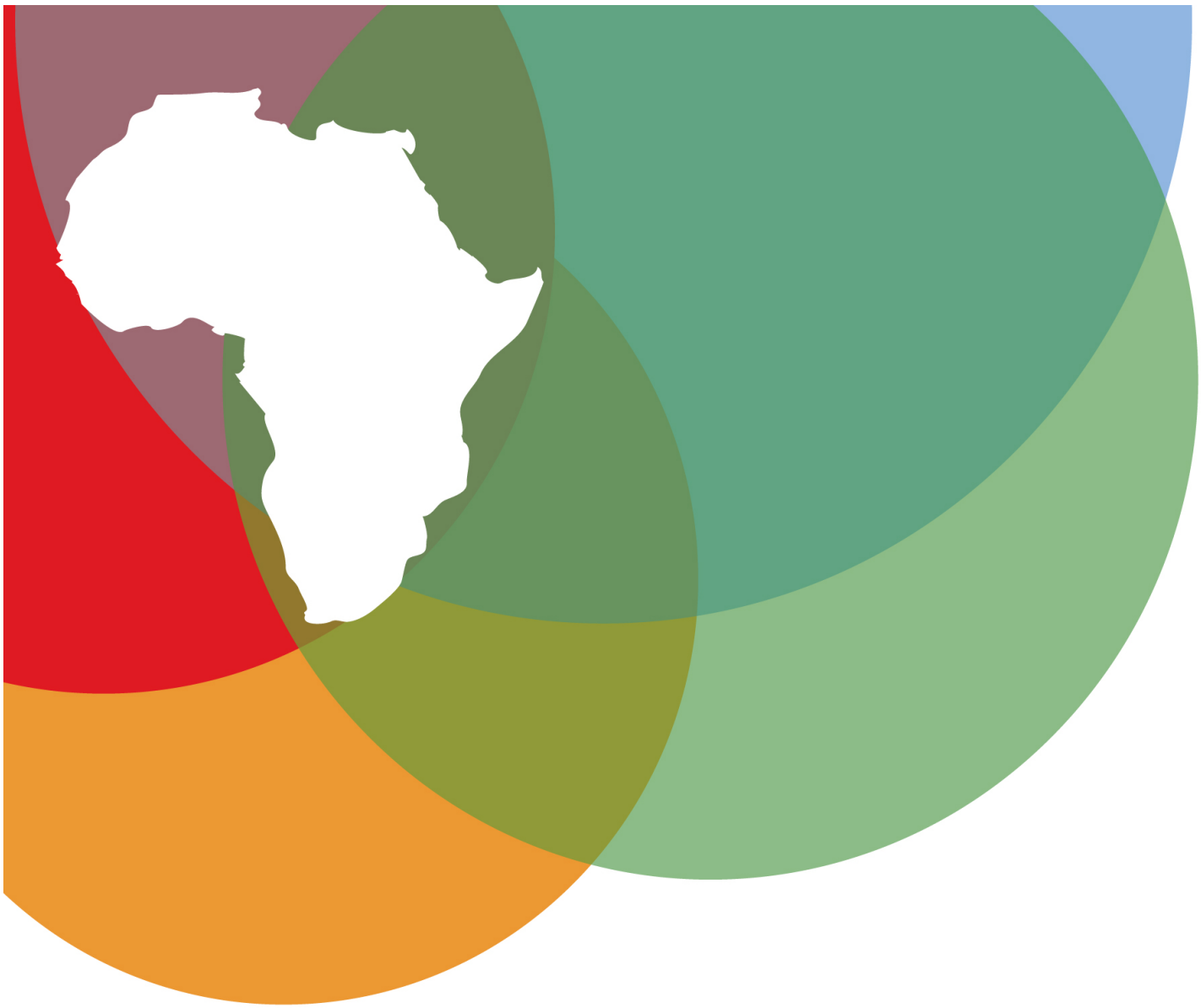

# The Maker Movement in Gauteng Province, South Africa

Erika Kraemer-Mbula and Chris Armstrong

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## Authors

Dr. Erika Kraemer-Mbula
Associate Professor, Faculty of Economic and Financial Sciences, University of Johannesburg
Research Associate, Institute for Economic Research on Innovation (IERI), Tshwane University of Technology (TUT), Pretoria
Researcher, DST-NRF Centre of Excellence in Scientometrics and Science Technology and Innovation Policy (SciSTIP)

Dr. Chris Armstrong
Visiting Fellow, Learning Information Networking Knowledge (LINK) Centre, University of the Witwatersrand (Wits), Johannesburg
Research Associate, Centre for Law, Technology and Society, Faculty of Law, University of Ottawa

## Abstract

This Working Paper sets out findings from research into the dynamics of the emerging "maker" movement in South Africa's Gauteng Province. The authors position the maker movement as a potentially strong contributor to, and manifestation of, informal-sector innovation on the African continent. Drawing on data from interviews conducted with participants in eight maker collectives Gauteng, the authors provide findings in relation to makers' approaches to outreach, skills development, networking, innovation and collaboration.

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## Keywords

maker movement, informal sector, innovation, collaboration, skills development, learning, sharing, openness, Gauteng, South Africa

# Introduction

There is little doubt that the "maker" movement has begun to achieve meaningful momentum in South Africa. There are now established maker-oriented initiatives in the Western Cape Province (Cape Town, Knysna), KwaZulu-Natal (Durban), and Gauteng (Vanderbijlpark, Johannesburg, Pretoria) and the Free State (Bloemfontein), as well as instances of significant maker outreach into the Northern Cape, Limpopo and Mpumalanga Provinces. The year 2016 saw solidification of a national grouping, the South African Maker Collective, which coordinated successful Makers Corners at each of the three 2016 Decorex SA exhibitions – March in Durban, May in Cape Town, August in Johannesburg – and featured prominently in the annual Wits University Fak'ugesi African Digital Innovation Festival in Johannesburg in late August and early September 2016.

August 2016 also saw staging of a Mini Maker Faire Cape Town, under the umbrella of the global, US-based Maker Media brand. And late October saw the 2016 edition of Durban's MakerCon, convened and hosted by one of the driving forces of the national South African Maker Collective, Durban's The MakerSpace.

Notwithstanding the coherence and dynamism it has shown in 2016, South Africa's maker movement can still be seen as a new and emergent phenomenon. Even the pioneering US incarnation of the movement, Make Media in California, was launched only 10 years ago. South Africa's movement is only half as old as that, with its first truly maker-focused space, House4Hack in Centurion, opening its doors in 2011.

The research we conducted to generate the findings outlined in this Working Paper sought to get a sense of some of the drivers of this emergent movement. Specifically, we researched how the movement was playing out in South Africa's most economically-powerful province, Gauteng. Gauteng is home to South Africa's most-populous city (Johannesburg), to the country's administrative capital (Pretoria), and, according to the Gauteng City-Region Observatory "holds 13 million people and generates a third of the country's GDP, on 2% of its land area" (GCRO, n.d.).

We conducted our field research in February-March 2016, when we interviewed 28 people participating in, or interacting in some fashion with, Gauteng maker collectives. In the next section, we provide a very brief introduction to the maker movement, in its global and African manifestations. Next, the section entitled "Research Methodology" outlines our research process and includes details regarding funding, the objectives, and where the research fits within the objectives and work of the network for whom this paper is authored, the Open African Innovation Research Partnership (Open AIR). It is followed by a section describing "The Maker Collectives Studied", providing descriptive information, and categorisations for the eight Gauteng maker collectives from which interviewees were drawn. Then there are five sections that provide our findings in respect of the dynamics of the eight maker collectives across the following dimensions:

- outreach
- skills development
- networking
- innovation
- collaboration

We conclude with some preliminary conclusions and ideas for further investigation.

# The Maker Movement

## 1. Global

The maker movement, which is a drive to support innovation by collectives of "crafters, hackers, and tinkerers" (Hatch, 2013), began roughly a decade ago in the United States (see Anderson, 2012; Eakin, 2013; Hatch, 2013; Maker Media, n.d.). In the words of Eakin (2013) makers are "digitally sophisticated hobbyists who […] are building all kinds of custom objects". A key proponent of the maker movement is San Francisco's Maker Media, which states that it aims to serve "a growing community of Makers who bring a DIY [do-it-yourself] mindset to technology" (Maker Media, n.d.). Maker Media also says it aims to build the "worldwide Maker Movement, which is transforming innovation, culture and education" (Maker Media, n.d.). Maker Media publishes Make magazine and supports the convening of Maker Faires, at which Makers exhibit and share their work. The first issue of Make magazine was published in 2005, and the first Maker Faire took place in San Mateo, California, in 2006.

Maker Faires aim to popularise the maker concept and introduce it to potential new makers. The core work of "making" occurs in what are known as "makerspaces". Such spaces operate according to a variety of governance, management and funding models, and they vary in terms of the facilities and equipment they provide to their participants. Other names for such spaces are Hackerspaces, FabLabs and TechShops. As Cavalcanti (2013) points out in an account of the history of these terms, the oldest term is "hackerspace", which has its origins in software-hacking (and thus for some people should not be conflated with a makerspace, which has a strong hardware element). The names "FabLab" and "TechShop" are trademarked brands for types of makerspaces. The FabLab brand – FabLab stands for Fabrication Laboratory – originated at the Massachusetts Institute of Technology (MIT). FabLabs are supposed to be free (or very low cost) to the user. TechShops, which began in California, are for-profit makerspace franchises that have been established in several US cities (Cavalcanti, 2013).

Hardware found at a makerspace typically includes:

- computer numeric control (CNC) laser-cutters, which can cut wood, metal and other materials
- computer-controlled vinyl-cutters, also known as sign-cutters
- CNC milling machines, which, among other things, can be used to make circuit boards
- woodworking routers
- electronic components
- microcontrollers and microcontroller software (e.g., Arduino kits)
- low-cost microcomputers (e.g., the Raspberry Pi)

- PCs and/or laptops needed to programme and control the other hardware, via computer-assisted design (CAD) software and other software packages.

