# Ross Dalziel PhD

Explore the ‘dark matter’ of literacy in the convergence of microbiological research with technical culture through *embodiment* and *resilience*.

## Practice & Position Statement

I bring people together from across disciplines, practices and backgrounds around unique, playful and collaborative projects and spaces. These projects manifest as table-top workshops, demos, maker fairs, artist labs, media labs, market stalls, micro conferences, performances, open source hardware & software, pop up production lines, temporary installations, card games, artefacts, hackdays, symposia, minecraft maps, publications, cafés, residencies, text adventures, game hacks and jams, ‘critical kits’[[1]](#footnote-0) and learning resources.

The projects often explore potential transformative points in science and technology through a contextual, participatory and situated practice that fosters forms of communal ‘grass roots’ literacy, agency and ultimately, resilience. I take selected practices from *technical culture* and embed them in situations to build new and engaging perspectives. I see the sciences and the technical not as subjects for artistic spectacle, speculation or critique but rather a *technical culture* for artists to critically participate in.

This non-representational antidisciplinary[[2]](#footnote-1) approach entangles ‘master’ narratives of emerging or established research with other knowledge practices through critical doing, playing and making. These become strategic social encounters intuitively distilled from the careful building of unique relationships, collaborations and conversations from key individuals and communities. A background in informal workshop based education in creative technology, arts & crafts based youth & play services work, community art and documentary media and public engagement with art and heritage informs this relationship building.

*Technical culture* then for my practice is an entangled social and physical sphere of the communities that build and maintain the physical systems and services that make up the network of artefacts of science and engineering knowledge in the human environment.

It’s worth noting that my recent practice is informed by participating in the technical culture of the north west of England. Notably volunteering and advocacy in the early NorthWest Maker scene, the co-working makerspace DoESLiverpool and early MadLab community, an independent laser cutting studio based at STATIC Liverpool and 15 years of research, development and delivery with FACT as a freelance artist, technician, curator, educator and critical friend. I am co-founder of SoundNetwork, Domestic Science and Currently in Oslo, all artist led organisations exploring art, music, science and technical culture in social settings often outside of conventional art spaces.

## Project Rationale

### Foreground and context

I use the term *technical culture* to refer to a broad space of science and engineering practices that extend and give critical perspective to the emerged ‘maker’ culture and makerspaces which have been recent settings for my practice. It encompasses the idea of ‘digital making’ but also the lived experience of **building** and **maintaining** software and hardware systems and communities through hybrid forms of documentation and distribution. It is informed by all the physical sciences and manifests across amateur, artisan and professionalised crafts and systems engineering. It includes so called geek culture, open source and DIY culture and pre-maker hackerspaces.

Critical Kits[[3]](#footnote-2) is a collaborative project I co-developed with Re-Dock[[4]](#footnote-3) looking at the post-’maker’ landscape and how it meets participatory, inclusive and community-based forms of artistic digital practice. I see “Critical-Kits” as a tool to engage in ‘maker’ culture and open up space for the ‘messy’ humanities in a highly creative yet STEM based culture. Many of the concerns of this ongoing project led to the approach for this proposal and a need to formalise and continue practice based research in this field.

‘Maker’ or ‘DIY’ practices, seen through it’s upstream source of *technical culture*, are increasingly embedded in both domestic and laboratory settings; these are fascinating spaces for a ‘scientific literacy’[[5]](#footnote-4) to play out: a literacy made up of diverse knowledge practices that result in a slippery mix of agency, ethics and control, possibility and anxiety. This literacy and the agency it implies is a key maker culture claim, something that the Critical Kits frame can be used to explore.

I’ve been exploring this area with Domestic Science[[6]](#footnote-5), Re-Dock and FACT. With FACT, Dr Mark Wright and Paul Harter we re-framed the game and social phenomenon of Minecraft as an embodied social design tool then further with MCQN Ltd[[7]](#footnote-6), built kits and resources for encounters with the Internet Of Things, RF-Craft[[8]](#footnote-7) part of the FACT/AHRC ITaaU Network project, CloudMaker[[9]](#footnote-8). Recently I used the game culture of interactive fiction and the playful spaces the computer game arcades and fairgrounds of the past pioneered to explore ‘big’ and small data through Interactive Non-Fiction[[10]](#footnote-9)

All these projects took place while being embedded in the technical culture of the co-working and makerspace DoESLiverpool[[11]](#footnote-10). These projects used formats of open source kit making and documentation in hardware and software, project and community management tools and culture learnt from this experience and key relationships with community members. Embedded as a participant in the DoES culture led to the practice based realisation of the potential of these practices as new forms of developing, maintaining, distributing and documenting art practice.

