An Improved Beehive Design
To Support Local Urban Agriculture

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IZINDABA ZOKUDLA

ABSTRACT

Honeybees provide the irreplaceable service of pollination for many of our food-crops and as such their survival is directly linked to food security. In South Africa there has been a recent movement towards localised food production through urban agriculture for socioeconomic development and access to healthy food in marginalised communities. Due to modern agricultural practices the annual survival rate of honeybees globally is in a severe decline, whilst the success of urban agriculture initiatives has been limited by low income generation. This Design Research study aimed to find solutions that would help urban farmers adopt beekeeping to increase their economic capabilities and protect their pollinators. The study borrows from Appropriate Technology Development whilst adopting Human-Centered Design methods to developing accessible beekeeping technology for local urban agriculture. Through participatory research with expert beekeepers and urban farmers the design approach to beekeeping was improved through the creation of a beehive design toolkit. The product outcomes were: an entry-level cardboard beehive, a permanent cement beehive and moulds to produce multiples of the cement beehive. All of these catered to an intervention framework intended to facilitate the development of sustainable beekeeping businesses through community driven manufacture and staggered implementation. The revised approach to beehive production resulted in reduced costs and presented further opportunities for sustainable beekeeping and social development. Initial testing confirmed the products technical performance, however testing through implementation would need to be undertaken to determine the further success of the intervention.

KEYWORDS

Urban agriculture, beekeeping, appropriate technology, accessible technology, socioeconomic development, design for development, human-centred design, beehive design, industrial design, South Africa, Izindaba Zokudla.

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CHAPTER 1: INTRODUCTION

1.1 Background & Contextualisation

According to the Food and Agricultural Organisation (FAO 2015:8) of the United Nations in 2015 about 780 million people living in low-income communities do not have access to adequate nutritional sustenance. Although food security has improved in recent years, issues surrounding the sustainability of modern agriculture are threatening food supplies worldwide (FAO 2015:8; Allen 2010:295). Commercial agriculture is widely criticised for the detrimental effects that it has had on biodiversity, ecological systems and natural resources (Thrupp 2000:295). In their 2010 Emerging Issues publication the United Nations Environmental Programme (UNEP) (2010:1) state that “The Earth is losing between one and ten percent of biodiversity per decade, mostly due to habitat loss, pest invasion, pollution, over-harvesting and disease”.

Chief among the concerns this raises is the ‘pollinator crisis’ referring to a global decline in insect pollinator species, namely the honeybee (UNEP 2010:1). A recent Harvard University study (see Fig. 1) has shown that up to 56% of the population in developing nations are at risk of becoming ‘food insecure’ as a result of the ‘pollinator crisis’ (Ellis, Myers & Ricketts 2015:1). According to the UNEP (2010:1) the honeybee accounts for about 70% of food-crop pollination globally and animal pollinated crops can yield up to five times higher quantities than those pollinated by wind or rain. Modern apiculture (agricultural beekeeping) has had the adverse effect of spreading diseases, pathogens, bacteria and parasites that affect bees (ibid.). With pesticides, herbicides and monocultures contributing to the ailments, annual colony survival rates have declined consistently in the past few decades (UNEP 2010:3). The movement to rethink the future of agriculture in order to provide sustainable food access must therefore include a new holistic approach (see Fig. 2) to apiculture as a supporting component (Ellis et al. 2015:14).

In their publication titled The State of Food Insecurity in the World 2015 the FAO indicates that: “Economic growth is a key success factor for reducing undernourishment, but it has to be inclusive and provide opportunities for improving the livelihoods of the poor. Enhancing the productivity and incomes of smallholder family farmers is key to progress (FAO 2015:ii).”

In South Africa where over 60% of the population is urbanised and unemployment is prevalent small-scale farming is being advocated as a means of poverty-alleviation and food-security (Crush, Frayne & Pendleton 2012:273). However the success of Urban Agriculture (UA) has been called into question, with concerns surrounding income generation, food-production and social interest (Frayne, McCordie & Shlomboleni 2014:10; Crush et al. 2012:273; Stewart, Korth, Langer, Rafferty, Da Silva & van Rooyen. 2013:1). In the report titled Situation Analysis of Beekeeping Industry the Total Transformation Agribusiness (TTA) state that in 2008 beehives produced an average of 14kg of honey, earning beekeepers upwards of R3000 (TTA 2008:74). However the TTA also points out a 1000 ton insufficiency in honey production based on import quantities (TTA 2008:74). Further stating that that:
Although interest in beekeeping in the second economy is huge and increasing, the return in terms of income to beekeepers is still very low and unattractive. Methods which enhance honey production and other services such as pollination and bee removal must be developed. The individual profit motive should be recognized and encouraged. With some hives recorded to produce over 380kg of honey per year leading bee expert Martin Johannsmeier (2001:5) believes that “with available natural resources, the industry could expand twice or three times its present size” this is a matter that can be addressed through design research and problem solving.