## 2. Africa

Maker Faire Africa, an initiative separate from the Maker Faire franchise of US-based Maker Media, emerged in 2009. It bills itself as

> [a] fellowship of creators who believe making is the most authentic form of manufacturing, and manufacturing is what forges a vigorous middle class. […] we connect up, size up, mash up, and up the [ante] on redefining the future of the world's most promising continent through our own authentic, relentless African ingenuity. (Maker Faire Africa, n.d.)

To date, there have been five Maker Faire Africa gatherings, as follows:

- 2009 in Accra
- 2010 in Nairobi
- 2011 in Cairo
- 2012 in Lagos
- 2014 in Johannesburg

The US-based Maker Faire brand has also found its way to Africa, and its South African iterations to date have been the 2015 Maker Faire Cape Town and the 2016 Mini Maker Faire Cape Town.

To the best of our knowledge, House4Hack, established in 2011 in a former private home in the Pretoria suburb of Centurion, is South Africa's pioneering maker collective.

However, it must be acknowledged that there were references made by our interviewees to the maker-oriented work of the Cape Craft and Design Institute (CCDI). The CCDI was founded in 2001, but it would seem its incorporation of maker elements is relatively recent. It must also be acknowledged that FabLabs were introduced to South Africa, by the Department of Science and Technology (DST), in 2005; although in general these first DST-supported FabLabs did not catch on with their intended beneficiaries, and very few of them are still fully operational.

# Research Methodology

The research that informs this Working Paper falls under the Open AIR Partnership's "informal sector innovation" theme, which is grounded in the awareness that, across the African continent, the majority of business enterprises are informal. For Open AIR, the emergence of the maker movement in Africa potentially represents a contribution to, and manifestation of, the power of informal sector innovation on the continent. According to Open AIR,

> The skills and knowledge for [African urban, informal] businesses are often acquired through apprenticeships, through imitation, and even through the expanding use of online sources. These are also some of the principles behind the global maker movement and this sharing of knowledge in creative settings can be conducive to innovation. (Open AIR, n.d.)

Moreover, as its name suggests, the Open AIR Partnership has a strong interest not only in innovation but also in modes of innovation oriented towards openness and open collaboration among groups of innovators. These too are principles often associated with the maker movement.

Accordingly, we sought through this research to generate understanding of the innovation and collaboration dynamics in Gauteng maker collectives. We also sought to determine the degree to which Gauteng maker collectives were successfully engaged in outreach and skills development with grassroots, informal South African innovators and craftspeople – a focus informed by our initial supposition, based on anecdotal evidence, that Gauteng maker collectives might be developing somewhat in isolation from the work of grassroots innovators and craftspeople, i.e., that there might be a prevailing middle-class, suburban, male demographic that would make broad outreach difficult. As is outlined later in this Working Paper, our supposition was not in fact borne out by our findings, as we found significant connections between several of the Gauteng maker collectives and grassroots, informal innovators and craftspeople. Also of interest, given the newness of the movement, was the degree to which Gauteng maker collectives were networking, and how they were networking, with other collectives in Gauteng, in South Africa as a whole, and internationally.

## 1. Focus on Gauteng

Our decision to study the maker movement in a single South African province, Gauteng, was to some extent based on convenience, as we are both based at Gauteng universities. However, we were also of the view that a study in Gauteng had much to offer beyond convenience, given the province's substantial economic power in both the South African and continental contexts.

We also presumed that our findings would be of interest and value to our Open AIR colleagues elsewhere in Africa (e.g., in Egypt and Kenya) who are also investigating Maker movements, and our Open AIR colleagues in Canada investigating the movement in the Canadian capital city Ottawa. Among Open AIR's objectives are the cross-fertilisation of learnings not only between African contexts, but also between African and Canadian contexts, i.e., fostering of both South-South and South-North flows of research-based knowledge and insights on African innovation matters.

## 2. Data Collection and Analysis

We collected our primary data via semi-structured interviews with participants in Gauteng maker collectives, guided by an interview protocol. We interpreted participation broadly to include both individuals working directly in Gauteng maker collectives and individuals interacting with the collectives in one way or another. The vast majority (24) of the interviewees were direct participants in Gauteng maker collectives, while the other four consisted of people supporting or interacting in some fashion with, the work of one or more of the collectives. [1]

The analysis of the information gathered led to the identification of five key themes: outreach, skills development, networking, innovation, and collaboration.

[1] The research was supported by a four-way institutional partnership among the University of the Witwatersrand (Wits) in Johannesburg, Tshwane University of Technology (TUT) in Pretoria, and two of the Open AIR Partnership's managing universities the University of Cape Town (UCT) and the University of Ottawa. Our research proposal received funding approval from the Open AIR Partnership offices at UCT and University of Ottawa in January 2016, which allowed a mix of SSHRC, IDRC and DFID funds to be accessed to cover our research and data analysis costs and the work of our three research assistants (listed in the "Authors' acknowledgements" above). Our research ethical clearance applications, to the ethics boards of Wits and TUT, were submitted in January 2016 and approved in February.

# The Maker Collectives Studied

We speak of maker "collectives", rather than "spaces", because we found that two of the eight maker groupings we identified – Geekulcha and I Make Makers Lab – were not confined to a single workspace, and we also wanted to be able to account for all of the collectives' participation in pop-up makerspaces, hackathons and innovation competitions, during which collective members are away from their core workspaces.

We were able to identify eight collectives in Gauteng Province, as outlined in Table 1 below.[2] The Table provides their year of establishment, a description of the core workspace(s) they use, and their URLs. As can be seen, only four of the eight collectives identified existed before 2015, and the longest-running of the collectives, House4Hack, was only five years' old at the time of this research, having been established in 2011.

*Table 1: The Eight Maker Collectives*

| Name of Collective | Year of Establishment | Core Workspace(s) | Online Presence |
|---|---|---|---|
| House4Hack | 2011 | • several rooms in a private home, Centurion, Pretoria | www.house4hack.co.za |
| BinarySpace | 2012 | • a room in a private home, Vanderbijlpark | www.binaryspace.co.za |
| Makerlabs | 2013 | • a storeroom in the basement of a private office, Randburg, Johannesburg | http://makerlabs.co.za |
| Geekulcha | 2014 (Geekulcha founded in 2013, maker element begun in 2014) | • rooms at mLab Southern Africa and the FabLab, Innovation Hub, Pretoria<br>• trainings at Ekasi Lab Ga-Rankuwa<br>• hackathons and innovation competitions at high schools<br>• public hackathons at multiple locations<br>• (starting 2016) use of UK-funded Maker Library Network mobile | http://geekulcha.com |

[2] After completion of the data collection, we learned of an additional maker-oriented collective that we had not been aware of at the time of the research: the Sebokeng FabLab, established in 2014 at the Vaal University of Technology (VUT) Southern Gauteng Science and Technology Park. In August 2016, a new makerspace, the Made In Workshop, opened in Randburg, Johannesburg. Late 2016 and early 2017 saw the launch of eKasi Labs in Soweto, Alexandra and Mohlakeng townships, and an additional one planned for launch in Sebokeng in mid-2017. The Soweto eKasi Lab had a FabLab, the Sebokeng eKasi Lab was expected to link up with the FabLab already existing at the same VUT premises, and maker-oriented facilities were being planned for the Alexandra and Mohlakeng eKasi Labs.

| | | | |
|---|---|---|---|
| | | Maker unit for pop-up Maker trainings and events | |
| Wits Digital Innovation Zone (DIZ) Maker Space | 2015 | • rooms in the Digital Innovation Zone (DIZ) building, University of the Witwatersrand (Wits) Tshimologong Digital Innovation Precinct, Braamfontein, Johannesburg | http://tshimologong.joburg |
| University of Pretoria (UP) MakerSpace | 2015 | • rooms in University of Pretoria Merensky Library, Hatfield, Pretoria | https://www.facebook.com/MakerspaceAtUP |
| eKasi Lab Ga-Rankuwa | 2015 (eKasi Lab established in 2014, maker-type work began in 2015) | • a room in Manufacturing section of the eKasi Lab,Ga-Rankuwa Arts and Crafts Centre, Ga-Rankuwa | https://www.facebook.com/ekasilabs |
| I Make Makers Lab | 2015 (I Make Makers Lab established in 2015 as part of existing Makers Village; the Village's Railways Café established in 2011) | • workspaces at I Make Makers Lab in Makers Village, Irene, Pretoria, part of craft village complex also hosting Irene Trading Post and Railways Cafe<br>• I Make Mobile Lab (began August 2015) used to engage with rural craftspeople | www.makersvillage.co.za |

Table 2 below breaks down the eight collectives we studied according to their municipalities, and the localities where they sit within their municipalities.

*Table 1: The Collectives by Municipality, Locality*

| Municipality | Locality | Collective |
|---|---|---|
| City of Tshwane | Ga-Rankuwa | eKasi Lab Ga-Rankuwa |
| City of Tshwane | Pretoria | Geekulcha |
| City of Tshwane | Pretoria | University of Pretoria (UP) MakerSpace |
| City of Tshwane | Irene | I Make Makers Lab |
| City of Tshwane | Centurion | House4Hack |
| City of Johannesburg | Randburg | Makerlabs |
| City of Johannesburg | Braamfontein | Wits Digital Innovation Zone (DIZ) Maker Space |
| Sedibeng District | Vanderbijlpark | BinarySpace |

Across the eight collectives, we found different models being followed in relation to governance, management, staffing, and funding. In terms of governance and management, we differentiated between collectives that were informally governed and managed by their members, and those that were embedded in larger and formal management structures (such as universities or government initiatives). In terms of staffing, we differentiated

between collectives that had dedicated paid staff designated to carry out specific tasks, and those that did not. In terms of funding, we looked at a variety of funding strategies, including collectives that relied on membership fees, those that had a steady stream of funding from one single source, and collectives that relied on a range of funding sources that changed over time. We decided to delineate the models as follows:

- community-based (three collectives)
- university-based (one collective)
- government-based (one collective)
- hybrid (three collectives)

## 1. Community-based Collectives

We categorised three of the collectives – House4Hack, Makerlabs and BinarySpace – as community-based, because their origins did not lie in an organisational or institutional initiative.