### Perspective and Metaphors

The main perspective then for this project is built up from a uniquely combined situated practice, background and position. There is an ethnographic perspective at work in a practice based approach informed by work on embodied interaction by Paul Dourish and recent readings of Karen Barad.

***Dark matter[[12]](#footnote-11)*** *is invisible yet inferred, entangled with everything, distributed everywhere but difficult to quantify; the gravity well of dark matter accounts for our own galaxy holding together and not flying away and yet it remains elusive and opaque in it’s nature. It is a useful metaphor for describing the opportunities, problems and key processes of collaborating across artistic, scientific and maker practices, co-creation, literacy, agency, documentation and knowledge as a practice.*

***Resilience*** *is seen as ultimately the implication and effect of the ‘dark matter of makerspaces’[[13]](#footnote-12) of a network of* ***anti-disciplinary*** *[[14]](#footnote-13)knowledge practices. I argue that this is a key perspective for DIY and hackerspace technical culture. Within the maker meme: ‘making’ is sometimes a mis-direction with focus on the made ‘awesome’ object: making should really be seen as the process of embodiment of literacy, agency and resilience, the made object or project are the artefacts of knowledge in practice, ‘Critical Kits’ ready for distribution.*

*A powerful narrative of technical and maker culture is of learning and sharing information particularly in the open source approach to working, the friendly accessible face of technical knowledge, lowering barriers to entry, this to becomes a path to a resilience through literacy and agency*

*Resilience also alludes to maker responses to social ‘issues at hand’ prevalent in the more civic minded DIY/Open Source area of technical culture: projects like Field Ready[[15]](#footnote-14), Public Practice[[16]](#footnote-15), Post-Biotics[[17]](#footnote-16) perform this in the most obvious way and characteristic of technical culture to solve or optimise a problem. Startup culture effectively scales up and exploits this resilience to disrupt but it is also a path to exploring less mainstream notions of ‘critical engineering’, ‘tactical media’ and ‘stacktivism’ as well as exploring concerns in STS studies and embodied interaction*

*Resilience* re-frames the rhetoric of “Technology Will Save Us”[[18]](#footnote-17) maker innovation so we can look more closely at the agency, ethics and knowledge transfer at work.

***Critical Kits;*** the ‘kit’ format, predominant in Maker culture, is a modular self contained format that can be deployed in a situation independent of the artist or maker. The collaboration with Re-Dock, Critical Kits “consider(s) the wider context of a 100 years of art practice that engages with popular educational formats such as kits, recipes and instructions ... to find new moves for participatory art, moves that use digital making to question our relationship to technology and explore multiple and alternate possibilities for its role in our lives.”[[19]](#footnote-18)

Critical Kits are not just sets of instructional interactions with interactive media but more like the embodiment of resilience and hybrid forms of documentation, publication and distribution of participatory artistic and technical practice. The kit is a materialisation of the nature-culture it comes from and the awareness of this is the critical perspective in the project.

I was an artist and facilitator for a DoESLiverpool, FACT and Crafts council project exploring contemporary tool making, [Desktop Prosthetics](http://cheapjack.github.io/2015/06/20/desktopprosthetics)[[20]](#footnote-19). The made objects where custom measured 3d printed prosthetic hands from an existing open source ‘kit’ made by [Enabling the Future](http://enablingthefuture.org/upper-limb-prosthetics/the-raptor-hand/)[[21]](#footnote-20) for young people. The core of the work in addition to building from (& contributing to) instructions however, was myself and DoESLiverpool embedding our makerspace practice (team working, open sourcing, version control, documentation and project management by issue tracking) into a conventional design exhibition; a production line of 3D printed prosthetic limbs specified by local families and charities and run by volunteers and gallery staff. Here the technical cultural practices of makerspace desktop 3D printing, the learned resilience, around the kit were inherited from its use despite being notably absent from the kits instructions. These practices where passed on to a fledgling makerspace starting up in Norwich part of the convention of a touring exhibition. To make practices and cultures tour is a concept worth pursuing beyond scope of that work.

