critical making* was coined to describe an innovative approach to scholarship (Ratto and Hockema 2009) combining critical thinking and making to help engineering students understand so-called wicked problems. This idea was based on critical technical practice, aiming to bridge disciplinary mindsets as a precondition to hybrid multi-disciplinary practices in technology development (Agre 1997). Later, it was extended towards grassroots

¹³ <https://criticalmaking.eu/>

approaches and critical citizenship, which have been described through the terms “maktivism” and “DIY citizenship” (Ratto and Boler 2014). Subsequently, the term was adapted to look beyond the idealized picture of the maker and to “reintroduce a sense of criticality back into post-2010 maker culture to un-sanitize, un-smooth and re-politicize it” (Hertz 2015). Hertz encouraged a type of making different from mainstream making, which dares to express political critique through art, activism, and social innovation. Ratto extended critical making as a practice “from academic critique to situated intervention” (Ratto 2016), working with a non-profit social enterprise, developing personalized 3D-printed prosthetics for people in Uganda and Cambodia. Finally, the term was co-creatively explored to understand whether it resonated with makers working outside of Western makerspaces (Sipos and Wenzelmann 2021). Thus, in terms of maker activities outside of academia, the term has been developing towards a better understanding of citizen’s practices and situated intervention outside of academia, as well as an encouragement of makers to express more critique through their material practice.

3 Towards a Critical Making Responsibility Framework

In the Critical Making project, the “critical” in “critical making” refers to the exploration of makers’ approaches to critical thinking and reflexivity about responsibility. The Critical Making Responsibility Framework, which is work in progress, draws from the analytical framework proposed to research grassroots innovation movements (GIM, Smith et al. 2016) to understand the social embeddedness of maker movement and puts that into dialogue with concept of Responsible Research and Innovation (RRI) capabilities developed within the European-centric research policy debates on responsibility of innovations (e.g. Stilgoe, Owen, and Macnaghten 2013). Combining these two conceptual/analytical approaches into the Critical Making Responsibility Framework aims to help researchers in participatory action research projects to better understand the criticality, reflexivity, and responsible practices of innovation within grassroots, involving the points of view of grassroots practitioners. At the same time, the consortium aims to provide a practical version of the framework as a critical reflection tool to makers and maker communities.

3.1 RRI capacities in grassroots innovations

RRI is a concept originally developed for the specific context of EU research and innovation funding (e.g. Gianni et al. 2019). The need for a new framework arose from the critical notions within science and technology studies claiming that research and innovation activities are not always well-aligned with the needs and realities of citizens and researchers should consider them more (e.g. Irwin 1995). It has been claimed that a closer connection between society and science is needed (Gibbons 1999), as the results of research are often ambiguous: they bring about better standards of life, but as by-products they also produce some considerable societal risks. The RRI framework therefore highlights the importance of engaging the public into scientific and innovation processes (e.g. Stilgoe et al. 2014) and the need for building capacities for successful encounters between science and society (e.g. Selin et al. 2017; Tassone et al. 2018).

The RRI approach has been organized around six policy keys, namely gender, governance, ethics, stakeholder and public engagement, and science education. These six keys come with their own sets of indicators that can be used in evaluation of science and innovation activities.¹⁴ The RRI framework also has the aspect of building capabilities for a more reflexive, inclusive, anticipatory, and responsive future. These capabilities form the RRI capacity framework (see Figure 1; Tassone et al. 2018). We use the RRI capabilities framework to create a new understanding of the responsibility questions important in grassroots innovation communities.

¹⁴ See for example <https://rri-tools.eu/> and <https://wbc-rri.net/tag/rri-keys/>

So far, RRI tools and indicators have been mostly built for institutionalized settings of research and innovation. The viewpoints of grass-roots communities and small-scale innovation have not been considered in depth (Mamidipudi and Frahm 2020). The RRI framework has also been criticized for being Euro-centric (Bhaduri and Talat 2020), as it fails to recognize concepts such as grassroots and frugal innovation, which are especially prominent in the Global South (Mamidipudi and Frahm 2020). Currently available RRI tools and indicators are thus difficult to apply in the context of the global maker movement. However, we deem the RRI framework to be tailorable for diverse contexts. As we combine the four RRI capacities with the framework of Grassroots Innovation Movements, we believe the RRI frame will offer fruitful perspectives and new insights. Grass-roots innovations are more closely tied to the contexts of innovation compared to traditional, institutionalized research and innovation activities, and thus a fresh perspective has to be deployed.

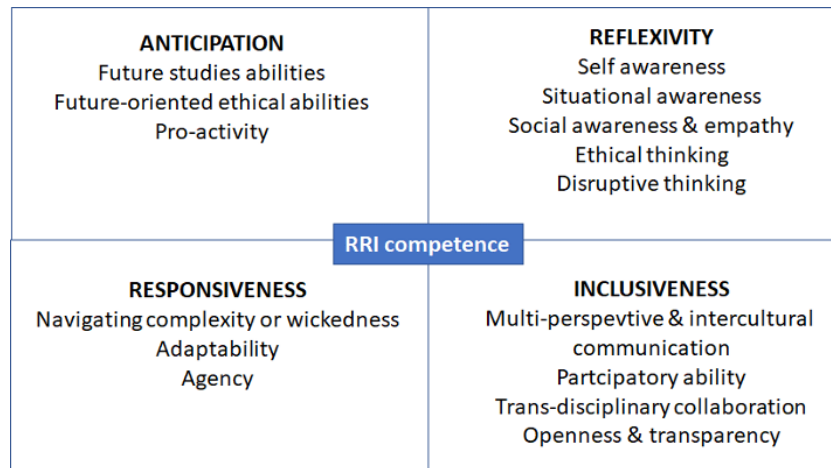


Figure 1: RRI Competences (Source: Tassone et al. 2018)