The pioneering collective among these three – also a pioneer in the Gauteng provincial and South African national contexts – was found to be House4Hack in Centurion. House4Hack was established in 2011 by two friends, one of whom made available a house as the workspace for the collective. Both BinarySpace, established in 2012 in Vanderbijlpark, and Makerlabs, established in 2013 in Randburg, were found to be, to a significant extent, offshoots of House4Hack. The founders of BinarySpace and Makerlabs were both former House4Hack participants who decided that traveling to House4Hack in Centurion was inconvenient and that they wanted to have a makerspace closer to where they lived (the distance from Centurion to Vanderbijlpark is 113 km; and from Centurion to Randburg the distance is 39 km).

All three of these community-based collectives were found to be governed and managed by their members on an unpaid, volunteer basis.

In terms of funding, House4Hack did not charge membership fees, and financed itself through members' in-kind contributions of equipment and services; through charging small fees for some of the training courses it provides; through rent paid by offshoot businesses making use of space at the House4Hack house on a daily basis; and through occasional skills development and mentorship provided to funded programmes. For instance, at the time of our research, House4Hack was providing Maker training and mentoring to prospective entrepreneurs in a pre-incubation innovation programme funded by SABMiller's SAB Foundation Social Innovation Awards programme. Both BinarySpace and Makerlabs were found to be charging very small monthly membership fees to users of their workspaces and equipment.

## 2. University-based Collective

The one university-based collective we identified was the University of Pretoria (UP) MakerSpace. This collective was established in 2015 by the UP Department of Library Services, housed in a room in the Merensky 2 Library on UP's main campus in Hatfield, Pretoria. It was found that the MakerSpace manager was a paid UP staff member, and the space was staffed by students who were paid stipends by the university. The users, all of whom were UP students, did not have to pay membership fees and only paid (small amounts) on occasions when they made extensive use of certain materials, e.g., 3D-printing filament.

## 3. Government-based Collective

The one government-based maker collective we identified was the collective operating at eKasi Lab Ga-Rankuwa, in Pretoria North. We found the collective housed in the Manufacturing section of the eKasi Lab, which is a co-creation, innovation and entrepreneurship hub funded and managed by the Gauteng Provincial Government's Innovation Hub in Pretoria through its eKasi Labs programme. In addition to Gauteng provincial government support via the Innovation Hub, the eKasi Lab was also being supported by the City of Tshwane, which owned and operated the Ga-Rankuwa Arts and Crafts Centre where the Lab resided. The users of the maker equipment (e.g., 3D printer, laser cutter) within the Manufacturing section of the eKasi Lab were all participants in an Innovation Hub innovation/enterprise incubation and commercialisation programme. Users did not have to pay for use of the facilities during their time in the programme, which began with an initial nine-month product incubation phase, followed by an 18-month commercialisation phase for innovators whose incubated products that showed commercialisation potential.

## 4. Hybrid Collectives

The other three collectives we identified – Wits Digital Innovation Zone (DIZ) Maker Space, Geekulcha, and the I Make Makers Lab – followed what we categorised as hybrid models of governance, management and funding.

We found that the Wits Digital Innovation Zone (DIZ) Maker Space was a hybrid in several respects. The broader DIZ facility, of which the Maker Space was part, fell under the Joburg Centre for Software Engineering (JCSE), which was governed and managed by the University of the Witwatersrand (Wits) but also received core funding from the City of Johannesburg. The DIZ was, in turn, part of a broader hybrid entity, the Wits Tshimologong Digital Innovation Precinct, founded and coordinated by Wits as a three-way university-public-private precinct with significant funding and operational involvement from, among others, the City of Johannesburg, the Gauteng Provincial Government, the national (publicly-funded) Technology Innovation Agency, and private firms IBM, Microsoft, Cisco and Telkom.

The DIZ, as one element of the Tshimologong Precinct, aimed to be an incubator for digital entrepreneurial start-ups. Start-ups were paying small monthly membership fees for access

to the DIZ's communal hot desks and meeting spaces and, as part of their membership, they got access to the DIZ Maker Space. The Maker Space fell, along with the rest of the DIZ, under the overall governance and management of the JCSE, but the personnel who were running the space, and who provide much of its equipment and training services, were two private-sector firms. These two firms received rent-free use space in the DIZ in return for the equipment and training they provided to Maker Space users.

The second collective we categorised as a hybrid, Geekulcha, was receiving Gauteng Provincial Government support by virtue of being located in the Gauteng Provincial Government's Innovation Hub (specifically, in the Innovation Hub's mLab Southern Africa offices). Geekulcha was also receiving funding support – for delivery of training, hackathons, and other innovation/entrepreneurship start-up competitions/events – from the City of Tshwane, the City of Johannesburg, the Northern Cape Provincial Government, national government departments, foreign donors, international organisations, and private-sector IT firms. Such funding allowed Geekulcha to employ management staff based at the mLab, to employ interns, and to cover the operating costs of its outreach programmes.

Geekulcha's maker programmes were for the most part being delivered by university-student interns, from Tshwane University of Technology (TUT) and other universities, who delivered the programmes across a wide array of locations: at high schools, universities, public events, at the Innovation Hub's mLab offices, at the Innovation Hub's under-utilised FabLab facility, and at government-supported facilities such as the aforementioned eKasi Lab Ga-Rankuwa. Additionally, at the time of our research data collection, Geekulcha had just begun cooperation with the British Council's Connect ZA programme, through which Geekulcha was going to start to make use of the UK-supported Maker Library Network mobile caravan, allowing Geekulcha to expand its maker programmes into new areas of Gauteng.

The third hybrid collective we identified, the I Make Makers Lab initiative, was one of the initiatives headquartered at Makers Village, a large craft village in Irene, next to Pretoria, run by the non-profit D'Afrique Fairtrade Foundation. Drawing on experience gained through work with craft villages and maker-oriented development projects in India, Ghana and The Netherlands, the founder of the D'Afrique Fair Trade Foundation had built up an interlocking set of activities at the craft village, including:

- Makers Village, including the I Make Makers Lab
- Irene Trading Post
- Railways Café

The Makers Village was producing designer craft items – in wood, glass, metals and textiles – for sale at the Irene Trading Post. On the same premises, the Railways Café was operating as a popular restaurant and live music venue which would attract several hundred patrons on some weekend evenings. The people working at the site at the time of our research data collection were combining entrepreneurial craft work in the Makers Village with work

for, and service delivery to, the Trading Post and Railway Café. According to interviewee 18, the craftspeople typically worked in more than one capacity, i.e., they did their craft work using Makers Village facilities (and earning direct income as independent entrepreneurs), while also providing labour and services to the Café and/or Trading Post. Most of the Village's operating costs, including paying each of the craftspeople a monthly wage, were covered by revenue from the Café and Trading Post, and the Village was, according to interviewee 18, self-sustaining.

Established in 2015, the I Make Makers Lab was a relatively recent component of the Makers Village. The equipment for the Lab was funded by South Africa's state Industrial Development Corporation (IDC), and some of the programmes run via the Lab were being conducted in partnership with a variety of private-sector, educational and government entities. For instance, several of the participants in the Makers Lab at the time of our research were part of a national-government-funded apprenticeship programme falling under the Media, Information and Communication Technologies Sector Education and Training Authority (MICT SETA). The I Make Makers Lab also had a Mobile Lab (funded by the IDC), through which the collective was conducting visits to groups of rural craftspeople in Limpopo, Mpumalanga and KwaZulu-Natal Provinces. Governance and management of the entire village, including the Trading Post, Railway Café, the I Make Makers Lab, and the I Make Mobile Lab, fell under the D'Afrique Fair Trade Foundation, with operational matters handled by a small management team.

Table 3 below provides an overview of the models – and corresponding governance, management, staffing and funding arrangements – we identified across the eight collectives.

*Table 2: Collectives' Models*

| Model | Name of Collective | Governance, Management, Staffing | Funding |
|---|---|---|---|
| Community-based | House4Hack | • governed and managed on a volunteer basis by the members of the collective | • no membership fees<br>• member voluntary contributions of workspace and materials<br>• some income received from rental of workspaces to offshoot businesses building commercialised products<br>• some corporate funding, e.g., SAB Foundation, for training/mentorship provision |
| Community-based | BinarySpace | • governed and managed on a volunteer basis by | • small monthly membership fees |

| | | | |
|---|---|---|---|
| | | members of the collective | |
| Community-based | Makerlabs | • governed and managed on a volunteer basis by members of the collective | • small monthly membership fees |
| University-based | University of Pretoria (UP) MakerSpace | • governed and managed by paid university staff<br>• staffed by paid students | • university-funded |
| Government-based | eKasi Lab Ga-Rankuwa | • governed, managed and staffed paid City of Tshwane and Gauteng Government Innovation Hub employees | • funded by City of Tshwane and Gauteng Provincial Government |
| Hybrid | Digital Innovation Zone (DIZ) Maker Space | • governed and managed by Wits University<br>• staffed by members of two private-sector firms who receive rent-free space in return for running the space, providing training, and providing some of the equipment | • funded by Wits University and City of Johannesburg<br>• monthly membership fees for regular users |
| Hybrid | Geekulcha | • governed by Gauteng Provincial Government's Innovation Hub<br>• managed by a management team composed of Tshwane University of Technology (TUT) graduates<br>• staffed by university student interns | • office space and training spaces provided by Gauteng Provincial Government's Innovation Hub<br>• programmes funded by public, private-sector, university and donor funders<br>• salaries of management team, and operational costs, covered by public, private-sector, university and donor funders |
| Hybrid | I Make Makers Lab | • governed by a non-profit foundation, managed by management team | • equipment funded by state Industrial Development Corporation (IDC) |

| | | | |
|---|---|---|---|
| | | paid by the foundation<br>• staffed by paid craftspeople who combine work for their individual craft businesses with work for the foundation's income-generating enterprises (e.g., craft store, procured craft services, restaurant) | • operational and staffing funded through income from craft store, paid craft services, restaurant |

# Outreach

All of the interviewees spoke of the importance of maker collectives' outreach, with the outreach targeting multiple groups, and with the objectives and forms of outreach dependent on the target groups. Key target groups identified were:

- the general public
- university students
- high school students
- entrepreneurs
- grassroots, informal innovators and craftspeople
- girls and women

## 1. The General Public

We found that the collectives' outreach to the general public had both online and offline elements.