Critical kits then are a new critical awareness of a kits cultural and social context which demands appropriate documentation. In Desktop Prosthetics case we used github to do this and frequently pointed arts organisers and marketeers and the wider public to this dense form of documentation with some success in articulating quite a complex story and some frustration.

### Study

Critical Kits Bio-club: Exploring a ‘dark matter’ of literacy in the Biomedical & Life Sciences through *embodiment* and *resilience* in laboratory and domestic spaces.

From the perspective and position of my practice, explore the transformative research area of bacterial communication, behaviour and taxis where it converges with technical and digital culture.

The core of the study embeds my artistic practice in a research group of biomedical researchers in **Microbial communication & taxis, Microfluidics and Transmission of disease by insect vectors.** This informal group, “ClubBioMed” co-founded with Dr Rod Dillon to embed creative practice in the faculty of Biomedical Life Sciences at Lancaster University, will become a focal point for this practice based research.

The ‘Critical Kits’ concept will frame the practice and making; artworks, kits, artefacts and tools co-created by this group will embody the collaborative research informed by a series of critical reflections. The reflections and outcomes will be played out across a series of encounters and field work situated in laboratory and studio, research and teaching practice at Lancaster and LJMU and in the wider public sphere in community spaces and libraries in the North of the UK

It will generate artworks and ‘Critical Kits’ to provoke models of scientific literacy, agency and resilience within biological research, artistic and technical practice.

## Proposed Methodology

### Research Questions

* By participating in the dark matter of technical culture, embedded in a microbiology lab and associated research groups, what are the opportunities for agency, literacy, ethics and resilience?
* What are the opportunities to entangle scientific literacy with more diverse practices and practitioners?
* What Critical Kits can be made to embody and materialise these opportunities in the emerging transformative tech space of microbiological research and bio-engineering (eg. biological analysis, computation substrates, heuristics)
* How do kits further embodied interaction?
  + How can kits contribute to the relation between STS research and artistic practice?
  + What is the nature of challenge in terms of literacy and agency in kit responses to bio-engineering?
  + What are the scaling opportunities for Critical Kit and DIYbio practices along the lines of RCA's [Future Makespaces in Redistributed Manufacturing](http://futuremakespaces.rca.ac.uk/)[[22]](#footnote-21) research and MCQN ltd [IoT scaling research](https://indie.mcqn.com/)[[23]](#footnote-22)
* What approaches informed by these questions can be made in the DIYBio space?

#### Methods

* **Community**
  + Develop ClubBioMed research network with regular social meetups and co-creation sessions across Lancaster University & LJMU exploiting and contributing to the LJMU Art & Science MA.
  + Develop other groups across LJMU research labs and in local tech community;
    - DoES Liverpool
    - LJMU Labs
* **Documentation**
  + Develop and maintain fine-grained **documentation** of the work modelled on artist’s experience of version control social platform github.
    - Refer to Library carpentry[[24]](#footnote-23)
    - Also the [dark matter of community documentation](https://gitlab.com/redock/critical-kits/blob/master/resources/presentations/DarkMatter.md)[[25]](#footnote-24)
* **Mapping**
  + Acknowledge and map out the established DIYBio[[26]](#footnote-25) groups like Hackteria[[27]](#footnote-26) and GaudiLabs[[28]](#footnote-27) and their relationship to this study
    - Mapping akin to NESTA makerspace mapping applied to DIYBio
  + Research on bacterial communication used as an heuristic in network and technical culture
  + Main bio industry movements
    - Lab-on-a-chip developments
    - Bio Engineering
    - BioInformatics
    - Biological computation & substrates
* **Key Critical Reflections**
  + **Critical Kits**
    - Kits as embodiments of practice and entanglements
    - Compare [Bixels](https://www.kickstarter.com/projects/cellfree/bixels-dna-bio-display?ref=project_tweet) with [DIY Cytofluidics](http://www.cytofluidix.com/low-tech-microfluidics/)
* **Hacking, Prototyping**
  + Develop prototype DIY ‘kit’ approaches informed by the research groups the Critical Kits project, building on past work
    - Biological organisms modelling classic computer games MsBacMan
    - Embodiment of microbiological space[[29]](#footnote-28) through game frameworks
    - DIY Lab-on-a-chip [[30]](#footnote-29)
    - AIY[[31]](#footnote-30) applied to microbiology
    - DIY microfluidics [[32]](#footnote-31)
    - Participate in key events like the recent Biofabbing convergence conference[[33]](#footnote-32) and the Festival of Maintenance.
    - Indie.mcqn.com scaling research applied to bio kits
* **Development**
  + Develop kits ready for distribution
  + Reflect critically on development and ‘ready’
* **Participation, Distribution & Engagment**
  + Programme of participation with Critical Kit prototypes & development and critical reflection by contributing to key academic and technical culture events
    - Domestic spaces; school, community centres, shopping centres and homes.
    - Micro-mart learning event micro-organisms in studio practice
    - DIYBio space and community events at DoESLiverpool in The Tapestry
    - DIYBio space embedded in the LJMU Art & Science MA programme
    - Bio fabrication activity in the LJMU research labs
      * ADA Fablab with Lol Baker
      * FACT Lab and FACT engagement programme with Neil Winterburn
      * Other LJMU research labs
    - Corporate workshops at Lancaster & LJMU following RF-RailCraft work with virgin trains
    - Micro-mart teaching in lab practice
      * Lancaster University
      * LJMU Art and Design Academy
    - Further Critical Kits Symposia with Re-Dock
    - Festival of Maintenance 2018
    - Academic Conferences
      * https://easst2018.easst.net/theme/
    - Libraries in Northwest building on Domestic Science’s Interactive Non Fiction library network
    - Maker Events
      * Manchester MSI Mini Maker Faire
      * Liverpool MakeFest
      * Maker Faire Newcastle
* **Maintenance**
  + Maintaining prototypes in practice
  + Attend and contribute to the Festival of Maintenance

