A Framework for Socio-Technical Innovation: the Case of a Human-Powered Shredder

Angus Donald Campbell, Senior Lecturer - acampbell@uj.ac.za
Department of Industrial Design, University of Johannesburg, South Africa

Peter Hugh Harrison, MTech Industrial Design Student - harrison@afrihost.co.za
University of Johannesburg, South Africa

In order to envision a better future through design, whilst acknowledging the complexity of such an undertaking, the authors of this paper unpack a framework for socio-technical innovation. This framework combines social innovation with the amplifying power of appropriate technology to bring about positive change. The paper discusses the shortfalls of traditional human-centred design (HCD) and proposes the addition of framing and infrastructuring, appropriate technology, and capabilities to form a collaborative participatory design framework for socio-technical innovation that can be measured for impact. This framework is clarified through a case study that envisions the initial design criteria for a human-powered shredder for urban farmers to reduce organic material for compost and mulch. The context for this case study is the township of Soweto in South Africa, which is fraught with an unjust past. A highly collaborative design research process is therefore required to help ensure democratic outcomes. The process starts with initial framing and infrastructuring through multi-stakeholder engagement. A set of design criteria was then defined through HCD and participatory technology development to encourage an appropriate technological outcome that will enhance the urban farmers' capabilities. The impact of the socio-technical innovation process was continually monitored and will be finally evaluated for impact based on these criteria.

Keywords
Envisioning, Socio-technical innovation framework, Social innovation, Framing & infrastructuring, Collaboration, Appropriate technology, Capabilities, Human-Centred Design (HCD), Impact, Urban farming.

INTRODUCTION

To envision is to imagine a future possibility. The process of envisioning combines with a person's or collective's worldview and defines a future that is either an improvement or regression from the current situation. Envisioning is a vital part of design for social change, however unless it is pinned down by actual needs, it often results in irrelevant solutions. There are two ways of better aligning envisioning with reality, the first is social innovation (Manzini, 2015; Björgvinsson, E., Ehn, P. & Hillgren, P-A. 2010; Meroni, 2007) and the second is technology (Schumacher, [1973] 2010 pp. 120-131; & Feenberg, 1999, pp. 202-208).

In this paper these two actors are combined to describe a more holistic and integrated socio-technical system (Trist, E. 1981 & Ropohl, 1999) and a framework for socio-technical innovation. The reason that this has been proposed is that, through our experience of developing interventions to bring about positive social change, the best available tool/method for designers, namely Human-Centred Design (HCD), is not sufficient for such an undertaking (Brand & Campbell, 2014). This paper explores HCD's shortcomings and how we overcame them using the methods of framing and infrastructuring, appropriate technology and capabilities, to form a framework for socio-technical innovation. This is further clarified through a case study of the envisioning stage of a human-powered shredder for urban farmers to reduce organic material for compost and mulch. The case study is based in the historically marginalised township of Soweto in South Africa. We will begin with the exploration of social innovation and technology in order to better define socio-technical innovation.

SOCIAL INNOVATION

The *Younger Foundation*, who actively promotes social innovation, defines it as, "new ideas (products, services and models) that simultaneously meet social needs and create new social relationships or collaborations." (Murray, Caulier-Grice, & Mulgan, 2010, p.3). Social innovation tends to define collaborative human ingenuity resulting from an unsatisfied need. What is important in such a definition is that it describes an organic process of dense social relationships and cooperative behaviour, which are coordinated towards meeting these needs. Social innovations are beneficial to society and also enhance society's agency. Additionally the societal changes that social innovation generates helps to reinforce social fabric and reduce environmental impact (Manzini, 2014). At social innovation's core is both openness and participation (Hillgren, Seravalli & Emilson, 2011, p.170; Murray *et al.* p.7). Social innovation is therefore a powerful phenomenon that can be utilised by designers to spark social change through meaningful collaboration (Manzini, 2015). Such an approach also means that ownership begins and remains in the hands of a vested community. The designer can therefore plan an exit strategy at the outset with the knowledge that the social innovation will continue without their continued input (Meroni, Fassi & Simeone, 2013). This is an important consideration for the resilience and sustainability of an intervention.

