Are makers the new 'alternative'? Evidence from Africa's makerspaces

Erika Kraemer-Mbula[a,1], Elvis Korku Avenyo[b,2] and Chris Armstrong[c,3]

1. Introduction

Automation and digitalisation are changing the industrial processes of the global economy. While these technological changes promise to have profound ramifications on industrial productivity, employment, inequality, and the very way humans organise and produce goods and services at unprecedented scales and complexity, yet to imagine, the 'post-automation' consequences and risks remain even unclear. Uncertain as the post-automation era may be, it remains that humans will continue to organise and re-organise in several other alternative forms to make and consume, albeit digital.

The maker movement may just be one of such forms of re-organisation of production processes, where makers, either collectively or individually, are appropriating new technologies, re-creating skills, using and/or re-creating knowledge and technologies openly for new and more flexible production and consumption systems (Anderson, 2012). The digital revolution is at the centre of these dramatic and transformative changes. In fact, growing digitalisation does not only have the potential to 'democratise' production processes, it is also progressively giving impetus and autonomy to the maker movement and makers to own and control factors of production, make goods, and in the process challenge and disrupt conventional factory production (industrial production) (Anderson, 2012). Makerspaces can potentially disrupt how production and consumption are undertaken in the modern society (Dias and Smith, 2018). In the 'traditional' factory production, workers are often alienated and secluded from their final products, and hence the real value created (Braybrooke and Smith, 2018). Scholarly evidence suggests that the makerspace movement and makerspaces are already revolutionising the current ideas of production and consumption in several alternative ways (Makerspace, 2017).

While several definitions exist, ElHoussamy and Rizk (2018, p.3) define makerspaces as 'physical spaces with tools, where individuals of different backgrounds design, prototype, and create manufactured works.' These tools can be 'high' or 'no' technology tools (Makerspace, 2017), and the physical spaces could, in some cases, transcend physical boundaries (Kraemer-Mbula & Armstrong, 2017). In recent years, makerspaces are seizing new technologies - such as 3D printing, robotics and microprocessors- and, using and re-using them in non-industrial, free and open environments

[a] DST/NRF/Newton Fund Trilateral Research Chair in Transformative Innovation, the 4th Industrial Revolution and Sustainable Development, University of Johannesburg, South Africa.
[b] DST/NRF South African Research Chair in (SARChi) Industrial Development, University of Johannesburg, South Africa.
[b] Open African Innovation Research (Open AIR), Centre for Law, Technology and Society, Faculty of Law, University of Ottawa, Ottawa, Canada.
[1] erikakm@uj.ac.za
[2] elvisa@uj.ac.za
[3] c.g.armstrong@gmail.com

(contrary to conventional factory walls with workers on its floors and formal Intellectual Property Right (IPR) systems). In such environments makers are able to cooperatively experiment, create and innovate sustainably (ElHoussamy and Rizk, 2018; Kraemer-Mbula & Armstrong, 2017; Anderson, 2012). With some authors considering it as the dawn or the first morning light of the next industrial revolution, because of its resemblance to earlier pre-industrial revolutions (Anderson, 2012; De Beer et al., 2017), the maker movement and makerspaces are argued to be creating and driving a new 'manufacturing revolution', and changing the face of the manufacturing industry (Anderson, 2012). According to Baybrooke and Smith (2018, p.4), makerspaces are redefining 'new norms for manufacturing in open and circular ways.' As 'traditional' manufacturing processes increasingly gets undermined by the 'maker' industrial revolution (Anderson, 2012), the onus lies on developing countries to rapidly adapt not only to the current ways of making goods, but also re-adapt, re-organise, align and re-align these processes to local contexts to solve local problems.