These artistic encounters co-created with scientists in the Biomedical and Life sciences and supported by a network of cross discipline peers will act as an embodied case study with ‘critical kits’ distributed in a range of social spaces and contexts from laboratory to local library, charity shop to indoor market, conference to country show, living room to allotment, makerspace to National trust property.

### Needs and Mapping

A recent call for papers [Beyond show and tell: modes of manifesting STS research and artistic practice](https://nomadit.co.uk/easst/easst2018/conferencesuite.php/panels/6293) calls for “forms of encounter which use or go beyond the exhibition”. My practice rarely uses the format of a conventional exhibition or conventional gallery space; this has become a core characteristic of my work; situated in non-art social spaces as a strategy to open up engagement and interaction. Typically encounters take place on the fringes of art and tech festivals or activity developed for public engagement, bringing ‘the outside in’, of a particular exhibition or heritage site. It is participatory and partly performative in nature and attempts to go beyond the conference/maker faire ‘show and tell’. Combined with kit culture, these are essential forms of encounter to materialise an intimate embodiment of knowledge in the Art, Technology and Science space.

Recent studies of the impact of maker culture such as FutureMakespaces and Redistributed Manufacturing by the RCA[[34]](#footnote-33) have begun to analyse how this culture could transform economics and business as usual. These recent makerspace mappings indicate a messy relationship between the agency of grass-roots approaches characteristic of these spaces and the ability, need or even desire to scale.

Microbiological research is often seen as the final frontier of engineering, so the maker culture version, the DIYbio space is vital here, but there seems to be a need for similar post-maker mappings for the DIYbio space.

Convergence in computer science, engineering and microbiological research is already leading to manufacturing scale change in fields such as bioinformatics and lab-on-a-chip approaches to analysis and bio-engineering, how can the public, the consumer and ultimately a wider commons build forms of agency in this space?

I think the resilience, my agency led practice and Critical Kits work are important frames to explore this convergence.

### Academic Context *Worlds world, Matter matters*

There is a broad academic spectrum this practice based study works within. Broadly it aligns with phenomenology and new materialist thought and research but also it sits within fields of STS, Science Studies and HCI Human Computer Interaction Research. The role of academic microbiology research will become more clear as the project progresses

It uses Paul Dourish’ thoughts on the foundations of embodied interaction and Karen Barad’s thoughts on widening the diversity of practices in scientific literacy and entanglement, how “matter matters”

I have a recent awareness of a new materialism[[35]](#footnote-34) sparked off by work with Sam Skinner’s Theatre of Measurement project.