Many social innovations, such as *Uber*, *Airbnb*, *Zipcar* and *Kickstarter*, include a significant technological aspect that enables its up scaling. The ubiquity of mobile telephony and the web have enabled social innovations to be scaled beyond their original contexts. This brings with it additional complexities over and above the social needs that were originally being met. It is useful at this stage to explore the critical theory of technology, which will help to guide how we can think about the development, adoption, adaptation and innovation of technology within society. This will lead us to an understanding that technology

and society have become so intertwined that to leave the technology out of social innovation is to ignore a critical part of it.

TECHNOLOGY

Technology has long been positioned in opposition to nature and man (Verbeek, 2005, p. 3). Heidegger argued that technology alienated humans individually, from each other, and from reality and the world around us (1977). However, as technology has become more pervasive, less obtrusive and more integrated into our daily lives, a more optimistic, although not uncritical, view has come to light. Critical theorist Andrew Feenberg posits that technology provides a powerful potential to create democracy through human agency (Feenberg, 1999, pp. 131-147). Hence technology becomes a very powerful means to enhance and scale-up social innovation.

SOCIO-TECHNICAL INNOVATION

German philosopher of technology Günter Ropohl (1999) maintains that there is very little understanding of the "technical society" due to disciplinary silos: social scientists are not particularly concerned with the role that technology plays in society and engineers/designers of the social concerns in their work. This is changing as these silos are slowly deconstructed from within the academy, but there is still much work to do. Ropohl uses the systems model to describe "both social and technical phenomena, persons and machines, the technization of society and the socialization of technology" (Ropohl, 1999). He defines this system as the *socio-technical system*, borrowing the concept from labour studies of the 1960s where it was used to describe the interaction between human behaviour and society's complex infrastructure[1] (Emery & Trist, 1960). Ropohl extends this theory to link the act of invention to social change:

Every invention is an intervention, an intervention into nature and society. That is the reason why technical development is equivalent to social change. (1999).

Feenberg (1999) furthers the act of invention or realisation of technology and its integration into society into two phases. The first "primary instrumentalisation" is a process of technology design; the second "secondary instrumentalisation" is the possibility of the innovative use and adaptation of such technology in society (1999, pp. 202-208). Primary instrumentalisation occurs when a particular technology is designed, and this is frequently non-innovative particularly when it reifies the position of a powerful group of people in society (1999, p.2). The conflict between the user and the expert is overcome through methods such as HCD, however it can only be considered truly democratic once the technology

[1] For further exploration of this concept Professor of Technology and Society, Wiebe E. Bijkers's 1995 book *Of bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change* is invaluable reading.

is integrated into society. This integration requires users, or "actors", to adapt and even transform the original design (1999, p. 205-208) often resulting in more appropriate technology (Feenberg, 1999, pp. 123-125; Smillie, 2000; Schumacher, [1973] 2010); this is secondary instrumentalisation. What Feenberg describes can be described as a marriage of technology development with social innovation, or more concisely socio-technical innovation.

How does one go about initiating socio-technical innovation? This is where the current method that most participatory designers would reach for, HCD, falls short.