This presents a window of opportunity to Africa, in particular, to create communal solutions that would spur shared prosperity and improve well-being. Most importantly, it is an opportunity for an Africa-led global development trajectory. Makerspaces, conceived as possible 'drivers' of the Africa-led development trajectory, remain nascent on the continent. In just about a decade, the number of makerspaces, however, has increased tremendously across the continent (Schonwetter and Van Wiele, 2018; De Beer et al., 2017). One explanation may be due to the culture of shared creations of makerspaces. Africa remains a very communal continent where societies communally share ideas and resources to solve specific societal problems. As a result, evidence exploring the marker movement and makerspaces is gaining traction, both from policymakers and researchers. The available evidence shows that makerspaces in Africa are: oriented towards solutions to satisfy individual or communal needs; open; innovative; use new 4IR technologies; employ practical learning and skill development strategies; and use informal and semi-formal IP protection (El Houssamy and Rizk, 2018; Schonwetter and van Wiele, 2018; De Beer et al., 2017; Kraemer-Mbula & Armstrong, 2017).

These findings suggest that maker spaces provide a platform for democratic production processes on the continent. While a growing body of evidence exists on makerspaces, still little is known about their nature, organization, governance and activities in terms of openness, technologies, and scalability of innovations. The available evidence is broad, however it fails to explore, for instance, questions such as: are African makerspaces changing production processes on the continent? Combined with the already existing maker culture on the African continent (Hersman, 2013), activities and the experiences generated from maker spaces could bring along new value creation processes and networks, new delineations of work with possible changes in the 'traditional' ways in the organization of production, and most notably, new gendered identities of work. This paper aims to explore and examine, in detail, these issues in the context of post-automation in Africa's makerspaces. It also poses several critical questions: Can Africa's makerspaces be the new seed of the continent's industrialisation drive? How are Africa's maker spaces positioning and training makers for new digital production processes? Can makerspaces serve as hubs of knowledge-sharing

and open innovation to drive the Africa-led development? What is the role of government and policy in promoting Africa's makerspaces?

The remainder of the paper is structured as follows. Section 2 critically analyses the available literature on makerspaces and the maker movement in Africa. Section 3 discusses the secondary data sources as well as the data collection procedures for our primary data. Section 4 empirically analyses, presents and discusses our preliminary findings. Section 5 looks at what is next for the paper, and Section 6 concludes the paper and makes policy recommendations.

2. Makerspaces in Africa[4]

While 'making' may be cultural, and 'makers' may have existed in diverse forms on the African continent, 'makerspaces' and the 'maker movement', strictly speaking, are relatively new on the African continent. The Accra Maker Faire, held in 2009, has been identified as the first Maker Faire on the continent. The Accra Maker Faire has since been followed by other faires held in the four corners of the continent, namely South Africa (2014, 2015, 2016), Lagos (2012), Cairo (2011) and Nairobi (2010) (Armstrong, de Beer, Kraemer-Mbula and Ellis, 2018; De Beer, Armstrong, Ellis and Kraemer-Mbula, 2017; Kraemer-Mbula and Armstrong, 2017). Available theoretical and empirical literature on makerspaces is also generally noted to be limited in developing countries (Coban, 2018). Despite, makerspaces and the makerspace movement have gained a lot of research and policy interests over the last few years, particularly in Africa.[5]

The available evidence suggests that makerspaces in Africa, though having similar objectives, differ from country to country, and from one makerspace to another in the same country. One of the first empirical works examining makerspaces on the continent, specifically in the Gauteng Province of South Africa, is by Kraemer-Mbula and Armstrong (2017). In their study of Gauteng Province maker 'collectives'[6], the authors interviewed 28 makers from eight maker collectives and found that maker collectives, as the authors referred to them, differ in terms of management and governance structures as well as funding sources. The authors found that the majority of maker collectives aimed to nurture and grow entrepreneurship abilities of their members through innovations- 'Do-It-Yourself' (DIY), 'necessity', 'incremental' and 're-purposing'-, collaboration at personal levels, and engagement in skill development of their immediate communities. Studying makerspaces in North Africa, ElHoussamy and Rizk (2018) also found similar results suggesting that DIY and entrepreneurial spirit were key in driving makers appetite to provide local solutions to personal and societal problems, particularly after the Arab Springs. In an effort to study and present a national picture of the makerspace ecosystem in South Africa, De Beer et al. (2017) gathered data on 25 maker communities across five South African provinces. The authors found that maker

[4] See Kraemer-Mbula and Armstrong (2017) for description of makerspaces at the global level.