3.2 Grassroots innovation movements analytical framework

Grassroots innovation, as opposed to mainstream innovation, is a phenomenon that has gained ample research interest in the past decades (e.g. Hess 2009 or Smith 2005). The term refers to innovation activities outside of formal institutions, often done by and for citizens to answer direct, immediate, contextual needs and problems. Grassroots innovation movements as a concept has been used to describe different makerspaces, hackerspaces, and other spaces of small-scale, grassroots innovation communities around the world. Central values widely shared by such spaces are open sharing of designs and cooperative nature of working, where innovative solutions are developed as a community effort. The strength of these communities is their adaptive and responsive nature, as they are generally able to change and adapt faster than institutionalized, large innovation units.

To better understand the grassroots innovation movements, Smith et al. (2016) developed the Grassroots Innovation Movements framework (GIM). The framework includes four distinct yet interrelated aspects, namely pathways, spaces and strategies, context and framings. Each of these dimensions acts as a lens through which different aspects affecting the development of grassroots innovation movements can be analysed. The aim of this framework is to provide researchers with a set of aspects that can help better understand the developments of such movements over time, often retrospectively. Smith et al. (2017) applied it to show the diverse landscape of making in Western countries, while Arancio (2021) applied GIM to analyse the Global Open Science Hardware (GOSH) movement.

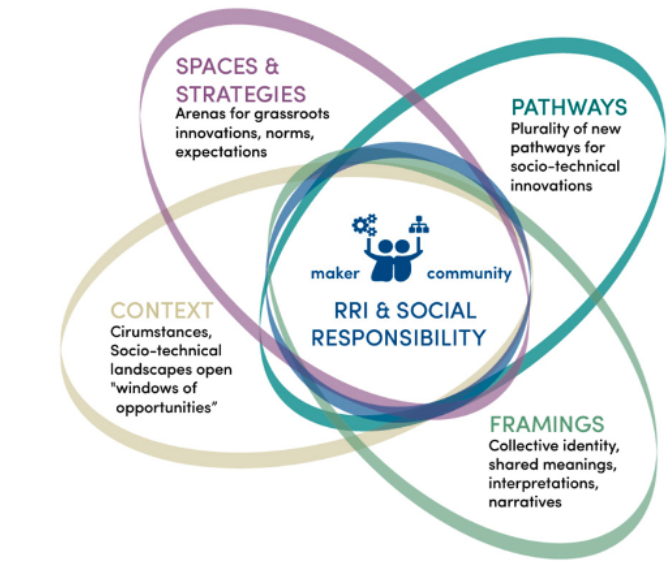


Figure 2: The GIM framework in relation to RRI & Social Responsibility. The Consortium's illustration.

We use the GIM framework in combination with the RRI capacities framework to make it more concretely usable for steering the grass-roots movements into desirable futures. However, it is not our aim to use the tool as researchers from outside these movements, but to build it to be an useful and empowering tool for the grassroots movements themselves. For this purpose, combining the specific developmental dimensions of the GIM framework with the forward-looking capabilities of RRI is regarded as a fruitful approach.

3.3 The Critical Making Responsibility Framework

Based on these two approaches of RRI and GIM the Critical Making consortium came forward with a matrix combining GIM dimensions and RRI competences. This matrix includes short descriptions of each created intersection, picturing what the combination of different aspects could mean in practice (see Table 1). Overall, the matrix consists of 14 fields instead of 16, as the combination of RRI and GIM was deemed not applicable in two cases¹⁵ (Sipos et al. 2022b).

Combining all aspects clearly resulted in a lengthy, onerous, cognitively demanding exercise and a complex matrix, which does not lend itself easily for practical purposes. Thus, we build on a transdisciplinary co-creation process to further develop the matrix into a useful tool for makers, as outlined in the next sections.

¹⁵ See the published toolkit which is available under <https://zenodo.org/record/5948298#.YysuWC222i4>. The relevant part can be found under Chapter 5: Critical Making Responsibility Framework.