SHORTCOMINGS OF HUMAN-CENTRED DESIGN

SCOPE

Powerful national and international actors often misuse participation as a panacea for all projects of a social nature (Cornwall & Brock, 2005; Cooke & Kothari, 2001). However, if well facilitated with democratic intentions, it can allow for a level of "citizen control" (Arnstein, 1969). The participatory design method of HCD (IDEO, 2014a), although beneficial in encouraging designers to co-create with communities of users, also tends to narrow the designers' focus when aiming for social change (Brand & Campbell: 2014). By only focusing within a designer-user bounded context (in-context) the designer runs the risk of narrowing his/her scope to enable the outcome of a 'solution' within a given time frame, but with the resultant 'solution' being inappropriate due to the misalignment of the designer to the greater ecology of the problem (Brand & Campbell, 2014). On the other hand, the designer can attempt a much broader view of the problem ecology, but risks becoming paralyzed by the expanse of the problem and not knowing where to focus (IDEO.org, 2014b). This is the issue of framing, which is not only difficult to define in design-based research, but all forms of research where the tension between scope and achieving outcomes is a constant balancing act. This is where social innovation's framing and infrastructing methods are key in ensuring that project scope is delimited sufficiently for an intervention whilst actively encouraging collaborations outside of the project frame for sustainability and resilience.

ADDITION: FRAMING & INFRASTRUCTURING

Framing and infrastructuring go hand-in-hand. Framing defines a boundary within the problem ecology on which the designer or design team will focus, however infrastructuring acknowledges the fact that this boundary is porous and that "innovation today is rather heterogeneous, partly open and public, engaging users and other stakeholders across organizational and community borders" (Björgvinsson, Ehn & Hillgren. 2010. p. 3). Infrastructuring is the process of

extensive collaboration with many role players (both human and technological) over time to advance community interests through innovative outcomes (Karasti, 2014). Social contexts, practices and technologies are constantly in flux requiring continuous infrastructuring by the designer to align partly conflicting interests (Björgvinsson, Ehn & Hillgren 2010, p. 130). Good infrastructuring therefore helps to build long-term relationships with stakeholders resulting in networks and alliances that encourage emergent design opportunities (Hillgren Seravalli & Emilson, 2011, p.1).

OWNERSHIP

Examples of socially orientated design work, using participatory and HCD methods, are frequently criticised as being undertaken with ulterior economic motives under the banner of charity (Arad, 2012). This results in the intended users denouncing what they consider a form of imperialism through design (Nussbaum, 2010). Although HCD models seem to highlight user participation as a priority, many of these methods propose relatively fast turnaround from concept to solution, by designers who mostly come from distinctly different socio-cultural backgrounds, to 'solve' the problems of local 'underdeveloped' communities through design (Campbell, 2013b). Many of these methods encourage, although not intentionally, the distinct separation of 'user' and 'designer'. In short-term design development projects designers/students are dropped into communities to develop 'solutions' to their 'problems'. It is very difficult to leave personal preconceptions and agendas behind, resulting in many HCD projects meeting the outcomes required by the designer/student/donor but failing to address community needs.This burgeons on what Klaus Krippendorff describes as "technology-centred design" (2006, pp.31-32) and limits the intended users ownership and hence adoption of the outcome.

ADDITION: APPROPRIATE TECHNOLOGY

A more socially beneficial approach to technological development can be found in the work of Schumacher (1973). Schumacher's theory of intermediate or Appropriate Technology (AT) was a reaction to the poorly considered transfer of technology from the West to 'developing' countries during the 1970s under the auspices of development aid. Influenced by the field of development economics, Schumacher defined technology as being appropriate when it was affordable, fairly simple and understandable, and easily maintained ([1973] 2010, p. 148-150). Hazeltine and Bull (2003, pp. 3-4) expand on this definition:

Appropriate technology is defined as any object, process, ideas or practice that enhances human fulfilment through the satisfaction of human needs. A technology is deemed appropriate when it is compatible with local, cultural, and economic conditions, and utilizes locally available materials and energy resources,

with tools and processes maintained and operationally controlled by the local population.

AT therefore requires local input, understanding and engagement. As such, it serves as a perfect complement to participatory technology development methods (Campbell, 2013a) such as HCD (IDEO.org, 2014a) by grounding technology in society. This is especially important when working in highly marginalised contexts (Hussain, Sanders, & Steinert, 2012).