[5] The available research on makerspaces in Africa has been largely pioneered by the Open African Innovation Research (Open AIR) network.

[6] Kraemer-Mbula and Armstrong (2017) make reference to 'maker collectives' rather than makerspaces, to emphasize the fact that there are often groups of people that operate as a community (maker collectives), not necessarily in a physical space (makerspaces).

communities use 4IR technologies such as laser cutters, robotics, and CNC machines, among others, with maker collectives focusing on developing 4IR skills in robotics, 3D CAD, electronics and IoT, among many others. In essence, makerspaces provide access to 4IR technologies that makers would not otherwise have access to. This corroborates with findings by Schonwetter and van Wiele (2018) in their case study of 3D printing and FabLabs in Kenya and South Africa. Some maker collectives were also found to have strong presence in their respective communities. The evidence also suggests that maker communities in South Africa thrive towards inclusivity, and are becoming institutionalized through networks and associations, for instance (Kraemer-Mbula and Armstrong, 2017; De Beer et al., 2017).

Several other follow-up studies were done in other parts of the continent in the bid to understand the makerspace movement. Presenting cross-country evidence from North Africa- Egypt, Tunisia and Morocco-, ElHoussamy and Rizk (2018) found that makerspaces in the region largely emerged after the Arab Spring with the ultimate goal to solve specific local issues such as unemployment and inequality. This suggests that makerspaces offer could offer alternative forms of production and consumption as well as new means of livelihood that could help provide real life solutions to pressing individual and social issues. The makerspace in Africa, could serve as the place, the medium and the mechanism through which innovations and knowledge, particularly in the informal sector, is translated into solving these societal challenges (Adu-Gyamfi and Adjei, 2018; Armstrong et al., 2018).

It is widely emphasized that new skill sets are required for the changing nature of work in the 4IR and post-4IR eras. Available evidence from African makerspaces shows that skills development, be it through apprenticeship, observation, DIY, among others, using 4IR technologies are integral to the operations of makerspaces on the continent (El Houssamy and Rizk, 2018; Kraemer-Mbula and Armstrong, 2017). This suggests that makerspaces could help to develop and build the needed manufacturing skills required for the post-4IR era. While the presence of women was generally found to be low in Gauteng maker collectives (Kraemer-Mbula and Armstrong, 2017), evidence shows that makerspaces provide room for women and young adults to experiment and sharpen their skills. In North Africa, for instance, El Houssamy and Rizk (2018) found that makerspaces provide the platform for female entrepreneurs to develop their nascent skills into businesses. For instance, the authors identified that a makerspace in Egypt nurtured a female maker to start an accessory and decoration business. 'The makerspace provided her with the design and implementation skills needed for her business, in addition to affordable access to machinery' (El Houssamy and Rizk, 2018). This type of democratic platforms may be essential in helping women and young girls to break boundaries that were previously uncharted territories.

3. Methodology and data

This paper aims to shed light on the role of makerspaces and makers in Africa by using data from various studies conducted in South Africa by Open AIR, mainly Kraemer-Mbula & Armstrong (2017) and De Beer et al. (2017). Employing snowball sampling procedure and semi-structured

interviews, De Beer et al. (2017) interviewed and collected data on 25 makerspaces across various South African cities between 2016 and 2017. The data collected covers issues such as the formation, governance, revenue model, location, tools and equipment, and skills development in South African maker communities, among many others.

Table 1 (see Appendix) shows the description of all surveyed maker communities, their location, year of establishment, available technologies and skills focus as well as their participants. (See De Beer et al., 2017 for detailed description of data). The data shows that majority of makerspaces are nascent, with Bloemfontein FabLab being the oldest makerspace established in 2006, and Made in Workshop, eKasi Lab Soweto and ZS6COG Fablab (formerly BNT Masinga Trading and Projects) being the youngest maker communities established in 2016. Table 1 also shows 3D printers, CNC machines and circuit boards are the most dominant technologies in South African makerspaces, serving mainly entrepreneurs and hobbyists.