| | Anticipation | Reflexivity | Inclusiveness | Responsiveness |
|-------------------------------|---|---|--|--|
| Context | Ability to understand and act upon the ongoing changes in social, historical, political, economic, cultural, religious contexts (trends & weak signals) and other circumstances and what kind of opportunities, restrictions and requirements they may provide in the future. | To become aware of how social, historical, political, economic, cultural and religious context have affected on ones activities (innovations, projects etc.) and what kinds of contexts their reactions & innovations might create, (eg. vicious circles or hope, and for whom?) | To become aware of exclusive, contextual patterns - to understand that you don't by accident exclude others (like women, elderly, etc) - understanding how exclusion works and supporting people based on the contextual patterns of exclusion | To understand the particular societal needs arising from the context and to respond to them through making & innovations and in addition knowing "how to react and whom to contact to influence the societal rules of the game. |
| Framings | not applicable | To become aware of how used language and terminology shapes the actions taken and what kinds of values and interests are mobilized, maintained or challenged with the language used. Shared framings can help and hinder dialogues and once that is recognized, something new can be learned. | To reflect upon and become aware of the wordings that are used, or the setup of the space, and whether they create inclusion or exclusion? Does the shared umbrella of interpretation lead to missing any perspectives? | not applicable |
| Spaces/ Strategies | To become aware of one's own strategies to act, to learn to deliberately build strategies towards desired futures and to be able to anticipate what kinds of futures (and future spaces of action) the applied strategies create. | To become aware of how chosen strategies influence other people or environment - what are the risks and rewards for the surrounding community and environment of the chosen strategies | To become aware of the norms and conventions that "made the space" of making & innovations: if excludes someone, become aware of these norms and conventions, physical structures and language. | To explore how available resources will influence what you do (skills in the team; tools available) and how to act to expand them. |
| Pathways | To become more aware of what sort of pathways are supported: what future pathways are made while doing concrete projects, and reflect upon the potential plurality of it, to anticipate the impact of the ethical pathways. To recognize the path dependencies, become aware of what one can change with the created pathway and what not. | To become aware of one's own role and the situatedness of the activities carried out: how those impact/influence the environment. By recognizing the various pathways (anticipation), the potential social and ecological impacts can be reflected upon. | To reflect upon whether the developed or imagined pathways maintain existing exclusive structures, do they create new exclusions, new divisions between people? How can they be made more inclusive? | To investigate what kind of support the desired pathways would need in the broader social context (knowledge, funding, policy changes etc.) and/or whether they may face resistance and to consider how this support can be gained and resistance addressed. |

Table 1: GIM x RRI Matrix (Sipos et al. 2022b)

4 Reflective participatory co-creation process

In the Critical Making project, we follow a participatory approach that is strongly engaging representatives from the maker communities in all phases of the project. To build the Critical Making knowledge-base and advance it with original evidence, we apply a mixed method approach, based on participation, and inspired by participatory action research. This enables us as a consortium to collect data, analyse it, actively improve practices, and develop theories and synthesize findings with representatives from both, grassroots innovators from global maker communities and social innovation academics.

The theoretical framework presented above was inspired by existing maker practices aimed at supporting self-reflection, such as the set of "Sustainable Making Principles" (Nuesse and Wanalo 2019). Based on these principles and an initial workshop with global makers where different facets of critical making practices were reflected, the critical making consortium came forward with a working definition for responsibility in making and grassroots innovations. This initial definition refers to the following: Responsible innovation and making in grassroots practices means that those who tinker with existing technologies and develop new solutions do this critically. This criticality reflects on their responsibility to ensure that the solutions are:

- locally situated and community-based
- responsible, ethically correct and addressing societal needs
- based on critical thoughts and reflections about power structures
- aim to have positive impact and change structures
- and the practice itself is joyful and meaningful to the makers (Sipos et al. 2022a)

Adding the working definition with the state-of-the-art analysis on critical making practices and adding the theoretical constructs of RRI and GIM lead to the first GIM x RRI matrix or Critical Making Framework. The aim of the original matrix was to explore how the forward looking and reflexive RRI principles and retrospective GIM framework enrich each other. We have particularly wanted to understand and explore which dimensions align with each other and which might not. In total, eight multidisciplinary researchers with backgrounds in social sciences and STS, experience with maker communities, GIM and/or RRI, as well as disciplinary foci on gender, education and specializations in open source technology and development shared their experiences during this step of the process. They explored the feasibility and opportunities of developing the matrix and engaged in discussions on its usefulness and practicalities of implementation.

As a next step this theoretical construct, which was already an outcome of a collaborative effort, was put to test by filling it with examples and exemplary triggering questions in a reflexive exchange with makers. This was seen as a first attempt to support the understanding and the thought process of the future users of the framework. The initial examples and questions were mostly generated by practitioners engaged in Critical Making project activities. As some of those engaged in the global case actions work in complicated political contexts the cases are anonymized to protect the identities of those who could be negatively affected by having their names or projects revealed.

As the first framework ended in a large set of highly complex and partly overlapping questions, a next reflection round with a selected group of makers was initiated. It led to a critical revision of the matrix approach and the generation of applicable scenarios for the future use of the framework and the leading reflective questions.

Overall, this co-creation approach of the framework and the reflective questions involved more than 50 individuals from global maker communities and related practices. Due to the pandemic, interactions were mostly done in online sessions, such as the initial co-creation workshop in April 2021 or a dedicated workshop to discuss in detail about examples and reflective questions in September 2022. In addition to the online encounters, informal feedback was also collected during various face-to-face encounters, such as consortium meetings or the re:publica 2022 event in Berlin, where a panel and multiple workshops related to the work done in the Critical Making project were held.

The co-creation of the Critical Making Responsibility Framework is a reflective circular process (Fig. 3) with various loops and the findings so far will feed into further reflections and enhancements. In the next section we will present the critical outcomes so far and the final section will discuss some very initial ideas on how the framework may develop further and become a useful tool for critical making practices in the future.