### (a) Online

All of the collectives were making use, to varying degrees, of websites and online social media to make their activities known and to invite participation in their meetings or events. Six of the collectives had one or more dedicated online channels for outreach purposes. For the other two – Wits DIZ Maker Space, the I Make Makers Lab – much of the online outreach regarding the work of the collective was being conducted via the online presence of partner initiatives. For the Wits DIZ Maker Space, online outreach was primarily being driven by the online presence of the two private-sector firms running and equipping the space, along with the online work in support of the DIZ more generally as an innovation-entrepreneurial hub and, even more generally, the online promotion of the Wits Tshimologong Precinct of which the DIZ was part. For the I Make Makers Lab, online outreach was for the most part being conducted as part of the broader online presence of the Makers Village.

Also valuable to the online presence of the Gauteng Maker movement was the consistent coverage the movement was receiving from the Johannesburg-based htxt.africa website, which has a dedicated "Makers" section (htxt.africa, n.d.).

### (b) Offline

In keeping with the hands-on, DIY, hardware focus of the maker movement, there was general agreement among interviewees that many of the key forms of outreach to the general public were via offline means, chiefly:

- weekly meetings, open to the public, hosted by the collectives at their core workspaces;
- convening, and/or participating in, hackathons and innovation-entrepreneurship-start-up competitions/events; and
- convening, and/or participating in, pop-up demonstration-training events.

***Weekly meetings:*** Three of the collectives – House4Hack, Makerlabs and BinarySpace – were conducting the majority of their outreach via promotion and hosting of a weekly meeting, on a weekday evening, at their core workspace.

***Hackathons and competitions:*** It was found that members of all of the collectives had hosted and/or participated in one or more hackathons or innovation/entrepreneurship start-up competitions/events, and that these hackathons and events had been advantageous in allowing the collectives to:

- give exposure to their collectives and the abilities of their collectives
- draw new people into their collectives
- give exposure to the broader maker movement
- meet and network with makers from other collectives

Geekulcha was running a wide range of hackathons and competitions/events, including, for instance, SkateHacks in which youth were workshopped through a process of adding electronics to their skateboards (for tracking and reporting purposes).

Key outreach moments cited by the Wits DIZ Maker Space were two #Hack.Jozi Challenge events staged by the JSCE and City of Johannesburg at the DIZ, as well as public hackathons focused on, in one instance, government open data, and, in another instance, building robotic arms.

***Pop-up demonstration-training events:*** The following were identified by several interviewees as being important outreach and networking instances for Gauteng collectives:

- Maker Faire Africa in November 2014, which took place in Newtown, downtown Johannesburg, but also included participation by Wits University in the neighbouring Braamfontein district, and in which several Gauteng makers, and some of the collectives that were already in existence at that point, participated;
- Decorex SA's Johannesburg exhibition in August 2016, which featured participation by several Gauteng Maker collectives in a pop-up Makers Corner, under the banner of the national South Africa Maker Collective; and

- The annual Wits University Fak'ugesi African Digital Innovation Festival in the Wits Tshimologong Digital Innovation Precinct in Braamfontein.[3]

## 2. University Students

The outreach focus of the University of Pretoria (UP) MakerSpace is on UP students, and we were told by interviewees that one the collective's most successful events in its first year of operation was its Student Innovation Contest in September 2015, which the MakerSpace ran in conjunction with the Southern African arm of the US-funded ResilientAfrica Network (RAN).

The Wits DIZ Maker Space had made links with university students, from both Wits and the University of Johannesburg, through demonstration sessions and trainings.

## 3. High School Students

There was a strong current of engagement by Gauteng maker collectives with high school students, in service to the goals of what has come to be known internationally as STEM education or STEAM education.[4]

Geekulcha, in particular, was expending a significant amount of its outreach work in the direction of STEM and STEAM. At time of our data collection in February-March 2016, Geekulcha said more than 7,000 high school students had participated in Geekulcha trainings and competitions (interviewee 3, 2016).

The Wits DIZ, I Make Makers Lab and House4Hack had also engaged in maker activities with high schools, in service to STEM and STEAM goals.

## 4. Entrepreneurs

eKasi Lab Ga-Rankuwa, the Wits DIZ Maker Space, and I Make Makers Lab were all operating within broader initiatives that had an explicit entrepreneurial incubation and job creation focus. The eKasi Lab programme, run out of Gauteng Province's Innovation Hub, states online that it aims to establish "co-creation and innovation spaces" that foster "skills and enterprise development" (eKasi Labs, n.d.). The Wits Tshimologong Digital Innovation Precinct website states that the focus of the DIZ is "[g]rowing jobs through high-tech start-ups and skills development" (Tshimologong, n.d.). The Makers Village, of which the I Make Makers Lab is a recent addition, positions the entire Village as an "incubation unit" (interviewee 18, 2016). Accordingly, we found that much of the outreach work of eKasi Lab

[3] The August-September 2016 Wits Fak'ugesi Festival, which took place after our data collection, featured participation by Gauteng collectives under the banner of the South African Maker Collective and also featured collaboration between Geekulcha, other collectives, and the local arm of the UK-based Maker Library Network, with this collaboration facilitated by the British Council's Connect ZA programme.
4 STEM = science, technology, engineering and mathematics; STEAM = science, technology, engineering, arts and mathematics.

Ga-Rankuwa, the Wits DIZ Maker Space, and I Make Makers Lab was linked to the objectives of their parent projects.

For instance, the maker collective participants we found working in the Manufacturing section of eKasi Lab Ga-Rankuwa were all enrolled in an Innovation Hub entrepreneurial incubation programme. At the Wits DIZ Maker Space, a core area of service delivery for the two firms managing, equipping and running the Maker Space was the start-up entrepreneurs using the hot-desk space in another section of the DIZ building. These DIZ-based entrepreneurs, by paying a monthly DIZ membership fee, had direct access to the Maker Space personnel and (under supervision) the maker equipment, in order to develop prototypes and other materials necessary to take their start-up ideas forward. Also contributing to the entrepreneurial aspect of the Wits DIZ Maker Space was the on-site work of the two start-up firms, African Robot and BushveldLabs that were running the space. African Robot, for instance, makes and sells 3D-printed-toys – see the "Innovation" section below.

Likewise, the I Make Makers Lab in the Makers Village was serving to a great extent as a resource for the entrepreneurial activities of the craftspeople in the Village – in concert with the Village's other facilities for glassmaking, woodworking, metalworking and sewing.

Geekulcha, in keeping with having its headquarters at the Innovation Hub, had many entrepreneurially-oriented programmes, including work with participants in eKasi Lab Ga-Rankuwa's Innovation Hub-funded innovation incubation and commercialisation programmes.

The UP MakerSpace, although it did not have an explicit entrepreneurship support mandate, was found to have engaged in entrepreneurially-oriented outreach. Its 2015 Student Innovation Contest had an entrepreneurial element, with one of the partners in the Contest being the UP Graduate Centre, which provided advice to contest winners on how to take forward their ideas into the marketplace.

None of the three community-based maker collectives– House4Hack, Makerlabs and BinarySpace – was found to be explicitly targeting entrepreneurs, but as shall be seen below in the section below entitled "Innovation", successful entrepreneurial spin-offs have emerged from the works of makers currently or formerly participating in the activities of House4Hack.

## 5. Grassroots, Informal Innovators and Craftspeople

As stated above, one of questions we sought to address with this research was the extent to which Gauteng maker collectives were engaged in outreach to grassroots, informal innovators and craftspeople. Our supposition going into the research, based on anecdotal evidence, was that most of the collectives would have a pronounced middle-class, suburban, male demographic that would pose barriers to strong outreach to grassroots

innovators and craftspeople. But the findings did not correspond with our initial suppositions.

We found that three of the collectives – Geekulcha, eKasi Lab Ga-Rankuwa, and I Make Makers Lab – were actively engaged in ongoing outreach to grassroots innovators and craftspeople. [5]

Much of Geekulcha's outreach, including its work with eKasi Lab Ga-Rankuwa, was linked to grassroots, informal entrepreneurs and craftspeople, including large numbers of girls and women, from disadvantaged areas in Gauteng. In addition, Geekulcha was just beginning, at the time of our research, to make use of the UK Maker Library Network's South African mobile maker caravan for improved outreach, via a cooperation agreement with the British Council Connect ZA programme (interviewee 3, 2016).

At eKasi Lab Ga-Rankuwa, the entrepreneurs we interviewed could all be said to have begun as grassroots, informal innovators. They had all entered the Lab's innovation incubation/commercialisation programme by responding to a public call put out in the Ga-Rankuwa area, an area with high levels of unemployment and poverty. One of the interviewees was a woman who was using the facilities in support of an emerging printing, woodworking and engraving enterprise.