MEASURING IMPACT

At the Social Impact Design Summit held in 2012 (Smithsonian Institution, 2013, p24- 25) it emerged that one of the biggest shortfalls of current social design methods, such as HCD, is their failure to effectively measure the impact of interventions. This problem has been overcome in the field of Development Studies through a rigorous process of monitoring and evaluation (Bakewell, 2003). Most HCD interventions document outputs (what was done) and outcomes (what happened), but few document impact (what actually changed). Impact is concerned with long-term sustainable changes that are introduced by an intervention into the lives of stakeholders (Bakewell, 2003, p. 19). In order for impact to be measured the initial situation or baseline first needs to be documented. Again, the field of Development Studies offers a useful framework for such an undertaking in the form of the Capabilities Approach.

ADDITION: CAPABILITIES

The human development of capabilities or the Capabilities Approach (CA) (Sen, 1999 & Nussbaum, 2011) is a theoretical framework that consists of two normative claims. Firstly, "that the freedom to achieve well-being is of primary moral importance" and, secondly, "that this freedom is understood in terms of people's capabilities, or their genuine opportunities to do and be what they have reason to value." (Robeyns, 2011). Ilse Oosterlaken (2013. pp. 61-74) takes this framework a step further by arguing that CA should not only focus on the justice and development of human capabilities through policy and proposals for social change, but also through the design of artefacts. Nussbaum defines ten central capabilities, ranging from life expectancy to the material and political control one has over their own environment (2011, pp. 33-34). Interestingly, many of these capabilities are echoed in AT and can be used to define a community's baseline at the start of an intervention. These capabilities can also act as a moral rudder throughout the design intervention and can finally be used as a checklist when validating the intervention's impact.

In summary CA and AT are both incredibly useful to HCD in that they both shift the designer's perspective, from focussing on societal problems, to instead focus on people's potential to better themselves through efforts that they have already initiated. It is the designer's task to then amplify such activities

through design and technology. Framing and infrustructuring help integrate the right stakeholders into the project frame enabling a focus for the designers and a broader resilience for the intervention. In figure 1 the socio-technical innovation framework is illustrated. The orange area defines what currently forms the context for traditional HCD.The addition of infrastructuring broadens social interconnectivity; AT helps ensure ownership through participation; and the intervention is finally measured in terms of its impact on capabilities. The application of this framework will now be demonstrated through a case study.