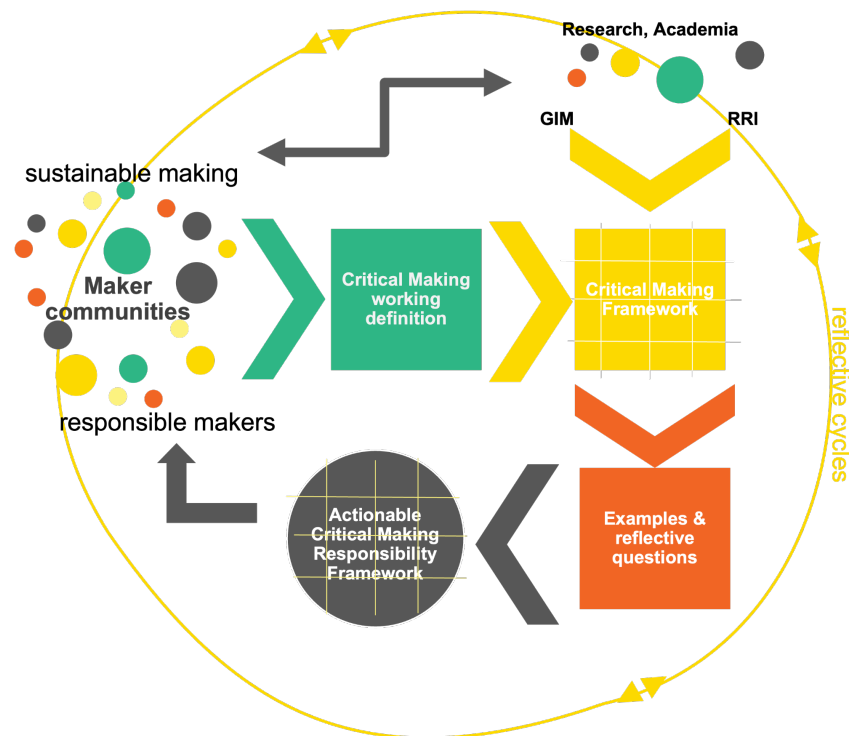


Figure 3: Cyclic process towards an actionable Critical Making Responsibility Framework.

5 Experiences from Co-creating a Critical Making Responsibility Framework

While the interactions and co-design process of the Critical Making Responsibility Framework has spanned over many months and includes various iterations and mostly unstructured reflective cycles, as described above, in this section we focus on the insights gained during a dedicated online workshop held in September 2022. This workshop was organized specifically to collect examples from experienced global makers (joining us online from Brazil, Germany, Namibia, and Singapore), to discuss leading questions for self-reflection, and to reflect on the potential usefulness and application scenarios of the framework in maker practices. To facilitate the discussion and make the process easier, questions were pre-selected by the authors of this paper. The interaction was facilitated using a collaborative white board online (Fig. 4).

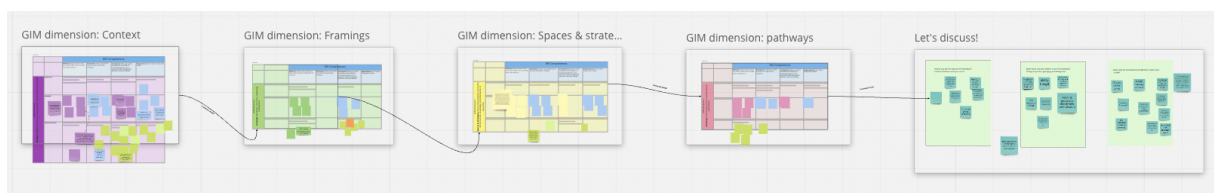


Figure 4: Online white Board supporting co-creation in the Critical Making Responsibility Framework workshop with makers.

After a general presentation of the framework workshop participants were asked to give examples for each of the four RRI competences (reflexivity, anticipation, inclusiveness, responsiveness) focusing on the four concepts of grassroots innovation movements (broader contexts, framings, spaces and strategies and pathways) one after the other. As a next step the pre-selected triggering questions were discussed to see whether they fit for self-reflection on the aspects or not (see Table 2).

| GIM/RRI | Reflexivity | Anticipation | Inclusiveness | Responsiveness |
|--------------------------------|--|--|--|---|
| Context | <i>What societal changes do you promote with your making practices?</i> | <i>What kinds of trends or development pathways enable or hamper your maker practices in the future?</i> | <i>Are there any cultural, economic or other contextual factors that exclude some groups (eg. women, people with disabilities etc.) from making? Can you do anything about that?</i> | <i>How do you answer the specific needs of your community?</i> |
| Framings | <i>How does the way you speak about your making affect the decisions you make?</i> <i>Do all parties understand the terminology you use similarly, or are there different understandings?</i> | <i>Not applicable</i> | <i>Is the language you use inclusive of different groups and people?</i> | <i>Not applicable</i> |
| Spaces & Strategies | <i>Have you considered social and ecological sustainability when planning your actions?</i> | <i>What is your strategy for sustaining your activities in the long run?</i> | <i>What might be particular barriers (also physical ones) for any societal groups to participate? How could these be overcome?</i> | <i>How can you (as a team) work to overcome material scarcities and/or lack of skills?</i> |
| Pathways | <i>How can you create a culture around making that encourages critical thinking and sustainability values while also being fun?</i> | <i>Are your actions creating a pathway towards the kind of future that you want to see (even if in a small way)?</i> | <i>Are you building towards a more inclusive future? For whom?</i> | <i>From which societal actors would you need support to realize the future you hope to see?</i> |

Table 2: Initial reflexive questions that were discussed in the co-working workshop.

During the discussion, we paid particular attention to which proposed questions seemed to engage the minds of the makers, e.g. by triggering ideas, or the number of examples they were able to share from their own experiences. Some questions were easy for them to re-formulate, others were still somewhat detached from their everyday practice or existing reflections, hence, we saw a lot less engagement with those questions. Moreover, towards the end of the 3-hour workshop, the participants were getting tired, and we received less input than at the beginning. We can derive two hypotheses from this: first, that the questions proposed in the last round were potentially less well formulated or engaging than the first three rounds, or that the topic of “pathways” is not one people are either familiar with or can reflect upon in relation to spaces that are only a few years old - pathways is one of those topics in GIM that are easier to address in retrospect. The second hypothesis is that a 3-hour long reflexive workshop might be too demanding for people. We, the researchers, also encountered this problem as we developed the matrix and will be proposing solutions below.