In the case of the I Make Makers Lab, the entire Makers Village of which the Lab is part was found to be focused on connecting with grassroots innovators and craftspeople from disadvantaged areas. At the time of our research, the Makers Village had roughly 700 entrepreneurs working at the site, combining their work for their own (mostly-craft-related) enterprises with work for the Village's core income-generating units: its restaurant/entertainment venue and craft store (interviewee 18, 2016). In addition, the Makers Village was using its I Make Mobile Lab to connect with, and work with, rural craftspeople in Limpopo, Mpumalanga and KwaZulu-Natal Provinces. At the time of our research, the Makers Village had entered into an agreement with a group of roughly 80 crafters in the remote St Lucia region of KwaZulu-Natal – an agreement through which the Makers Village would work for three years with the crafters to develop a new product, using a combination of local traditional crafting practices and other practices made possible by equipment in the Mobile Lab, such as 3D printers, laser cutters, and embroidery machines (interviewee 18, 2016).

While we did not collect precise demographic data in respect of the maker collectives we studied, we feel confident in saying, based on the information received through the interviews, that Geekulcha, eKasi Lab Ga-Rankuwa, and the I Make Makers Lab were all succeeding in extending their outreach to reach grassroots innovators and craftspeople. At the same time, it was true that the profile of the majority of participants in the three

[5] Later in 2016, after the completion of our data collection, evidence also emerged of the Wits DIZ Maker Space managing to successfully connect with township-based innovators in Johannesburg, with the entrepreneurs prototyping innovative products at the DIZ Maker Space.

community-based maker collectives we identified – House4Hack, BinarySpace and Makerlabs – largely appeared to fit with the middle-class, suburban, male stereotype. Notably, however, there was awareness on the part of members of all three of these collectives that they needed to find ways to move beyond narrow demographics.

## 6. Girls and Women

We found that the strongest outreach towards women was in the work of I Make Makers Lab, Geekulcha and eKasi Lab Ga-Rankuwa, but with cognizance among all interviewees of the advantageousness of better gender balance.

The Irene Makers Village, where the I Make Makers Lab is based, was found to have a large number of women craftspeople, thus making it relatively straightforward for women to become involved in I Make activities. By way of example, one of the businesses that the I Make Makers Lab was helping to incubate at the time of our data a collection was a shoemaking business being established by a woman. The I Make Mobile Lab was also achieving significant outreach to women. For example, it was found that the majority of the rural people participating in the aforementioned St Lucia craft initiative, making use of the I Make Mobile Unit, were women.

Geekulcha was found to have many initiatives with a focus on participation by girls and women. And by the time of the finalisation of this report, Geekulcha had a female member of its management team was devoting specific attention to programmes aimed at girls and women.

eKasi Lab Ga-Rankuwa's public calls for innovators to apply for support was seen to be giving it the potential to connect with local women entrepreneurs. Indeed, one of the most active users of the eKasi Lab's maker equipment at the time of our data collection was a woman.

And while the other maker collectives from which our interviewees were draw were being used predominantly by males, there was evidence of recognition of the need to address the gender imbalance. For instance, interview 11 (2016), at the UP MakerSpace, stated that:

> Every [woman] that's ever been in here seems to be very scared of technology. And any [woman] that's interested in technology doesn't seem to know about this place. So perhaps marketing is where we have made a mistake there.

And it was found that House4Hack had made concerted efforts, though with limited success, to draw larger numbers of women into its collective. According to interviewee 15 (2016), from House4Hack:

> Any software developer meet-up, it's 99% […] white males basically. Any technology-related stuff, that tends to be the demographic. So, for example, one of the things I tried to do for a year […] we said let's take away any

> barriers there are to women coming here. […] Do we need extra toilets or whatever it is, you know, whatever we could think of as potential barriers, we said we would make sure there wasn't any […]. So we do actually get women that come here, and there's some that come fairly regularly as well, but there isn't a big group of them. So one of the things I tried to do was, for example, to start a House4Hack women group. But to do that you need a woman who's going champion it and for that you need someone who comes regularly and so on.

# Skills Development

The maker collectives that were part of this study were all actively committed to the development of skills, not only among their members but also as a service to others. Moreover, in some cases the provision of skills-development services constituted a source of revenue for the initiative.

The specialised knowledge and abilities held by many makers constitute valuable skill sets that can be transferred to students (in line with the aforementioned STEM and STEAM objectives) and entrepreneurs. The maker movement, internationally, has been acknowledged to hold great potential implications for education. New tools and technology, such as 3D printing, robotics, and microprocessors, are appealing to the youth, and this has resulted in makers moving into classrooms to instil the principles of learning-by-sharing and problem-solving through collaboration.

The UP MakerSpace was found to be providing specific courses to students enrolled at the university, and was collaborating actively with lecturers in the design and implementation of assignments for engineering students.

The Wits DIZ Maker Space had put significant focus on its training services, with training facilities created via donations of Mac computers by Wits University, and was found to be offering training on different technical aspects to private companies, schools, colleges, Wits students, and students from the University of Johannesburg. Many of these trainings were demos, on a pro bono basis.

As indicated above, the I Make Makers Lab was also found to be involved in skills development work, with craftsmen and craftswomen in remote rural areas, through its Mobile Unit. The I Make Makers Lab was also being used to deliver on the Makers Village's training partnership with the aforementioned MICT SETA (an industry- and state-supported national skills development body), through which recent university or college graduates, roughly half of them black and female, were receiving on-site technical training and experiential learning at the Village. Linked to this initiative, I Make had developed a Makers Academy, which at the time of this research had just been formalised. As indicated by interviewee 18 (2016):

> Basically, I am bringing in all the craft training under that […] and then all the CNC training. I have spoken to SETA, because we are going to register a formal CNC certificate course. With that I work with the University of Tshwane […] because they assisted us with […] the course materials. […] Because I think that, in the South African environment, that […] provide[s] a good space for people to have additional opportunity for employment. Because, you know, staff moving, people move on, and there's a lot of people that buy CNC

> equipment, yet […] if you really have to identify, what is the kind of candidate that runs an operation like that? There is always training involved.

According to a Geekulcha interviewee, "we champion skills development". Much of Geekulcha's work aims to achieve "skills redistribution" – e.g., skills transfer by university students who have their internships at Geekulcha and engage in collaborative projects with high school students, with other youth, and with young entrepreneurs at mLab Southern Africa where Geekulcha is headquartered (interviewee 3, 2016). Geekulcha's approach is to build an "ecosystem" where people learn, develop skills, and create solutions (interviewee 3, 2016).

There was also evidence of joint skills development activities by more than one of the Gauteng maker collectives. For instance, at the time of our data collection, I Make Makers Lab trainees were receiving 3D-printing training from the Morgan 3D-printer business run on-site at House4Hack. Also, Geekulcha was serving as a key training provider for innovators being incubated by eKasi Lab Ga-Rankuwa, with Geekulcha providing skills development sessions both on-site at the eKasi Lab and also at the Innovation Hub. Geekulcha was also participating in skills development sessions at the Wits DIZ, with elements of collaboration with the Wits DIZ Maker Space.

See also the sub-section on "Learning and Knowledge-sharing" in the section below on "Collaboration".

# Networking

## 1. Within Gauteng

We found substantial evidence of interpersonal networks connecting Gauteng maker collectives. For instance, certain members of the three community-based collectives – House4Hack, BinarySpace and Makerlabs – had strong interpersonal connections forged during period 2011-2013 when the eventual founders of BinarySpace and Makerlabs regularly attended House4Hack weekly meetings – before establishing their own collectives (BinarySpace in 2012, Makerlabs in 2013). There was evidence of continued interaction among members of these three collectives, both via online tools and via offline face-to-face contact at hackathons-competitions and demonstration events, e.g., at the Maker Faire Africa 2014 event in Johannesburg.

We also found evidence of cooperation between the I Make Makers Lab in Irene and present and past members of the House4Hack collective. At the time of writing, not only were I Make members receiving 3D-printing training (as mentioned above) at House4Hack, but I Make was also awaiting delivery of a large Cheetah 3D printer procured from Fouche 3D Printing, a company formed by a former House4Hack participant Hans Fouche – with Fouche 3D Printing and I Make having made initial contact via their representatives' attendance at weekly House4Hack meetings.

Also mentioned above were Geekulcha's links with both eKasi Lab Ga-Rankuwa and the Wits DIZ Maker Space.

The most recent instances of networking among Gauteng maker collectives took place after our interviews. In August 2016, there was participation by I Make, House4Hack resident Morgan 3DP, and House4Hack offshoot Fouche 3D Printing, in the Decorex SA 2016 Makers Corner in Johannesburg. In late August and early September 2016, House4Hack, BinarySpace, Geekulcha, and an independent Johannesburg maker, collectively participated in the Wits Fak'ugesi Digital Innovation Festival.

## 2. National

Many of the interviewees felt that, in addition to networking among themselves, the Gauteng maker collectives could benefit from participation in a national network or federation of some sort, through which to share knowledge and experiences and collaborate via certain events. At the time of our interviews in February-March 2016, Durban's The MakerSpace and an independent maker in Johannesburg were particularly active in working towards solidification of the newly-launched (in early 2016) South African Maker Collective. These efforts resulted in successful staging of pop-up Makers Corners at each of the three Decorex SA 2016 exhibitions. In addition, the Collective helped to

coordinate the successful Gauteng maker presence at the August-September 2016 Wits Fak'ugesi Digital Innovation Festival.