4. Preliminary empirical findings

The preliminary descriptive from De Beer et al. (2017) data suggest that makers are driving new production processes in South Africa. Our evidence shows that makerspaces are bringing together, to a much closer contact, producers and consumers as well as resources and markets to create new value that satisfy specific customer needs in Africa. The bridging of the producer-consumer chasm by makerspaces is not only altering the traditional mass production system where production is about 'one size fits all', but it is also redefining livelihoods through small businesses that are creative as a result of new technologies and collaborations.

Our empirical evidence shows that Africa's makerspaces employ 4IR technologies, albeit at smaller scales. Notwithstanding, these technologies are fundamental to the changes we are witnessing in the global production system. For makerspaces in Africa to be able to drive its industrialization ambitions in the era of 4IR, makerspaces must be at the frontier of the 4IR. The increasing development, adoption and diffusion of these 4IR technologies in the surveyed makerspaces suggest their readiness to lead and drive Africa's digital transformation.

There is evidence that suggests that new production processes and new waves of technological revolutions change how, what and where men and women work, including the social roles of men and women and to a large extent, the very institution of work. These social possibilities, progressive as they may be, could bring tensions to the social fabric and organization with regards to how things are done, and who does what by males and females. Our evidence shows further that makerspaces in South Africa are advancing social values by creating room for women to nurture, operate and be creative beyond certain social boundaries. According to some female makers, makerspaces are helping them to demystify and confront the so-called man thing.

5. What is next?

Given these preliminary findings based on existing empirical evidence, we are confident that a

deeper analysis of cases in South Africa would provide interesting new elements on specific issues such as the gender delineations of work and also makerspaces as the new drivers of value creation. The next step is to specifically examine these key dimensions of the evidence by using primary data from four makerspaces in the Gauteng Province of South Africa. The paper will complement the secondary data sources with these case studies to examine post-automation possibilities- new demarcations of work, new gender roles and identities, and the role of 4IR technologies-, and how these prospects are being revealed in Africa's maker spaces. Using data collection procedures outlined in Kraemer-Mbula & Armstrong (2017) and De Beer et al. (2017), our follow-up survey will collect data from House4Hack, Tinker Space, MakerLabs, and Geekulcha Makers. The choice of these maker communities is based on proximity and the fact that the research team has established good contacts with these makerspaces. Given time constraints, our social capital would bee helpful in allowing the research team easy access to the community. The data collection is scheduled for September 2019.

The makerspace and the maker movement is a political act as it fundamentally disturbs 'power', be it conscious or otherwise (Dias and Smith, 2018). We also aim to examine, more deeply, the role of makerspaces in democratizing 'power' in production, and also look at the possible role of government and policy in this process.

6. Conclusion

Makerspaces are redefining the way we produce and consume, including the roles of men and women. These fundamental changes to the production and consumption economy are expected to bring inevitable changes to how humans interface in the production process, and possibly, changes in role of Africa in the global production system. This paper examines these issues in the context of 'post-automation' based on data collected in makerspaces in South Africa. Our preliminary findings suggest that 'making' is a cultural and innate phenomenon in Africa, where makers tinker, hack, fix and re-fix things in order to solve specific social needs on the continent, of which there are many on the continent, from hunger, poverty, unemployment and rising inequality, among many others. Makerspaces are also helping to redefine the social role of men and women.

Makerspaces may be the engine of economic and social prosperity in Africa's 'post-automation' era. As a result, deliberate policies are needed to incentivise and to promote makerspaces on the African continent.