Overall, the feedback received from the experienced makers on the framework itself and on the leading questions was very positive. All participating makers easily contributed to the matrix with examples from their own practices, making the applicability of the combined terms clearly visible. However, it was not always clear which RRI competence the example would mostly respond to (e.g. reflexivity and responsiveness was thought of as overlapping concepts), indicating that clearer definitions might be needed to distinguish them, which is an interesting finding to explore in the future.

Based on some *context*-related examples a discussion emerged around the aspects of *reflexivity*, which defines the competence of becoming aware of how your actions reflect the surrounding world and influence it, and *responsiveness*, defined as the capability to act to make a change when needed, and

different interpretations of the term. The “Computers against COVID” initiative of Salvage Garden in Singapore¹⁶ can be understood as an example of both competences. The local maker community collected donations of old, unused laptops and electronic devices and refurbished them. Not only did the initiative show a fast response to an unforeseen crisis by providing laptops to low income families, but it also showed the gaps of the digital readiness policies and promoted rapid action from the Ministry of Education. In addition, electronic waste material that was left over from the refurbishing process was collected and turned into useful devices again, such as speakers. So, the idea of repurposing of the spare parts and refurbishing bluetooth speakers was born from the reflection on the potential negative impact of creating e-waste.

When discussing the RRI competences with regards to their possible *framings* we realized that there was a discrepancy between the provided examples and the guiding questions. While the examples also included aspects of underlying assumptions and narratives the questions were mostly focusing on the responsible way of how to use language and how to communicate with others. A good example that was brought up in the context of framing and inclusiveness was to think not only of who is participating in certain activities and workshops, but also who is running those activities: a maker posed the self-reflexive question “how could someone think of whom they are excluding if they are not excluding them consciously?” With this question, the legitimacy of the framework as a prompt to start those discussions was reassured.

An important discussion also emerged around the aspect of *spaces & strategies*. While most of the initial pre-selected questions were formulated having individual makers or maker communities in mind, we realized that especially this point should include some questions that are targeting teams running makerspaces. Discussions took place around what constitutes a “community”, which, to some, means an established group of people. Here one might think about the “membership” of a makerspace instead if the human connection that forges a community has not been established yet. Previously, similar concerns about “citizens” were expressed, as e.g. in the case of a project working with refugees, they might not be citizens of the place where the project is located. Moreover, recommendations were shared to address a town or city instead, where the makerspace is located. For example, if they grow a community around a certain project or local space, it is important to consider who they take money from to sustain the activities (in this case, e.g. the municipality of the town), as funding often comes with expectations from the funder’s side.

The most difficult aspect for the makers to come up with examples and reflect on their practice, was the future looking dimension of *pathways*. This is completely reasonable, as in GIM, pathways are most easy to utilize retrospectively. Difficulties might arise especially if the framework should be applied as a planning tool it is difficult to distinguish between pathways, which refers to alternative actions for possible futures, and strategies, which would be the concrete and deliberate ways one would plan to take in order to achieve a certain objective. A guiding question that came out of the discussion to support critical thinking in terms of pathways has been formulated as follows: “How do you create alternatives to the prominent way of doing things?”.

After going through the whole matrix by adding examples and reflecting on the questions, a refined set of questions had emerged (see Table 3). Most of the initial questions were changed in the process, although a few were accepted by the makers in the original form. The set of questions we have after the workshop is more understandable for makers and better reflects the complex intersections of different GIM and RRI dimensions, likely generating even richer reflections on different themes.

¹⁶ <https://salvage.garden/>

| GIM/RRI | Reflexivity | Anticipation | Inclusiveness | Responsiveness |
|--------------------------------|---|---|---|---|
| Context | What societal changes do you promote with your making practices? | <i>How do you future proof your practice?</i> | <i>Who is giving workshops or teaching in your space? Is it managed so that everyone can feel comfortable in the space?</i> | <i>What actions/steps can you take to better understand societal needs? How does this shape the actions you intend to take?</i> |
| Framings | <i>How does the way you speak about your making practice affect the decisions you make?</i> | <i>Not applicable</i> | <i>When presenting your space, are you choosing narratives/stories that are inclusive?</i> | <i>Not applicable</i> |
| Spaces & Strategies | Have you considered social and ecological sustainability when planning your actions? | <i>Who do you take money and/or resources from and how does that affect your making practices?</i> | What might be particular barriers (also physical ones) for any societal groups to participate? How could these be overcome? | <i>How can you work to overcome material scarcities and/or lack of skills in your project?</i> |
| Pathways | <i>How can you create and support alternatives to prominent ways of doing things?</i> | <i>Are your actions contributing to the kind of future that you want to see (even if in a small way)?</i> | Are you building towards a more inclusive future? For whom? | From which public or private societal actors (e.g. companies, politicians, schools) would you need support to realize the future you hope to see? |

Table 3: Elaborated reflexive questions after the workshop.

In a final round of brainstorming and reflection, the overall usefulness of the framework for makers and how it could be made appealing to them was discussed. These preliminary ideas makers shared with us of how the framework could become useful and remain a fun activity to engage with will be explained in the next section.