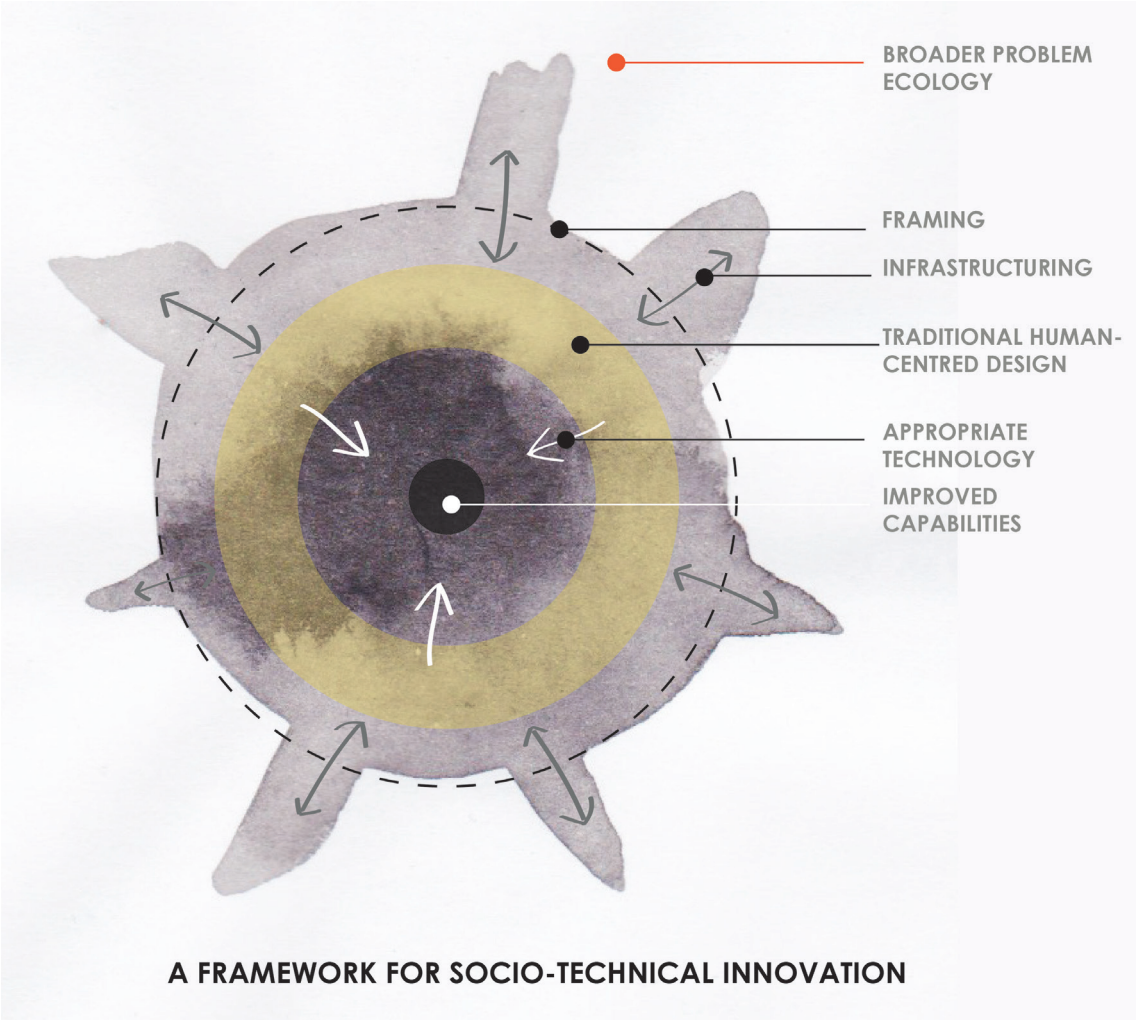

FIGURE 1 - A framework for socio-technical innovation. (Courtesy of Angus D Campbell)

CASE STUDY: A HUMAN-POWERED SHREDDER

The case study under review forms part of the interdisciplinary project called *Izindaba Zokudla* (IZ)[2] or "conversations about food" in the isiZulu language. The project's main focus is on generating innovation in the food system of the South Western Townships (Soweto) (Malan & Campbell 2014; Brand & Campbell 2014). It is a collaboration between the departments of Development Studies and Industrial Design at the University of Johannesburg, which has a satellite campus in Soweto; and it is a project of the De*sign Society Development DESIS Lab*[3].

Soweto is the most populous black residential area in South Africa with almost 1.3 million inhabitants in 2011 (Stats SA, 2011). Its first suburb, Kliptown, was constructed in 1903 by the apartheid government and Soweto's expansion was controlled under the *Native Urban Areas Act* with intentionally restrictive urban planning for purposes of control (City of Joburg, n.d.). Soweto has been the focus of much development work post-1994 but still reverberates with its marginalized past.

Further narrowing the context to Soweto's food system, the design researchers were faced with marginalised Sowetan urban farmers; on-going household food insecurity (SANHANES-1, 2013. pp. 145-146; Oxfam, 2014); soil degradation (FAO, 2001); uncertainty surrounding land tenure, poverty and climate change (Oxfam, 2014. p. 27); as well as the challenge of sustainable intensification for improved livelihoods on small urban farming plots (van Staden, 2014. p. 112). Within this historically turbulent context, general racial and socio-economic differences further complicated the interpersonal interaction of design researchers and urban farmers.

Before any genuine participatory design research could take place in such an environment, relationships with a certain level of trust and respect needed to be built. To this end the trans-disciplinary research team from the IZ project had maintained a presence and built relationships with emergent urban farmers in Soweto since mid-2013. This was achieved through involvement at civic farmers' meetings and through several workshops that helped to democratically direct the project's foci and begin the infrastructuring process.