Other sporadic reading includes Mackenzie Wark’s work on hacker classes, Latour’s work, the writings of Ilya Illich and some of the ethical commentaries of Mary Midgley and Chris Batemen around bio-engineering and post network culture.

Ethnographic approaches to technical culture and makerspaces relate to broader historical media studies with a distant connection to my University experience of English Literature and Film and Television Studies then more recently a ‘Deep Time Of the Media’[[36]](#footnote-35) but also a ‘Geology of Media’[[37]](#footnote-36) that considers the infrastructure of media and technology as both social and physical, a ‘nature-culture’ that includes studies of historical medialab[[38]](#footnote-37) culture and more recent mappings of Makerspaces by NESTA[[39]](#footnote-38) et al.

The frames of *technical culture, dark matter and resilience* represent more clearly a technology as a complex embodied ‘cyberg’[[40]](#footnote-39); that is, a technology is not just a single user experience of freedom to do something, but an interconnected network and infrastructure of dependencies. So if Latour says airplanes do not fly, airlines do, this applies to almost all technology; a car does not just drive; it’s freedom of movement is not free, it needs roads, traffic control, component price points, petrol stations, oil refineries and communities of technicians to build and maintain the infrastructure that supports it.

Both maker and technical culture already have the means and cultural practice to reveal these cybergs. They use fine grained documentation using tools like wikis, [read-the-docs](https://readthedocs.org/) and the version control social platform github or Instructables and YouTube videos, indeed these are predominant forms of participation in the culture. I have experimented with some success in revealing this more complex narrrative to a wider discourse. This perhaps is the real potential and core of ‘critical’ making and the space for agency in technology’s web of dependancy.

#### Key Literature

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**Paul Dourish** [Where the Action Is: The Foundations of Embodied Interaction.](http://www.dourish.com/embodied/)

**Karen Barad** on widening a scientific literacy in conversation with **Rick Dolphin** & **Iris van der Tuin**, [*New Materialism: Interviews & Cartographies*](http://www.openhumanitiespress.org/books/titles/new-materialism/)

**Bruno Latour** [Science in Action: How to Follow Scientists and Engineers Through **Society**](https://www.goodreads.com/book/show/134571.Science_in_Action?from_search=true)

**Hannah Stewart** [NESTA Makerspace mapping](https://www.nesta.org.uk/blog/top-findings-open-dataset-uk-makerspaces)

Historical perspectives of medialabs [whatisamedialab](http://whatisamedialab.com/overview/) and [hackerspaces](https://wiki.hackerspaces.org/)

**Donna Haraway** on a critical practice for ‘making meaning and a no nonsense commitment to faithful accounts of a real world.’, ‘staying with the trouble’ and ‘Guerilla’ research anecdote from *Situated Knowledges*

**Jussi Parika** on The Office <https://jussiparikka.net/2017/06/05/amt-an-office-manual/>

**Ted Nelson** (OHG) - original hypertext gangsta

**Chris Bateman** on ‘cybergs’ and knowledge *WikiPedia Knows Nothing* and *Only A Game* blog

Critical Kits[[41]](#footnote-40) Varoious, Re-Dock, Torque

Tactical Media

**Julian Oliver** *Critical Engineering Manifesto*

Media lab timelines and a Media Archaeology

**Siegfried Zielnski** *Deep Time of the Media*

Forensic Imaginaries and **Eyal Weizmann**

<https://publiclab.org/>

**Tad Hisch** and the public practice lab <http://publicpractice.org/wp/>

#### Tied to the Mast of Maker Culture: Intimate Contexts

My practice based perspective includes academic context and established mappings but also includes the fine grained texture of my intimate experiences with the maker and hackerspace community in the UK and Europe. I see this as vital to the academic potential of this research to further entangle research and practice.

The [UK Maker Belt Association](http://slyrabbit.net/uk-maker-belt-association/); a tiny unknown non influential group nevertheless made up of influential members of the early maker movement in the north of the UK Adrian McEwen, Aaron Nielsson, Stuart Chiilds, Dave Lynch, Dave Mee, Hwa Young Jung, Andrew Back, Patrick Fenner. This is part of the unique context of my practice, embedded in the fine grained texture of maker culture.