## 3. International

There was also evidence of awareness of, and some linkage with, maker activities elsewhere in Africa, elsewhere the developing world, and in the developed world. For instance, the D'Afrique Fairtrade Foundation that runs the I Make Makers Lab and Mobile Lab was basing some its work with South African makers on the experiences of it founder in working with makerspaces in India, Ghana, and The Netherlands. Geekulcha, meanwhile, was collaborating on some of its programmes with entities in Mozambique, Kenya and Botswana. In fact, one of the entrepreneurs interviewed at eKasi Lab Ga-Rankuwa said he had received useful collaborative support from Mozambican innovators, via a Geekulcha event at the Innovation Hub, in the course of developing his enterprise idea. In addition, Geekulcha's aforementioned participation in the British Council's Connect ZA initiative is putting Geekulcha collective members in contact with makers from Nigeria and the UK.

Examples we found of other international connections were: one Makerlabs participant's exposure to maker activities in Kenya, and another Makerlabs member's time spent at a makerspace in Nottingham, UK. And it was found that one of the drivers of the South African Maker Collective's participation in Decorex SA 2016 and Wits Fak'ugesi 2016 received her initial exposure to maker activities during a period of work as a designer in London.

# Innovation

As explained above in the section on "Outreach", several of the Gauteng maker collectives we identified operate within initiatives that have a pronounced entrepreneurship focus, i.e., a focus on innovation as a means towards enterprise incubation and development.

Interestingly, however, we found that the clear majority view of respondents across the maker collectives studied – both the entrepreneurship-focused and non-entrepreneurship-focused collectives – was that the innovation processes most central to the Gauteng maker collectives, and to the maker movement in general, are in fact *pre*-incubation, and *pre*-commercialisation processes. The majority view was that maker-oriented innovation is by nature *not* focused on end results, including commercialised end-results. Typical of this perspective was the view of one of the interviewees from House4Hack, who said as follows:

> I had a guy here from that's like an angel investor, and I sort of explained the whole thing to him, and his conclusion was that we are like a pre-commercial space. […] Because the whole idea it's a place where you can freely share ideas, freely learn from other people. So we try to do this, I mean, if you sort of look the House4Hack, like the whole idea is to promote technical innovation, but we're not really a business incubator. (interviewee 14, 2016)

According to interviewee 15 (2016):

> A lot of the projects that are built here are for personal use, or just for the kick of it and […] even though they could be commercialised, but we all know that the effort to build it for our own personal use and the effort to build it for commercial is two different things. One can take years out of their life, one is like maybe a couple of weekends, for a few months.

According to another interviewee:

> I am an inventor. I'm not really an entrepreneur in the traditional sense of the word. So I'll always want to invent stuff. That's my passion. So I've been doing that since my school days. I used to participate in these [expos] for young scientists. So that's always been part of what I do. (interviewee 21, 2016)

There were, at the same time, strong exceptions to this majority view, with respondents linked to three of the collectives – the UP MakerSpace, eKasi Lab Ga-Rankuwa, and the I Make Makers Lab – all positioning maker-oriented-innovation processes in more innovation/enterprise incubation and commercialisation terms. We saw above, in the section on "Outreach", the view from interview 18 (2016) of the I Make Makers Lab that the entire Makers Village (of which the I Make Makers Lab was part) was an "incubation unit". According to this same interviewee,

> [w]e go for the consumer market. And I am trying to also develop that in people. Because, you know, technology change[s] so quickly, that, how do we even begin to prepare people for careers of the future if they don't even exist yet? So, I do believe that if one can marry those aspects of education, technology and markets, there's a huge space for the future for people to be entrepreneurial, because now […] you can operate the technology in such a way [that] you don't just become a user, but you actually do something with it. (interviewee 18, 2016)

In the Geekulcha collective, meanwhile, there seemed to be equal appreciation for both the pre-incubation *and* incubation, and pre-commercial *and* commercial – potential of maker activities. For instance, the interviewees from Geekulcha extoled the virtues of making for youth skills development, based on STEM and STEAM goals, but at the same time were proud of the young innovators they had worked with who had managed to win hackathons and start-up competitions, or get accepted into an incubation programme, and were now moving towards taking their ideas to market.

Notwithstanding these differences in conception of the ultimate goals of maker innovation, we found there was general agreement across both camps – the pre-incubation/pre-commercial and incubation/commercial camps – as to the kinds of innovation that maker collectives are best at delivering. We categorise these kinds of innovation as follows:

- tinkering, hacking, DIY, organic innovation
- innovation born of poverty, necessity
- process innovation, incremental innovation
- re-purposing, recycling

After outlining our findings in relation to those four types of innovation, we will then briefly consider some of the actual products that had been developed, or were in the process of being developed, by members of Gauteng maker collectives we looked at.

## 1. Tinkering, Hacking, DIY, Organic Innovation

According to one interviewee, his collective's work was "[v]ery organic […] Like we throw things together, and see what happens, and then take it from there" (interviewee 15, 2016). According to another interviewee,

> it's going back to the culture of DIY, so back to the culture of do it yourself. But with a heavy influence of technology and the Internet and things like that, and things like YouTube. You know, the amount of times I've taught myself to do something from […] a 15-year-old kid on the Internet (interviewee 1, 2016)

According to interviewee 22 (2016), "part of the maker movement that […] resonates strongly with me is: Anyone can try it, anyone can be doing it. It can be a dad and his son,

tinkering in the garage, coming up with something". In the words of interviewee 1 (2016), "I think that's why a lot of guys within the maker movement are excited about South Africa, is because we have this grassroots, craft, do-it yourself kind of mentality anyway".

## 2. Innovation Born of Poverty, Necessity

There was a strong sense among many of the respondents that South Africa, notwithstanding its enclaves of wealth and prosperity, is to a great extent a country of poverty, and that it is, accordingly, home to a strong ethic of innovation born of poverty and necessity. According to one interviewee:

> I think it's hard to nail down exactly what it is, because it's so broad and general. […] I think we have a bigger […] need for the maker movement, as opposed to some other places. Because I do think true innovation happens […] out of necessity, and I think South Africa has a lot more of that necessity than, say, places in Europe. (interviewee 1, 2016)

The poverty-driven innovation dynamic was seen by many respondents as both an opportunity and a challenge: an opportunity in that there is undoubtedly a rich vein of poverty-induced innovation in South Africa, but a challenge in that many of the Gauteng maker collectives studied (e.g., House4Hack, BinarySpace, Makerlabs, the Wits DIZ Maker Space, the UP MakerSpace) did not yet have strong connections (as seen above in the section on "Outreach") with low-income communities.

At the same time, even members of the predominantly suburban, middle-class maker collectives, while aware of the gulf between their realities and the realities of the most impoverished South Africans, still seemed to see themselves as to some extent impoverished within the global economic-technological context. Several interviewees were keenly aware of how difficult it is to procure the necessary maker equipment at affordable prices in South Africa in comparison with Europe and the US. There was frequent reference among interviewees to the Afrikaans-language saying " 'n Boer maak 'n plan" ("A farmer makes a plan"). The respondents who cited this saying typically used it to refer to what they perceived as a tradition in South Africa of knowing how to make do with what one has at one's disposal.

According to one interviewee:

> One of the realities about South Africa, as a nation, with all of its multifaceted dimensions, is the fact that we tend to be natural improvisers. You know it's almost as if the pioneering spirit of the previous centuries has been kept alive. And we don't have the broad population having the kind of luxury of living in the so-called "First World conditions" where everything is organised. And therefore, you know, we have a saying in Afrikaans, which says " 'n Boer maak 'n plan". […] And if I could tell you some of the stuff my father did […] He was a maker of note, he was an improviser, because we didn't have much financial

> means […] We lived on a small farm[…] I could [tell] you stories about his inventions and maker talent that could keep you busy for a long time. That's the […] answer to this question about how the South African maker mentality, let's say, might be different from other parts, especially the more developed parts of the world, where people have sort of, I think, lost the ability to think for themselves. […] We're not helpless. We make a plan. (interviewee 23, 2016)

One of the most oft-mentioned innovations that has emerged from a Gauteng maker collective, the Morgan 3D Printer, appeared to be, in the minds of many respondents, emblematic of the innovation-born-of-necessity ethic (Morgan 3DP, n.d.). Developed by a participant in the House4Hack collective in Centurion, the Morgan 3D Printer is among the most celebrated products of the South African maker movement. Its developer, Quentin Harley, developed the printer as a "rep rap" (rapid replicator prototype) printer, i.e., the printer can, to a great extent, replicate itself, by printing many of the parts needed to assemble a printer of the same type. One of Harley's motivations for developing a low-cost 3D printer was that the models available from overseas were, at the time of the Morgan printer's development, too expensive. The Morgan 3D Printer was positioned by interviewee 21 (2016) as an effort "to put a high-quality machine into the hands of makers".

## 3. Process Innovation, Incremental Innovation

Several of the respondents appeared to position innovation occurring with Gauteng maker collectives as being primarily *process*-oriented, as opposed to *product*-oriented.

According to interviewee 22:

> I met someone who said she's a "process knitter, not a product knitter". So I guess for makers as well, you get process makers and product makers. And, as much as I always dream and scheme that I am going to design and take a product range to market, I always end up just making more and more new things, trying out ideas, trying out techniques, dreaming and scheming up something else, and not necessarily taking it all the way to market. Which hopefully will also still be part of the journey. But I find that the process of making, and the act of making, is very important and very valuable to me. (interviewee 22, 2016)

Interviewee 15 gave the example of House4Hack's PiScope project, through which the collective built an astrophotography unit using parts of a telescope, a Raspberry Pi and a Raspberry Pi Camera. According to interviewee 15 (2016),

> It has been done before, so I wouldn't say it's like unique in that sense but, you know […] it hasn't been done in the way we are doing it, and we've come

> up with great ideas of what it can do that [have] never been tried before, and stuff like that.

In respect of the ethos of incremental innovation in Gauteng maker collectives, interviewee 20 (2016) described it in these terms:

> I don't think as a maker that there's anything really that you are doing that's, like, brand-spanking-new. It's not […] there's something very similar out there. You've just got a different twist on it.