6 Towards a Maker-Friendly Tool

The creation of the initially theory-driven Critical Making Responsibility Framework and the attempts to turn it into a reflexive tool to support makers' sustainability has included many rounds of co-design and co-creation, as we have deemed it important to engage makers in the process. When producing a tool to be used by practitioners, it is crucial to engage them in the process to ensure that what we produce is meaningful, understandable, and attractive for them. To fit the tool for different contexts globally, we also tried to engage a diverse group of co-researchers, makers and makerspace leaders from different contexts and places. The work of elaborating the GIM-RRI matrix and related set of reflection questions into a tool usable in maker contexts is continuing, and more interaction with makers is still needed in the future to ensure the relevancy of our work.

As explained in this article, we departed from the scientific RRI and GIM frameworks that we believed could bring useful insights if brought together. The challenge has been the academic nature of both frameworks: they use academic language, difficult terminology and include complex concepts. Bringing them together and building an easy-to-use practical tool for non-academics who have different socioeconomic backgrounds and speak different languages is a challenge. That is also why we have made a considerable effort to explain the terminology, simplify the language and challenge our own thinking by engaging with makers. Engaging makers who work on diverse cultural settings and with diverse groups of people to provide input for us and ultimately to co-design a new set of reflection questions has been an invaluable help in bringing the tool closer to actual contexts of use.

To make the Critical Making Responsibility Framework useful for makers is not only dependent on the formulation of questions. In the next step, we also need to develop a concept of how the framework is

used by makers, how the reflexive process is implemented in practice and what could motivate makers to engage in responsibility (self-)evaluation. Here, we face the fundamental dilemma of implementing critical thinking in making without taking the fun out of maker practices. As researchers, we have a significantly different view on responsibility compared to makers, whose main interest is often to build things. To successfully translate the academic concepts into a tool for practitioners, we need to be aware of these differences in thinking.

So far, the feedback we have gotten from makers has been encouraging. The makers we have engaged with have expressed interest in using the reflexive questions to develop their working styles and to generate new discussions around the themes. In the workshop, the participating makers also found the reflexive questions to be fruitful in the sense that they triggered new thoughts and opened new viewpoints to responsibility. We have already gained interest towards our reflection tool from very different contexts, as makers from e.g. Singapore, Germany and Finland have explicitly said they would be interested in using the tool in the future, if an easy-to-use version were to be distributed.

However, to make this happen we still need to figure out how to make a version of the tool that would be motivating and even fun to use. Some initial ideas, which have to be further explored, prototyped and tested are for example to turn the questions into an online test, to gamify the approach and have it e.g. as physical playing cards in maker spaces and to translate the framework and questions into other languages and cultural contexts. Another question was raised around the possible usefulness of Critical Making badges to be obtained by going through the guiding questions. Maybe such a badge could add additional credibility for obtaining funding for future projects. However, we still see the tool mostly for self-reflection and by no means does the Critical Making consortium see itself as an authority who would decide on what is critical making and what is not. The final form of the reflexive tool will be defined later, as our work inside the consortium and together with makers continues.

It was also stressed in the workshop that to find the reflexive questions meaningful and inspiring, makers should have internal motivation to become more responsible in the first place. The makers we have engaged with so far have been diverse in many aspects, but they cannot be interpreted as a representative sample of makers' attitudes towards responsibility, critical thinking, or reflexive tools like the one we intend to develop. Therefore, it is central that we find the right channels to reach the makers who would want to get help in becoming more critical and responsible.

As we continue our work, we will test and define a format to present the questions that will be easy enough to use, inspiring and meaningful for makers looking for support in enhancing their practice. As we test preliminary versions of a tool based on this framework, we will also refine the questions as needed, based on the feedback we gather. We will also pay attention to testing the questions with a diverse group of makers to ensure it resonates to different practitioners. The tool will also be translated to different languages to test its usability in different languages, such as German and Finnish. Different maker communities will still be engaged in different phases and feedback will be gathered. Our aim is to co-create a tool with makers for makers to enhance their critical thinking and ultimately their sustainability practices.

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CHAPTER 5: CRITICAL MAKING ESCAPE ROOM GAME FLYER

CRITICAL MAKING

~ Critical Making game



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Are you a Critical Maker? Would you like to unpack your practices and reflect with your community?

Play the Critical Making escape room game here:
play.criticalmaking.eu OR scan the QR code



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REFLECTION AND CONCLUSION

The process of developing alternative framings of critical making (as in: investigating a reflexive grassroots innovation practice, as opposed to an academic practice) had to start with a tool that did not exist before.

Combining RRI and GIM was indeed a good idea, however, we realized quickly that the academic framework was not going to work for non-academic audiences, even if each component of the original matrix could be underlined with a case from the field. We also realized early on that this much reflection was onerous, and that if even we, who work with the frameworks on a daily basis were being exhausted by it, how would makers react to it? This is why one of the first realizations we came to was: “Overburdening people with seemingly theoretical or rhetorical questions who would rather be tinkering cannot lead to useful outcomes” (page 18, Sipos and Akerman 2022), or “the fundamental dilemma of implementing critical thinking in making without taking the fun out of maker practices” (page 69, Sipos et al. 2022).

Our next big question was: we know that we want makers to become more reflexive, but do they want to become more reflexive? What is their motivation? Some makers argued that the usefulness of such a set of questions lies in obtaining funding for future projects; and that a badge could add credibility to obtain those funds. Here, we took a step back: “(...) we still see the tool mostly for self-reflection and by no means does the Critical Making consortium see itself as an authority who would decide on what is critical making and what is not.” (page 69, Sipos et al. 2022).