Appendix

Table 1: Description of makerspaces in South Africa

Maker community	Location and year of establishment	Core tools and equipment	Core participants	Core skills development focus area
House4Hack	Centurion, 2011	3D printers, laser cutters, CNC machines, Microcontrollers, circuit Boards	Hobbyists	Arduino, raspberry pi, 3d computer-aided Design (cad), 3dprinting, Basic Electronics, internet Of things (iot), Soldering
BinarySpace	Vanderbijlpark, 2012	3D printers, laser cutters, CNC machines, Microcontrollers, circuit Boards	Hobbyists	Robotics, printed circuit Board (pcb) design, 3d Cad, 3d-printing
Tinker Space, University of Johannesburg (UJ) Resolution Circle tech hub	Johannesburg, 2012	3D printers, welding Equipment	Entrepreneurs	Prototyping
Makerlabs	Johannesburg, 2013	3D printer, soldering Station, CNC machine, Reflow oven, Microcontrollers, circuit Boards	Hobbyists	3D-printing, robotics, Antenna-building
Geekulcha Makers	Pretoria, 2014	Microcontrollers, circuit Boards, sensors	Youth	IoT
Sebokeng FabLab, Vaal University of Technology (VUT) tech hub	Sebokeng, 2014	3D printers, laser cutters, CNC machines	University Students, General public	3D CAD, 3D-printing, Prototyping

Ekuherleni FabLabs (Thokoza, Tembisa, Tsakane, Duduza)*	Ekuherleni 2011-16			
Digital Innovation Zone (DIZ) Maker Space, University of the Witwatersrand (Wits) Tshimologong tech hub	Johannesburg, 2015	3D printers	Entrepreneurs, University Students	3D CAD, 3D-printing, Robotics, prototyping
University of Pretoria (UP) MakerSpace	Pretoria, 2015	3D printers, circuit boards	University Students	3D CAD, 3D-printing, Prototyping
eKasi Lab Ga-Rankuwa Ga-	Rankuwa, 2015	3D printers, laser cutter	Entrepreneurs	3D CAD, 3D-printing, Prototyping
I Make Makers Lab, Makers Village	Irene, 2015	3D printers, laser cutters, CNC machines, Woodworking tools, Metalworking tools, sewing And embroidery tools, Ceramics tools	Artisans, Craftspeople, Entrepreneurs	Digitally-mediated arts And crafts production, Entrepreneurship
Made In Workshop	Johannesburg, 2016	3D printers, CNC plasma Cutter, welding machines (MIG, TIG and spot), knee Mill, metal lathe, laser Cutter, hand tools	Hobbyists, Entrepreneurs	Prototyping
eKasi Lab Soweto	Johannesburg 2016	3D printer, laser cutter	Entrepreneurs	Prototyping
ZS6COG Fablab (formerly BNT Masinga Trading and Projects)*	Heidelberg, 2016			

Kluyts MakerSpace	Knysna, 2012	Woodworking tools, laser Cutters, cnc machines, Engineering equipment, Craft tools	Artisans, Product Producers, Entrepreneurs	Woodworking
Craft and Design Institute (CDI) Product Support Space	Cape Town, 2013	3D printer, laser cutter, CNC Machine, woodworking Tools, metalworking tools, Moulding tools, sewing and Embroidery tools	Creative Businesses, Designers, craft Producers, Hobbyists, Students, General public	Digitally-mediated arts And crafts production, Entrepreneurship, Enterprise Development, human Capital development
Workspace	Cape Town, 2013	3D printer, laser cutter, CNC Machine, woodworking Tools, metalworking tools, Leatherworking tools, Sewing and embroidery Tools, screen-printing tools, Ceramics tools, automotive Tools, cooking tools	Youth, Artisans, Craftspeople, Entrepreneurs	Core skills for Employability, Entrepreneurship
Curiosity Campus*	Cape Town, 2013			
The Bank	Cape Town, 2014	3D printer, crafting tools	Designers	Business development
Maker Station	Cape Town, 2014	3D printer, laser cutter, CNC Machine, woodworking Tools, metalworking tools, Leatherworking tools, Moulding tools,	Artisans, Craftspeople, Designers, Entrepreneurs	Peer-to-peer learning Across all maker skill Areas (no formalised Training offerings)