## 4. Recycling, Re-purposing

Several respondents spoke of South Africans' talent for innovation grounded in recycling and re-purposing of existing items. According to one interviewee, "we basically take technology, whether it's cutting edge or not, and we repurpose it" (interviewee 15, 2016). In the words of another interviewee:

> To a real maker, something broken isn't broken, it's just parts for a new project, and definitely that has a huge, huge impact […] a lot of things you see, like even that projector blew recently, but it's like, I know just from looking at it, there's a cool magnifying glass I can get there, there's a this, there's a that, there's a little fan, there's a motor, and all of those can then, you know, that's then a free part for doing a project […] So recycling [is] very much a big part of it. (interviewee 1, 2016)

According to interviewee 4 (2016) from the Geekulcha collective,

> in the South African context […] I can say that […] using some of the recyclable materials and all that, we just can come up with new [ideas] and build some of the new things and then, as well as, I think if […] enough training could be provided, it can also help some of the younger ones to actually come up fresh with these ideas.

For example, two of the high school girls Geekulcha had worked with, from Mamelodi township next to Pretoria, won a start-up competition with an innovation called Fash Tag, which consisted of "these very stylish name tags, made from recycled materials" (interviewee 3, 2016).

Another innovation support effort with a recycling dimension was Geekulcha's work with youth who were making cars out of recycled wire. Via Geekulcha training, the youth were now "putting electronics into them, giving them more life" (interviewee 3, 2016). One of the originators of this "remote-control wired care" innovation, developed in the very days of the Geekulcha collective before it had formalised itself, was interviewee 4 (2016), who described the process in this way:

> Remember the wired car that you, we used to play with at home? So that was a manual one, we used to drive it. So now we were build one that was embedded with Arduino, you can […] use a mobile app to control the car […] We were […] going through this art, combining it with electronics, trying to make creative stuff […] We didn't have that idea that it was a makerspace. It was just actually trying to put our skills into use, and trying to see what we can create. But since we don't have the resources to build some of the electronic car we were trying to build, so we decided […] we can just try to use some of the recycled materials.

In a similar vein, one of the entrepreneurs we interviewed (interviewee 26, 2016), who had received some maker training from Geekulcha, was working towards a business based on a set of "art toy" characters made from recycled materials. He was working towards featuring the characters in animated cartoons, and also 3D-printing miniature versions of the characters that, he said, could be sold along with information on "how to create your own art toys using household things, because most of my art toys are made from […] urban waste."

## 5. Products

Notwithstanding the frequent statements by interviewees to the effect that their collectives were to a great extent about learning, about process innovation, about pre-incubation, and about pre-commercial activity, we found evidence that Gauteng's maker movement has in fact generated several innovative finished products, some of which have been scaled and commercialised to a limited extent.

The best-known of these products, all developed by members or former members of Gauteng's pioneering makerspace, House4Hack, are:

- the Robohand, a 3D-printed prosthetic hand developed by Richard van As, who lost all the fingers on his right hand in an industrial accident in 2011
- the Morgan 3D printer developed by Quentin Harley and his company Morgan3DP
- 3D-printed chocolates and large Cheetah 3D printers, developed by Hans Fouche and his company Fouche 3D Printing

The Robohand has been scaled up through use internationally, including in the US and Syria, and there are at present more than 200 users of Robohand prosthetics around the world (Robohand, n.d.). The Morgan 3D Printer is being produced on-site at House4Hack, and, at the time of our research, more than 40 of the units had been sold. And we saw above that Fouche 3D Printing was, at the time of our research, about to deliver one of its large-size Cheetah 3D printers to I Make Makers Village.

Other emergent or established businesses that we found, or were told about, linked to Gauteng maker collectives, included:

- the aforementioned (in the "Outreach" section) 3D-printed toys being produced by African Robot at the Wits DIZ Maker Space
- the aforementioned (earlier in this section) animation and 3D-printing of characters developed from recycled materials
- the aforementioned (in the "Outreach" section) printing, woodworking and engraving business run by one of eKasi Lab Ga-Rankuwa maker collective members and hoping to make inroads into the tombstone-engraving sector in the near future
- the aforementioned (in the "Outreach" section) shoemaking business being developed by a participant in the I Make Makers Lab collective
- a graphic design business being developed by two former Pretoria-area high school students (and former Geekulcha trainees) who won a start-up competition

In addition, we learned of a number of non-commercially-oriented successful innovations:

- the BinarySpace high altitude balloon (Van de Bon, 2015)
- the House4Hack high altitude glider (House4Hack, 2014)
- prosthetic legs produced as part of the Amazing Race competition among Pretoria University Engineering students, organised by the UP MakerSpace (interviewee 12, 2016).

In addition, Geekulcha's large maker community, and its large number of hackathons and trainings per year, had generated a number of interesting social innovations, including:

- Smart Bottle, a bottle with integrated electronics: "the idea is to get people living in urban areas to buy that bottle. It can be refilled, and then each time you refill, there's a profit of money that goes towards acquiring water tanks, boreholes for people in the rural areas" (interviewee 3, 2016)
- Face Learn, a gamified learning application using facial recognition software: "what they did is, they took a lot of questions in geography and history, put them into software, and then made sure that kids learn through hand gestures and all that, to make it more fun" (interviewee 3, 2016)

Geekulcha's most successful innovations, which had proved to be a powerful tool for drawing youth into the maker culture (and which could, according to one interviewee, have commercial potential in the future) – was the aforementioned building of electronics and computing into skateboards, via Geekulcha's SkateHacks programme. According to interviewee 4 (2016), putting electronic tracking into skateboards was

> based on having to monitor your skating. […] It was actually monitoring [distance] and trips that you do. And then […] we can actually do gamification. We can just do challenges on the skateboard, which we're monitoring via an

> app and which we can send our data through a cloud. It was actually measuring the speed, the distance that the skater travelled, and then actually measure if a skater has fallen, stuff like that, and actually measure the height […] that a skater can actually reach, and all […] gathering this kind of information, and seeing how, from our tech side, can we actually convert some of the ideas there were giving us into some of the tech stuff that we can include.

Geekulcha began its SkateHacks events in cooperation with the Northern Cape Provincial Government, because the Northern Cape capital city, Kimberley, plays host every year to the Kimberley Diamond Cup Skateboarding World Championship.

# Collaboration

All interviewees shared the view that a central dynamic of the activities of their maker collectives was collaboration, with the collaboration represented by the following:

- Learning- and knowledge-sharing
- adherence to the principle of openness

## 1. Learning and Knowledge-sharing

There was frequent reference in the interviews to learning and knowledge-sharing as core to the work of – and even, at a broader level, to the ethic or philosophy of – the collectives. Numerous interviewees spoke of how they enjoyed teaching someone else how to do something, and in turn being taught. Often this peer-to-peer learning was a matter of a software-oriented person passing on software skills to a more electronics/hardware-oriented person, or vice versa.

According to interviewee 2 (2016), from the Makerlabs collective:

> The idea is I think a lot of people originally coming here, is to learn skills. It was one of the reasons I was keen because I wanted to learn more about electronics, and get more into the hardware side of things. I am from the software side. [...] So it kind of emerged from that.

Interviewee 2 (2016) also explained: "I want to learn this stuff. I realised that you can sit on the Internet and try to learn stuff by yourself, but it's much easier if somebody shows you stuff."

In the words of interviewee 5 (2016), from the BinarySpace collective:

> So I came here […] assuming that I'm out of my depth between all these guys. And then I realised but everybody thinks that. We have people from all walks of life, and everybody has something to offer, and something to learn.

According to interviewee 7 (2016), also from BinarySpace:

> For a lot of guys, the reward is the learning experience, especially for me. I don't mind helping you with something. I don't mind even developing your whole project for you. Because for me, learning something out of it, is the goal, or, is the reward.

According to interviewee 1 (2016), from the Wits DIZ Maker Space,

> the most connecting thing is this idea of sharing knowledge, and I think that you can almost tell immediately when you meet with someone whether they have that kind of mindset or not. Especially in the past, they were like "this is my idea, but I mustn't share it because then that guy is just going to take it and make money off it". Whereas the big change is in like "cool I just figured out how to do this completely new thing, hey, let me show you and then you can do it because you might discover something that I wouldn't because your background's slightly different, then you'll share that back to me".

It was found that central to the emphasis on learning and knowledge-sharing was a belief in the power of interdisciplinarity. This dimension was found to be present in all of the collectives, but was particularly notable in the work of the UP MakerSpace, where students from several different disciplines run the centre and, in turn, interact with students from still-other disciplines.

According to interviewee 12 (2016), one of the students working at the UP MakerSpace:

> What this place is mostly meant for is that if you don't know something, you can basically find it from somebody else. I know two people that are doing a whole different course, and they have come here to try and learn programming, and programming is not related to their course. So I am guessing that actually helps out. People here are from various departments.

The students running the UP MakerSpace at the time of our interviews were from the disciplines of Mechanical Engineering, Biochemistry, Medicine and Education, with the Education student also working for the university's IT Department.

## 2. Adherence to the Principle of Openness

We also found that a core dimension of collaboration in the collectives is adherence to the principle of openness. For example, interviewee 4 (2016), when describing the initial SkateHacks sessions – during which he and others were collaborating on what could be done to add electronics to skateboards – said the following:

> Basically it was a new idea to them, so it was just like a "wow" thing. […] They were just throwing ideas, what they could think of. It was […] an open idea, so everybody who's willing to actually build a skateboard like that […] can actually build it as well.