### Critical Kits

Critical kits is a collaboration with Re-Dock an artist collective exploring particpatoy digital art. are toolboxes, resources, instructions for how to make great, or simply interesting, things happen with technology. But they also ask that we question why, and to be aware of the network of effects technologies participate in. Kit based artworks mark the convergence of two threads of practice, the use of pedagogy to stimulate experiments in social action, for example Tania Bruguera ‘Behavioural Art School’[[42]](#footnote-41) and the use of expanded publications to distribute art experiences, for example Fluxkits.

Art kits click into place between instructional art, interactive art and expanded publication.

Instructional art provides instructions without materials, interactive art offer

materials for manipulation without an instructional framework and expanded

publications offer objects and text to be seen, read and held, but not necessarily

used as tools for construction.

The ‘Critical Kits’ concept will frame the practice and making; artworks, kits, artefacts and tools co-created by this group will embody the collaborative research informed by a series of critical reflections. The reflections and outcomes will be played out across a series of encounters and field work situated in laboratory and studio, research and teaching practice at Lancaster and LJMU and in the wider public sphere in community spaces and libraries in the North of the UK

It will generate artworks and ‘Critical Kits’ to provoke models of scientific literacy, agency and resilience within biological research, artistic and technical practice.

### Past work & Connections

[Digital Media Labs](http://digitalmedialabs.org/) Das Labor, Domestic Science, Amateur Radio, John OShea, Owl Project & SoundNetwork networks

[Public Engineering](http://cheapjack.github.io/2017/02/13/gardening-dark-matter-grey-havens-and-the-background-radiation-of-makerhack-spaces)

[Critical Kits](http://kits.re-dock.org/)

[Shrimping.It](http://shrimping.it/) and [ShrimpCraft](https://github.com/cheapjack/ShrimpCraft/)

[CloudMaker](https://github.com/cheapjack/CloudMaker/)

[Oomlout](http://oomlout.com/)

STATIC and Terminal Convention [Viewing Area](http://cheapjack.github.io/ViewingArea)

[Domestic Science](http://domesticscience.org.uk/)

Other FACT work [Hacky Birthday](http://cheapjack.github.io/2013/02/23/Hacky-Birthday)

[Currently](http://www.currently.no/)