		sewing Tools, automotive tools		
Modern Alchemists, Women in Tech Cape Town, Arduino Cape Town (all coordinated by KATO Technology)	Cape Town, 2014	Microcontrollers, circuit Boards, sensors	General public, Women and Girls, artists, Engineers, Developers, Entrepreneurs, Startups, Companies	Electronics, robotics, Coding, iot, product Development, Entrepreneurship, Enterprise Development
University of Cape Town (UCT) Maker Society	Cape Town, 2015	3D printer, circuit boards	University Students	Engineering
The MakerSpace	Durban, 2013	3D printers, laser cutters, CNC machines, circuit Boards, woodworking tools, Welding tools, Leatherworking tools	General public, Students, Hobbyists, Entrepreneurs, Corporates	Prototyping, Entrepreneurship, Maker skills Mentoring/training
Bloemfontein FabLab, Central University of Technology (CUT) tech hub	Bloemfontein, 2006	3D printers, laser cutters, CNC machine, circuit boards Woodworking tools, Metalworking tools	University Students, General public	Prototyping, Production
WERK*	Port Elizabeth, 2014			

Source: Adapted from De Beer et al. (2017, pages 8 and 22).

* Only online data were collected.

References

Adu-Gyamfi, Y., and Adjei, B. (2018) *Skills development, knowledge and innovation at Suame Magazine, Kumasi*. Open AIR Working Paper No. 16. University of Cape Town and University of Ottawa: Open African Innovation Research (Open AIR).

Anderson, C. (2012). Makers: The new industrial revolution. Toronto: McClelland & Stewart.

Armstrong, C., De Beer, J., Kraemer-Mbula, E., & Ellis, M. (2018). Institutionalisation and informal innovation in South African maker communities. *Journal of Peer Production (JoPP), 12*(1), 14–42.

Baybrooke, K., and Smith, A (2018). Editor's introduction: Liberatory technologies for whom? Exploring a new generation of makerspaces defined by institutional encounters. *Journal of Peer Production (JoPP), 12*(1), 1–13.

Coban, A (2018). Making hardware in Nairobi: between revolutionary practices and restricting imaginations. *Journal of Peer Production (JoPP), 12*(1), 60–77.

De Beer, J., Armstrong, C., Ellis, M., & Kraemer-Mbula, E. (2017). *A scan of South Africa's maker movement*. Open AIR Working Paper No. 9. University of Cape Town and University of Ottawa: Open African Innovation Research (Open AIR). Retrieved from http://www.openair.org.za/wp-content/uploads/2018/02/WP-9-A-Scan-of-South-Africas-Maker-Movement.pdf

Ekekwe, N. (2015, May 29). Africa's maker movement offers opportunity for growth. Harvard Business Review. Retrieved from http://hbr.org

El Houssamy, N. and Rizk, N. (2018). *The maker movement across North Africa*. Open AIR Working Paper No. 17. University of Cape Town and University of Ottawa: Open African Innovation Research (Open AIR).

Hersman, E. (2013, February 26). The need for both makerspaces and incubators in Africa. Ventureburn. Retrieved from https://ventureburn.com

Kraemer-Mbula, E., & Armstrong, C. (2017). *The maker movement in Gauteng Province, South Africa*. Open AIR Working Paper No. 6. University of Cape Town and University of Ottawa: Open African Innovation Research (Open AIR). Retrieved from http://www.openair.org.za/wp-content/uploads/2017/06/WP-6-Maker-Movement-in-Gauteng-Province-South-Africa.pdf

Makerspace. (n.d.). What's a makerspace? Retrieved from http://spaces.makerspace.com/

Schonwetter, T., & van Wiele, B. (2017). *3D printing: Enabler of social entrepreneurship in Africa? The roles of FabLabs and low-cost 3D printers*. Open AIR Working Paper No. 6. University of Cape Town and University of Ottawa: Open African Innovation Research (Open AIR).