Working on the complex task of bringing about change in a food system whilst negotiating power differentials between interested parties, the coordinators of IZ borrowed the method of *Multi-stakeholder Engagement* (Peterson, 2013) for their workshops from *Transforum*; a Dutch EU-funded project focused on innovating sustainable development in the food system through connected values (Regeer, Mager & van Oorsouw, 2011). A series of facilitated IZ workshops were undertaken in 2013 and 2014, these included urban farmers, grassroots civic farming organisations (the Region D Farmers Forum), government (Departments of Social Development, Education, and Agriculture and Rural Development),

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[2] *www.designsocietydevelopment.org/project/izindaba-zokudla/*

[3] *www.designsocietydevelopment.org* & *www.desis-network.org*

non-governmental organizations (Siyakhana), academic institutions (University of Johannesburg) and other stakeholders.

All workshops were facilitated using methods such as *Open Space* (Herman, n.d.) and *World Café* (The World Café, n.d.), both self-organizing workshop methods used for diverse audiences in order to address complex problems. One of the main outcomes from these workshops was that participants democratically identified four areas needing intervention in the Sowetan context: better technology to increase farm productivity, marketing to increase sales and access to market, better systems for defining land tenure and, finally, training for the farmers. The case study in this paper focuses on the need for more appropriate technology.

FIGURE 2 - Framing & Infrustructuring: Izindaba Zokudla multistakeholder workshop 2 2013, UJ Soweto Campus. (Courtesy of Angus D Campbell)

As opposed to the multi-stakeholder methods used in the framing and infrastructing phase, more traditional participatory design methods (HCD) were used in the next phase within a more homogeneous group of farmers.

As per the identified need for technology to increase farmers' productivity and in line with documented and observed soil deficiencies in Soweto, exploratory interviews were held on 5 April 2014 with two expert urban farmers sitting as representatives of the Region D Farmers Forum (RDFF). The RDFF is IZ's main grassroots partner and an active community based urban farming organisation aiming to address the inequalities in Soweto through food. The exploratory interviews yielded three useful insights: the farmers indicated a need to improve their soil quality (Skhosana, 2014; Mokete, 2014). Secondly, they acknowledged

that their current ability to produce or rather reduce mulching materials is time consuming and inconsistent (Ibid.). Thirdly, participants affirmed an understanding that composting positively impacts plant health thereby reducing the risk of crop failure (Ibid.).

Further fieldwork and focus groups held on 29 April 2014 reconfirmed that farmers struggle to reduce organic waste material, currently only using hand-tools or leaving large matter to break down in the sun before composting or mulching (Skhosana *et al.* 2014).Another issue was that Johannesburg's hot and dry conditions rapidly reduce soil moisture content (Ibid.).This results in farmers spending much time, and scarce monetary resources, on often-insufficient although frequent hand watering of their crops (Department of Water Affairs, 2005, p.6).Although not completely solving this problem, mulch and the addition of organic matter to reduce evaporation and retain moisture.

The two focus groups confirmed the need for a device to reduce organic material for composting and mulching. At this point the design researchers needed to define a set of design criteria that would lead to, or envision, a product that is of real future benefit for the farmers. These criteria were based on a combination of Nussbaum's ten central capabilities (2011, pp.33-34) together with the ideals of Appropriate Technology (Schumacher, [1973] 2010; Dunn, 1978; Hazeltine & Bull, 2003; (NCAT, n.d.); Practical Action, 2012). It is important to note that although most of the criteria sound hopelessly optimistic, as per the process of envisioning, this early stage of the project is very much about the positive potential that mechanised processing could create.The reality may be quite different, but this will be documented post-intervention as a way to measure actual impact. Since they are such important moral rudders, if they are not considered at the outset it is near impossible to integrate them afterwards.