1. [Critical Kits](http://kits.re-dock.org/) Project with [Re-Dock](http://re-dock.org/) [↑](#footnote-ref-0)
2. MIT Media Labs subtitle/description [↑](#footnote-ref-1)
3. [Critical Kits Symposium & Publication](http://kits.re-dock.org/) with Neil Winterburn, Re-Dock and [Torque](http://www.torquetorque.net/) [↑](#footnote-ref-2)
4. [Re-Dock](http://re-dock.org/) Participatory digital art collective, Liverpool [↑](#footnote-ref-3)
5. Karen Barad on widening a scientific literacy in conversation with Rick Dolphin & Iris van der Tuin, *New Materialism: Interviews & Cartographies* [↑](#footnote-ref-4)
6. [*Domestic Science*](http://domesticscience.org.uk) Glenn Boulter, Ross Dalziel, Hwa Young Jung [↑](#footnote-ref-5)
7. [MCQN Ltd](http://mcqn.com/) Internet of Things company & advocate [↑](#footnote-ref-6)
8. [*RF-Craft*](https://github.com/cheapjack/RF-Craft) FACT, Ross Dalziel, Patrick Fenner, AHRC [↑](#footnote-ref-7)
9. [*CloudMaker: A utility to support social creativity*](http://www.fact.co.uk/projects/cloudmaker-making-minecraft-real.aspx)Wright MW, Stubbs M. [↑](#footnote-ref-8)
10. [*Interactive Non-Fiction*](https://gitlab.com/DomesticScience/InteractiveNonFiction/) data literacy project by [*Domestic Science*](http://domesticscience.org.uk)*.* [↑](#footnote-ref-9)
11. [*DoESLiverpool*](https://doesliverpool.com/) co-working/makerspace community in Liverpool. [↑](#footnote-ref-10)
12. Reference to [Dark Matter](https://en.wikipedia.org/wiki/Dark_matter) in physics and its use by Wouter Vanstiphout then popularised in [*Dark Matter And Trojan Horses*](http://strelka.com/en/press/books/dark-matter-and-trojan-horses-a-strategic-design-vocabulary) *by* Dan Hill . [↑](#footnote-ref-11)
13. [*The Dark Matter of Makerspaces*](https://doesliverpool.com/slides/future-makespaces-talk-the-dark-matter-of-makerspaces/)Adrian McEwen blogpost. [↑](#footnote-ref-12)
14. Ibid. [↑](#footnote-ref-13)
15. [Field Ready](https://www.fieldready.org/) Makers in Humanitarian spaces [↑](#footnote-ref-14)
16. [Public Practice](http://publicpractice.org/wp/) Research and design on pressing issues of local, national, and global concern. [↑](#footnote-ref-15)
17. [Post-biotic](http://www.post-biotics.com/) Science kit to participate in finding new antibiotics [↑](#footnote-ref-16)
18. [*Technology Will Save Us*](https://www.techwillsaveus.com/) is a company that makesmaker style kits [↑](#footnote-ref-17)
19. *Neil Winterburn & Ross Dalziel* Critical Kits and How We Use Them [↑](#footnote-ref-18)
20. [Desktop Prosthetics](http://cheapjack.github.io/2015/06/20/desktopprosthetics) DoESLiverpool, FACT and Crafts council project exploring contemporary tool making [↑](#footnote-ref-19)
21. [Enabling the Future](http://enablingthefuture.org/upper-limb-prosthetics/the-raptor-hand/) 3D printed prosthetic designs [↑](#footnote-ref-20)
22. RCA's [Future Makespaces in Redistributed Manufacturing](http://futuremakespaces.rca.ac.uk/) [↑](#footnote-ref-21)
23. MCQN ltd [IoT scaling research](https://indie.mcqn.com/) [↑](#footnote-ref-22)
24. <https://carpentry.librarydata.uk/> [↑](#footnote-ref-23)
25. [dark matter of community documentation](https://gitlab.com/redock/critical-kits/blob/master/resources/presentations/DarkMatter.md) [↑](#footnote-ref-24)
26. [*DIYBio*](https://diybio.org) [↑](#footnote-ref-25)
27. [*Hackteria*](http://www.hackteria.org/) [↑](#footnote-ref-26)
28. [*Gaudi Labs*](http://www.gaudi.ch/GaudiLabs/) [↑](#footnote-ref-27)
29. Deadwood workshop [prototype minecraft map](https://github.com/cheapjack/DeadWood) based on bacterial microscope samples [↑](#footnote-ref-28)
30. <http://www.post-biotics.com/> [↑](#footnote-ref-29)
31. [*Artificial Intelligence Yourself*](https://aiyprojects.withgoogle.com/) a *made with google* project [↑](#footnote-ref-30)
32. <http://www.cytofluidix.com/low-tech-microfluidics/> [↑](#footnote-ref-31)
33. [*Bio Fabbing*](http://citizensciences.net/biofabbing/programme/) Geneva [↑](#footnote-ref-32)
34. [*Future Makespaces in Redistributed Manufacturing*](https://www.rca.ac.uk/research-innovation/research/current-research/future-makespaces-redistributed-manufacturing/) Royal College of Art [↑](#footnote-ref-33)
35. <http://newmaterialism.eu/> research network [↑](#footnote-ref-34)
36. *Deep Time of The Media* Siegfried Zielinski [↑](#footnote-ref-35)
37. [*Geology of Media*](http://www.uminnpressblog.com/2015/04/fractured-media-materialities-on.html) [↑](#footnote-ref-36)
38. [*What Is A Media Lab? Situated practices in media studies*](http://whatisamedialab.com) Darren Wershler & Jussi Parikka [↑](#footnote-ref-37)
39. [*Makerspace Open Dataset*](https://www.nesta.org.uk/blog/top-findings-open-dataset-uk-makerspaces) Hannah Stewart [↑](#footnote-ref-38)
40. ‘[*Cybergs’*](http://onlyagame.typepad.com/only_a_game/2017/02/tip-of-the-cyberg.html) *“If a cyborg is what occurs when an organism is cybernetically enhanced by a tool like a hammer, we can call the network that produces and maintains the more complicated cyborgs like cars-and-their-drivers or computers-and-their-users, a cyberg.”* [↑](#footnote-ref-39)
41. [Critical Kits Symposium & Publication](http://kits.re-dock.org/) with Neil Winterburn, Re-Dock and [Torque](http://www.torquetorque.net/) [↑](#footnote-ref-40)
42. http://www.taniabruguera.com/cms/492-0-Ctedra+Arte+de+Conducta+Behavior+Art+School.htm [↑](#footnote-ref-41)