To avoid working on something that would ultimately end up gathering dust in a corner, at each opportunity, we asked the practitioners to help us develop the

reflexive questions, the medium carrying the questions, and the use cases for such a tool. We received many great ideas and a lot of encouragement, and while we could not develop all ideas (e.g. a physical set of cards, a boardgame, or a different format that is more community-based), those might still be possible in the future.

For now, the Critical Making game is open source and its code is available on GitHub for anyone to fork it. We are also gathering all the input so that in future research, a map of critical makers can be created, so that they can see how they compare with others on the global scale; and we can see how makers become more and more reflexive over time.

Overall, with the work in Critical Making and especially this WP we feel that we were able to contribute to answering the following open question:

“As maker communities often work, develop and think together, grassroots making is a non-linear and very creative process. We are curious to see: while grassroots often act in very hands-on ways, what happens if maker communities are given or give themselves the tools, time and permission to think, anticipate, reflect together?” (page 18, Sipos and Akerman 2022)

ANNEX I: QUESTIONNAIRE

Critical Making Responsibility Questionnaire

Hi Maker!

Thank you so much for helping us refine the "Critical Making Responsibility Framework". This framework is aimed to help makers reflect on their practice.

Below you will find 14 questions, some might be easy, others might be quite difficult. Our goal with this is to test if the reflexive questions we designed make sense and are useful. Thus, we hope that some of the questions might also help you think about your own practice.

You can fill this out on your own, or with your friends, or the whole maker community. Your data is only used for research purposes within the Critical Making team and not shared with third parties.

We hope you'll enjoy!

The [Critical Making](#) Project Team

* Gibt eine erforderliche Frage an

1. Who are you filling this out with?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Alone
- ☐ With members of my maker space
- ☐ Sonstiges: _____

Here are our 14 reflexive questions:

2. 1. What societal changes do you promote with your making practices? *

E.g. community-based innovation processes that reflect upcoming societal changes.

3. Did this question make sense to you? *

Markieren Sie nur ein Oval.

| | | | | | | |
|-----|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Not | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Yes, it did |

4. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

5. How would you better reformulate the question? (in case it was not clear)

6. 2. How do you "future proof" your practice?

Think about how social, historical, political, economic, cultural and religious contexts have affected your activities, and what kinds of contexts your actions and innovations might cause. A negative example for this could be the unintended impact caused by a grassroots innovation project trying to help homeless people by developing water filtration tools, but as newspapers started reporting about them, people in the settlements, who were considered as illegal, got evicted.

7. Did this question make sense to you? *

Markieren Sie nur ein Oval.

| | | | | | | |
|-----|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Not | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Yes, it did |

8. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

9. How would you better reformulate the question? (in case it was not clear)

10. 3. Who is giving workshops or teaching in your space? Is it managed so that everyone can feel comfortable in the space?

Projects proactively designed to include underrepresented communities and develop framework that support their inclusion based on the context. An example is a capacity building project that develops the self-esteem of minorities and allows them to become part of a "time share bank" for participating in incubation programmes, instead of having them pay, thus, building an alternative economy.

11. Did this question make sense to you? *

Markieren Sie nur ein Oval.

| | 1 | 2 | 3 | 4 | 5 | |
|-----|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------|
| Not | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Yes, it did |

12. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

13. How would you better reformulate the question? (in case it was not clear)

14. 4. What actions / steps can you take to better understand societal needs? How does this shape the actions you intend to take?

Responsive makers and grassroots innovators are those who directly address the needs of community. Responsiveness could also mean having the networks and ability to reach e.g. local politicians to generate influence on higher levels and achieving the goal through policy change or other types of support.

15. Did this question make sense to you? *

Markieren Sie nur ein Oval.

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|-----|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Not | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Yes, it did |

16. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

17. How would you better reformulate the question? (in case it was not clear)

18. 5. How does the way you speak about your making practice affect the decisions you take?

Different people understand the terms free, open source, open or social innovation differently, and different community members' experiences might clash in these wordings. Another example could be framings of beneficiaries in fundraising processes: for this purpose, they are often described as passive, "in need of help", downplaying their abilities to contrast with the abilities of those who will be funded to deliver that necessary help.

19. Did this question make sense to you? *

Markieren Sie nur ein Oval.

1 2 3 4 5

Not ☐ ☐ ☐ ☐ ☐ Yes, it did

20. How would you better reformulate the question? (in case it was not clear)

21. 6. When presenting your space, are you choosing narratives / stories that are inclusive?

Creating shared interpretations is a collective, discussion-based process, creating bonds but maybe excluding others. E.g. does the term "maker" exclude "makeuses" and vice versa?

22. Did this question make sense to you? *

Markieren Sie nur ein Oval.

1 2 3 4 5

Not ☐ ☐ ☐ ☐ ☐ Yes, it did

23. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

24. How would you better reformulate the question? (in case it was not clear)

25. 7. Have you considered social and ecological sustainability when planning your actions?

E.g. by asking your community what their goal is for the next years, or what kind of world do they want to see then and how does their project help them reach this, you can better understand how they build strategies towards desired futures.

26. Did this question make sense to you? *

Markieren Sie nur ein Oval.

1 2 3 4 5

Not ☐ ☐ ☐ ☐ ☐ Yes, it did

27. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

28. How would you better reformulate the question? (in case it was not clear)

29. 8. Who do you take money and/or resources from and how does that affect your making practices?