1. EMPOWERMENT: OWNERSHIP, AFFILIATION, EMOTIONAL CONNECTION AND CONTROL OVER ONE'S ENVIRONMENT

The infrastructuring process enabled the farmers to directly engage with government regarding their farming concerns; this enabled a level of political participation that was generally unachievable beforehand. Although indirect, the relationships built through the process may lead to stronger bonds within the local community.The shredder as a technology aims to allow the farmers better control over their farming practice and continued input from members of the RDFF and local stakeholders will be maintained to ensure that the technology developed meets real community needs and not those of the design researchers. As per South African Intellectual Property law (2008) and the co-design process, farmers will be acknowledged for their input particularly if patentable; if not, all outcomes will remain open source.The realisation of the shredder by the RDFF and its members may instil a sense of their own power as an organisation for change.

2. LIMITED USE: CAPITAL AND ENERGY

From the outset, the South African National Research Foundation has funded the project. The funding has been modest, and mostly covered student bursaries that enabled the initiation of the project. Funding options will be explored for prototyping, but thereafter the project aims to run as a self-sufficient enterprise.

Sowetan farmers' lack access to electricity and the rising cost of fossil fuels have led to the choice of energy source for the shredder to be human-power, it therefore only requires limited non-renewable energy to manufacture. Its manufacture aims to be designed for ease of disassembly and maintenance. Bicycle use is common in Soweto and by incorporating standard bicycle components into the shredder it is intended for servicing to be undertaken by local bicycle mechanics.

FIGURE 3 - Appropriate Technology: Boston checking bicycle components & ergonomics, 2014. (Courtesy of Peter H Harrison)

3. PROVISION: LOCAL EMPLOYMENT, GOODS AND COMMUNITY SERVICES

The FAO reports that, "the introduction of mechanical power into agriculture has normally brought about increases in both labour and land productivity" (Houmy

et al., 2013. p. 5). Unemployment is currently at 25% in South Africa (Oxfam, 2014. p. 2), the shredder aims to enhance farmers' activities to make them more productive and more profitable. Their produce is sold locally and the income generated is a large portion of their livelihood. It is intended that the shredder, as a product, will be retailed locally, possibly through the RDFF. Capacity building may be facilitated by drawing local communities into the urban agricultural process through interest garnered in the collaborative design process or the improved accessibility of farming. Blade sharpening of the shredder and the upkeep of bicycle mechanisms could become spinoff enterprises for local semi-skilled workers. Many urban youth have a negative attitude towards agriculture (Campbell, 2013a, p. 10). It is hoped that by introducing technology into the process inventive youth might gradually be prompted into urban farming.

4. USE: LOCAL RESOURCES

At all stages of manufacture an important balance between cost and quality will be maintained for the long-term sustainability of the product. Where possible, the manufacture of the shredder aims to be kept within Soweto's local infrastructure. The shredder will be designed for hand-assembly and this aims to be undertaken locally, Jabulani Technical College's automotive workshop may be suitable for this (Skhosana, 2014).

Soweto has very limited vegetation and without organic materials the shredder is only worth its weight in scrap; therefore organic materials aim to be sourced from local waste streams as per the government's National Organic Waste & Composting Strategy (Department of Environment Affairs, 2013, p. 15).

5. NURTURING: THE ENVIRONMENT, OTHER SPECIES, BODILY HEALTH & INTEGRITY AND LIFE

The shredder forms part of a food system intervention aimed at indirectly improving food security and local food production, which in the long term both directly impact on life expectancy (Department of Social Development, 2014). The product itself is designed to improve Sowetan soil health, which indirectly increases the nutritional quality of food. Healthy food increases bodily health.

Most farmers already have a respect and love for the plants they grow and work with. This extends to the care and effort that they take in farming to realise the potential that the plants offer them. Many farmers gain great satisfaction in the visible results of their physical efforts, the operation of the human-powered shredder may activate similar emotions. This may be the most optimistic of our assumptions, since the farmers may feel that the human-powered element of the technology is too physically taxing and not aspirational enough to warrant purchase. Knowing this necessitates significant input from the farmers during the shredder's development to ensure that it will be accepted.