Interviewee 15 (2016), a member of the House4Hack collective, explained his attitude towards openness with an anecdote about what happened after House4Hack won two competitions based on a particular remote-control innovation:

> A lot of people came to us and said, like, "okay, so have you patented this thing, are you gonna sell it?" […], and I was like, "you know what, all the code is on […] an open source repository. You can go and download it, and you can go make it yourself, and you can go sell it. Go have fun" […] I had zero interest in trying to build a company out of this. Like, I think it's a great thing and I would love to see it on the shelves. In fact, we spoke to a company down the road […] about making this as a product. So we looked at potential commercial ventures. But the last thing I want to do is sit there programming this thing for the next year, you know. I moved on to other projects. So that kind of gives you the vibe, at least from personal my point of view.

And in the words of interviewee 14 (2016):

> [i]f you have the ability to make, it's almost like you pretty much have a personal philosophy of generosity, of giving, because it's not a scarcity mentality, right? Because you're able to make things. It's the opposite of consumerism. […] We sometimes do get people that come here with the scarcity mentality, and how you identify them is the first thing they want you to do is sign an NDA [non-disclosure agreement]. And then pretty much at that point, we can tell them to go away, it's not gonna work, we're not there, that's not who we are.

# Preliminary Conclusions and Directions for Further Investigation

We now offer some preliminary conclusions and possible directions for further investigation, grouped into three sections:

- outreach and skills development
- networking
- innovation and collaboration

## 1. Outreach and Skills Development

We found a greater diversity of outreach and skills development than expected to find. We had, based on anecdotal evidence, assumed that Gauteng's maker movement would have a predominantly middle-class, suburban, male demographic that would make connections with grassroots, informal innovators and craftspeople difficult. We found this not to be the case. While three of the collectives fit the middle-class, suburban, male mould to a great extent, the other five did not. And the best-known of the three that did fit the mould, House4Hack, had taken steps to broaden its reach, and the other two were cognizant of the need to do so.

There was evidence of a wide array of modes of outreach being practiced by the eight collectives we identified, directed at (1) the general public, (2) university students, (3) high school students, (3) entrepreneurs, and (4) grassroots, informal innovators and craftspeople; and (5) girls and women. Given that the oldest collective we identified was only five years old, and that most had only been in existence for between one and three years, it was notable that such a wide range of outreach tools had been developed, all of which appeared to be having a high degree of effectiveness in growing awareness of, and participation in, the maker movement in Gauteng province.

We see several possible future directions for investigation in respect of outreach and skills development

### (a) Mobile outreach and skills development

One area that we feel deserves investigation is the use of mobile maker units – by Geekulcha and the I Make Makers Lab – to reach township-based innovators and rural craftspeople, respectively. These mobile units would appear to potentially offer avenues for sustained skills development interactions between somewhat-formalised and much-less-formalised innovation contexts, i.e., connections between different points along the continuum formal- and informal-sector innovation.

We have also been made aware, via the work of our colleagues at the Open AIR hub in Canada, of mobile outreach and skills development work being performed by the University of Ottawa's Richard L'Abbé Makerspace, including outreach to aboriginal communities. We feel there could be scope for linked studies, in South Africa and Canada, of mobile makerspace outreach and skills development.

### (b) Outreach to craftspeople

The efforts being made by I Make, through its Mobile Lab, to engage with rural craftspeople would seem, in our view, to offer potential for an extremely valuable case study of the degree to which the maker movement can be fused with the craft sector in the South African context.

### (c) STEM and STEAM outreach

Also potentially deserving further investigation is the work of several of the Gauteng maker collectives in support of STEM and STEAM education at South African high schools. Concern with building STEM and STEAM skills among young people is a global issue, but it takes on particular urgency in developing-world contexts, such as that of South Africa, which are characterised by low levels of STEM/STEAM proficiency and high levels of youth unemployment.

## 2. Networking

Our findings in respect of networking corresponded in some respects with our expectations, but in other respects exceeded expectations. We were aware, based on anecdotal evidence, that there was some networking among Gauteng maker collectives, particularly among the community-based House4Hack, BinarySpace and Makerlabs collectives. At national level, we were also aware of some efforts at national networking, driven to a great extent by The MakerSpace in Durban. At international level, we knew of the arrival of the Maker Faire Africa brand in Gauteng in 2014 via the staging of one of its events in Johannesburg in 2014. So we were aware of a certain degree of provincial, national and international networking by Gauteng maker collectives.

But what we found in the course of the research were the beginnings of intensified networking by Gauteng maker collectives: with other collectives in Gauteng, with collectives in other parts of South Africa, and with other collectives internationally.

In terms international networking, we found out that only a few days before our interviews with members of the Geekulcha collective, Geekulcha had been part of meetings and events staged in Gauteng, under the British Council's Connect ZA programme, which brought Geekulcha into contact with some key maker movement figures from Nigeria and the UK.

On the provincial front and national front, a few months after our data collection, in August and September 2016, several Gauteng maker collectives came together successfully, spurred on by the national South African Maker Collective that had only really been launched at the beginning of 2016, to stage activities at the Decorex SA Johannesburg event and at the Wits Fak'ugesi event also in Johannesburg.

Of interest going forward will be whether the South African movement finds its networking energies and resources are better focused at international, national, provincial or local/city levels, or whether all four can be sustained and leveraged. In respect of the possible advantages of strong local/city networks among makerspaces, we found evidence of apparently strong backing from both the Tshwane and Johannesburg municipal governments for innovation and start-up support, including hackathons and maker-oriented activities. Also there are potentially some worthwhile city-based-network models to emulate overseas, with one of the I Make Makers Lab interviewees pointing to the vibrancy of Amsterdam's network of makerspaces, many of which apparently put strong emphasis on selling of craft-oriented items to the public.

## 3. Innovation and Collaboration

The interview data that emerged in relation to the themes of innovation and collaboration were extremely rich. Among the areas we feel the interview data shed light on, which we would like to explore via additional pieces of writing and research, are: democratisation of innovation; and informal-sector innovation.

### (a) Democratisation of Innovation

Many of the findings generated by the 28 interviews seem clearly to intersect with elements of Von Hippel's "user innovation" framework (Von Hippel, 2005). In his 2005 volume *Democratising Innovation,* Von Hippel sets out his view, based on his examination of sectors as diverse as software and windsurfing equipment, that users, acting either within firms or as individuals, "are increasingly able to innovate for themselves" rather than being reliant on "manufacturer-centric innovation" (2005, p. 1).

According to Von Hippel:

> User-centered innovation processes offer great advantages over the manufacturer-centric innovation development systems that have been the mainstay of commerce for hundreds of years. Users that innovate can develop exactly what they want, rather than relying on manufacturers to act as their (often very imperfect) agents. Moreover, individual users do not have to develop everything they need on their own: they can benefit from innovations developed and freely shared by others. The trend toward democratization of innovation applies to information products such as software and also to physical products. (2005, p. 1)

Von Hippel sets out what he sees as the core causes, motivations and dynamics driving user innovation, many of which resonate, in our preliminary analysis, with the causes, motivations and dynamics described or implied by the Gauteng maker collective members we interviewed.

For instance, Von Hippel examines innovators' desire for customised products, and the "innovate-or-buy" decision-making that drives a lot of user innovation. And with particular resonance to our interview findings, Von Hippel posits that one of the incentives that drives "individual user-innovators to innovate rather than buy" is that

> they may value the *process* of innovating because of the enjoyment or learning that it brings them. It might seem strange that user-innovators can enjoy product development enough to want to do it themselves – after all, manufacturers pay their product developers to do such work! On the other hand, it is also clear that enjoyment of problem solving is a motivator for many individual problem solvers in at least some fields. (Von Hippel, 2005, p. 7, emphasis in original)

Also strongly resonant with the statements of many of our interviewees is Von Hippel's analysis of the openness, and lack of protectiveness, that user innovators tend to take towards intellectual property. As Von Hippel writes,

> Innovators often freely reveal because it is often the best or the only practical option available to them. Hiding an innovation as a trade secret is unlikely to be successful for long: too many generally know similar things, and some holders of the "secret" information stand to lose little or nothing by freely revealing what they know. Studies find that innovators in many fields view patents as having only limited value. (Von Hippel, 2005, p. 10)

This lack of faith in the patent system was generally held, with only one exception, by the Gauteng maker collective participants who addressed the topic in our interviews.

Also resonating with many of our interviewees' inputs is Von Hippel's writing on "innovation communities", in which he speaks of how "it is important for user-innovators to find ways to combine and leverage their efforts", adding that:

> Users achieve this by engaging in many forms of cooperation. Direct, informal user-to-user cooperation (assisting others to innovate, answering questions, and so on) is common. Organized cooperation is also common, with users joining together in networks and communities that provide useful structures and tools for their interactions and for the distribution of innovations. (Von Hippel, 2005, pp. 10-11)

Of particular resonance in the above-cited passage is Von Hippel's reference to "[d]irect, informal user-to-user cooperation (assisting others to innovate, answering questions, and so on)".

### (b) Informal-sector Innovation

The other lens we propose to analyse the interview data through, in a separate piece of literature, is an informal-sector innovation lens.

It is our view that the findings presented above in the section on "Innovation", and in the section on "Collaboration", shed valuable light on how Gauteng maker collectives can be seen as vehicles of informal-sector innovation. All four of the innovation themes covered above – (1) tinkering, hacking, DIY, organic innovation, (2) innovation born of poverty, necessity, (3) process innovation, incremental innovation, (4) re-purposing, recycling – connect in one way or another with existing frameworks for understanding innovation processes in the informal sector (see Bull et al., 2013; De Beer & Armstrong, 2015; Kraemer-Mbula & Wunsch-Vincent, 2016). So too do the two collaboration themes covered above – (1) learning and knowledge-sharing, and (2) adherence to the principle of openness – have direct relevance to existing analyses of the dynamics of informal-sector innovation (see Kawooya, 2014).

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**Research Interviews**

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Interviewee 3. (2016). In-person interview, 25 February.

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ottawa@openair.org,za
capetown@openair.org.za

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