E.g. By saying no to taking money from a big company, an already underfunded community remains low on financial resources, however, their practice stays uninfluenced. Instead, they decide to use limited but non-attached resources to avoid outside powers impact their values and practices in negative ways. Another example is when a community receives particular machines free of charge. If this is a 3D printer, they might move away from paper prototyping and create more plastic waste than previously in the process.

30. Did this question make sense to you? *

Markieren Sie nur ein Oval.

1 2 3 4 5

Not ☐ ☐ ☐ ☐ ☐ Yes, it did

31. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

32. How would you better reformulate the question? (in case it was not clear)

33. 9. What might be particular barriers (also physical ones) for any societal groups to participate? How could these be overcome?

In addition to physical inclusiveness (accessibility or safety of space, tools, website), cultural, and other influences might exclude people. In some countries, cultural issues might play a role, such as it being inappropriate for women to leave their homes in the evening. In one case, this has led to only men meeting in the spaces created for the whole community in a project. The issue was reflected upon, and additional activities were planned from then on during the daytime hours.

34. Did this question make sense to you? *

Markieren Sie nur ein Oval.

1 2 3 4 5

Not ☐ ☐ ☐ ☐ ☐ Yes, it did

35. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

36. How would you better reformulate the question? (in case it was not clear)

37. 10. How can you work to overcome material scarcities and/or lack of skills in your project?

Here, you can think about what skills are available within the team and which tools they have access to. Was there a case when they wanted to do something but their skills, tools, space, resources didn't let them, so they pivoted and did it differently? Did this modification still develop a suitable solution? How was this possible?

38. Did this question make sense to you? *

Markieren Sie nur ein Oval.

1 2 3 4 5

Not ☐ ☐ ☐ ☐ ☐ Yes, it did

39. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

40. How would you better reformulate the question? (in case it was not clear)

41. 11. How can you create and support alternatives to prominent ways of doing things?

What is the future the project is aiming at, and what are the different pathways to get there? Which change might be blocked by existing structures, with long-term planning of a pathway, one can have an impact. An example of such long-term planning of hidden agendas includes community network projects that at first glance are about physical infrastructures, however, their ultimate goal is empowering and protection of the rights of indigenous communities.

42. Did this question make sense to you? *

Markieren Sie nur ein Oval.

1 2 3 4 5

Not ☐ ☐ ☐ ☐ ☐ Yes, it did

43. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

44. How would you better reformulate the question? (in case it was not clear)

45. 12. Are your actions contributing to the kind of future you want to see (even if in a small way)?

E.g. if a maker community decides to opt for distributed manufacturing, they should recognize their own role in making it happen: based on business and start-up culture, or choosing a more environmentally or socially just direction; essentially representing changes the maker movement significantly contributed/can significantly contribute to.

46. Did this question make sense to you? *

Markieren Sie nur ein Oval.

1 2 3 4 5

Not ☐ ☐ ☐ ☐ ☐ Yes, it did

47. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

48. How would you better reformulate the question? (in case it was not clear)

49. 13. Are you building towards a more inclusive future? For whom?

E.g. The long-term work of a social innovator and activist lobbying for internet laws to be more open in the late 1990's to turn his country into a knowledge-based society + the completely separate work of another social innovator bringing micro-hydro plants for sustainable electricity remote areas = enabling remote communities today to have their own community-maintained electricity and internet without being hindered to do so by the market or complicated laws.

50. Did this question make sense to you? *

Markieren Sie nur ein Oval.

1 2 3 4 5

Not ☐ ☐ ☐ ☐ ☐ Yes, it did

51. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

52. How would you better reformulate the question? (in case it was not clear)

53. 14. From which public or private societal actors (e.g. companies, politicians, schools) would you need support to realise the future you hope to see?

E.g. For open hardware in healthcare, a project has explored what legal changes were needed to be adapted in order to become available, and realised it was medical device legislation. Makers might strategically engage with academia to receive new ideas, cooperate on interdisciplinary projects, gain visibility through scientific articles, leading to more impact to change future pathways. Some also engage with governments on different levels, or the United Nations, not only to receive funding, but also to influence e.g. the political support of creative economy and so shape a desired future pathway.

54. Did this question make sense to you? *

Markieren Sie nur ein Oval.

1 2 3 4 5

Not ☐ ☐ ☐ ☐ ☐ Yes, it did

55. Was the example useful for the question?

Wählen Sie alle zutreffenden Antworten aus.

- ☐ Yes, without it I would not have been able to understand the question clearly
- ☐ It explained the question better, but I would have answered the same anyway
- ☐ I did not need the example
- ☐ The example was confusing

56. How would you better reformulate the question? (in case it was not clear)

Feedback

Thank you so much for answering our reflexive questions! Only a few more moments for feedback and you're done :)

57. How did you like the questions overall?

Markieren Sie nur ein Oval.

1 2 3 4 5

The ☐ ☐ ☐ ☐ ☐ We had lots of fun!

58. Did the questions help you think about your practice in a way that you might change it in the future?

Markieren Sie nur ein Oval.

1 2 3 4 5

Not ☐ ☐ ☐ ☐ ☐ Yes, the questions were inspiring

59. Could you imagine using the questions in the future?

Markieren Sie nur ein Oval.

- ☐ Yes
- ☐ No
- ☐ Maybe

60. In which context or setting could you imagine using this framework (or questionnaire) in the future?

61. How can we make this questionnaire more fun and engaging for makers? (as playing card a canvas, an interactive website, a badge for filling it out, a new type of event or workshop any ideas welcome!)

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