FIGURE 4 - Capabilities: The same Sowetan urban farm in April and September 2014. (Courtesy of Peter H Harrison)

Considering the diversity of possible operators, in terms of language, age and educational levels, the design of the shredder must mitigate the risk that it may pose for them.

6. ACTIVATE: SENSES, IMAGINATION, THOUGHT, REASON & PLAY

Active involvement in the design process aims to empower the farmers by engaging their senses, imagination, thinking and reasoning. A sense of achievement may be attained through their involvement in the realisation of an idea and seeing it take physical form. The final design aims to intentionally be left incomplete, allowing for a level of customization for ergonomic and anthropometric considerations, and to encourage creativity and a sense of ownership. The human-power of the shredder also offers an initial fun aspect to its use, although this may wear off rather quickly!

7. JUSTICE: TECHNOLOGICAL

Practical Action define technology justice as a state "where people have the right to decide, choose and use technologies that assist them in leading the kind of life they value, without compromising the ability of others and future generations to do the same" (n.d.). The goal of technology justice is to encourage the developers of technology to be more considerate of its longterm impact on people and planet. It is through all the points above that the shredder is intended to be a technologically just intervention.

NEXT STEPS

The first physical prototype is now underway after the above criteria were validated at a third focus group on 11 September 2014 (Thabethe, Thabethe, & Malinga, 2014).The prototypes will be demonstrated and left with key informant farmers for evaluative testing.The design researchers will utilise widely available 'free' mobile phone applications to track the prototype testing amongst farmers. Once initial testing is completed local artisans will be approached to manufacture more refined iterations of the prototype based on continued user feedback. As the design process continues the criteria listed above will be used as a rudder to ensure an impactful outcome.The final prototype will be evaluated for impact against the same criteria.

FIGURE 5 - Human-powered shredder prototype 1 rendering, 2015. (Courtesy of Peter H Harrison)

CONCLUSION

This paper has defined and practically explored a framework for socio-technical innovation. We explain how, through the addition of collaborative framing and infrastructuring, appropriate technology and capabilities, the participatory design method of HCD can be both expanded and measured in terms of impact. In order to validate the framework this project needs to be completed. However, all the above criteria are approached as socio-technical innovation with the aim of enhancing the farmers' current capabilities and this is a positive pursuit (Hussain, Sanders & Steinert, 2012).Although the Sowetan farmers are marginalised, they have demonstrated an impressive resilience and determination to farm.The design research process has also made them acutely aware of their needs and the attention that these deserve. The knock-on effect of this is a personal and collective realisation that individuals can become self-determined rather than mere consumers (Meroni, 2007, p. 10). Socio-technical innovation is therefore,

even in its initial stages, a worthwhile undertaking of envisioning a more equitable future for all.

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THE VIRTUOUS CIRCLE

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DESIGN CULTURE AND EXPERIMENTATION

Design comes out of the interaction between a practice, which seeks to change the state of things, and a culture, which makes sense of this change. The way this happens evolves with time: practices and cultures evolve and so do the ways they interact; and the attention that is paid at different moments to one or other of these interacting polarities also evolves. In the current period of turbulent transformation of society and the economy, it is important to go back and reflect on the cultural dimension of design, its capacity to produce not only solutions but also meanings, and its relations with pragmatic aspects. Good design does not limit itself to tackling functional and technological questions, but it also always adopts a specific cultural approach that emerges, takes shape and changes direction through a continuous circle of experimenting and reflecting. Because the dimension and complexity of the problems is growing, it is becoming evident that to overcome them it is, above all, necessary to bring new sense systems into play. This is ground on which design, by its very nature, can do much. Indeed, the ability to create a virtuous circle between culture and practical experimentation is, or should be, its main and distinctive characteristic. However, for this really to happen it is necessary to trigger new discussion and reflection about the nature and purpose of design practice and culture.