1.2 Rationale
The implementation of apiculture projects in rural Ethiopian (see Fig. 3), South African, Tanzanian, Nigeria and Kenyan communities has proven successful in terms of socioeconomic development by increasing crop yields and providing an additional source of income (UNEP 2010:4; Illgner, Nel & Robertson 1998:360; Shima, Ballo, Alemayehu & Belayhun 2008:2). This demonstrates the potential for apiculture to supplement small-scale farming (see Fig. 4), although as of yet local UA initiatives have not taken to keeping apiaries. Therefore there exists an opportunity to develop a beekeeping solution to assist local urban farmers, promote apiculture and indirectly help ensure the ongoing survival of the honey bee. Hence the main aim of this study was to make beekeeping more accessible to urban-farmers in Johannesburg.

1.3 Significance & Motivation
This study falls within the domain of Agricultural Research for Development (ARC 2015) and was funded by the National Research Foundation of Southern Africa (NRF) and the University of Johannesburg (UJ) as a component of the UA initiative ‘Izindaba Zokudla’ (Conversations about Food). Izindaba Zokudla (IZ) focuses on the creation of a farmers’ market, participatory technology development, school gardens and security of tenure and the creation of a farmer’s school in Johannesburg’s South Western Township (Soweto) (Malan & Campbell 2014). In addition IZ develops research opportunities and interdisciplinary projects that emanate from the University of Johannesburg and intends to form sustainable food systems for the community stakeholders (farmers, retailers and customers/recipients) (Malan & Campbell 2014). The design and development of a more accessible beehive falls within the participatory technology development focus of IZ.

1.4 Challenge & Inquiry
Central Problem Statement: There is a lack of apiculture as a component of local urban agricultural projects, this limits the economic opportunities for farmers in such initiatives.

Central Research Question: How can a beehive be designed to assist urban farmers, promote apiculture and help ensure the ongoing survival of the honey bee?

Auxiliary Question: Why has apiculture not been adopted in local urban agricultural projects?
CHAPTER 2: LITERATURE REVIEW

As part of the exploratory research this literature review is intended to examine research areas relevant to the project: synthesising critical theories and contemporary knowledge that is valuable to the objectives of the inquiry. Initially the literature focuses on the broad context of urban agriculture, which leads into the field of beekeeping, the science of bees, the industry and beehive design.

2.1 Urban Agriculture

In Africa rapid population growth and urban migration, coupled with slow economic development, have resulted in widespread urban poverty (Crush, Hovorka & Tevera 2011:285). The growing demand for food in cities has put strain on agricultural production (Allen 2010:295). The food imported into the cities comes at high costs financially and environmentally. In reaction cities have begun to contribute to food production with a global movement towards localised food production through small-scale urban farming (Carpenter & Rosenthal 2011:xiii).

As part of the City of Johannesburg's Integrated Development Plan (IDP) (2013:1) and the Social Development Department’s Food Resilience Policy (2013:1) Urban Agriculture (UA)\(^1\) has been implemented as a local food security strategy. Projects such as IZ aim to promote UA in low-income communities by facilitating skills and technology development that can increase access to food and income generation (Malan & Campbell 2014). This has garnered government investment of both funding and resources such as land and water (IDP 2013:2). In Johannesburg UA is conducted in backyards, privately owned plots and public/municipal allotments of land (see Fig. 5 & 6). Although the vast majority of Johannesburg households do not grow food, in 2009 UA accounted for 19% of the overall income in the participating households, generating an extra R14 per day (CDS 2009:23).

Some of the biggest problems facing UA locally, as stated by Angus Campbell in his paper entitled *Urban Agriculture: A Growing Field Of Research* (2013:10), are the compensation and level of ownership received by the participants who farm for organisations or on municipal land; the social aversion towards farming or lack of skills therein; the theft of electricity infrastructure or fencing, leaving farms unprotected and non-operational. The size of the land available, the short four month rainy season and the cold temperate winters are also inhibiting factors for UA in Johannesburg (CDS 2009:4). Farmers struggle to produce large quantities of food regularly enough to sell and support themselves (AFSUN 2012:20). In their study on local UA Bruce Frayne, Cameron McCordie and Helena Shimboletni (2014:10) found that constant investment of time and finance from participants is needed. Similarly the study of UA in South Africa by the Centre for Development Support (CDS 2009:38) found that UA participants received the bulk of their finances from other jobs and social grants.

\(^1\) UA refers to food production from within peri-urban or intra-urban areas (Stewart, Korth, Lager, Rafferty, Da Silva & Rooyen 2013:2).
2.2 Product Specific Research

Apiculture has been practiced for thousands of years and as such there is a great deal of knowledge within the field. In order to develop an understanding for beekeeping in the context specific to this project this section serves to summarize the key issues regarding the practice.

2.2.1 Melitology

‘Melitology’ refers to the scientific study of the honeybee (Apis mellifera). Honeybees are social insects and live in colonies that typically consist of between 20,000 to 80,000 bees (Johansmeier 2001:17). Colonies typically nest in hollow structures in which they build vertical wax comb structures. The comb consists of back-to-back hexagonal cells that are joined in the centre by a flat dividing wall, with the cells tilted upwards slightly to be used for storage. Honeybees produce honey and wax by ingesting pollen, nectar and water, using the wax to build hexagonal (comb) structures (Warre 1942:8). There are three castes of honeybee (see Fig. 7): workers, drones and queens. A colony typically consists of one fertile queen, 70% workers and 30% drones (Warre 1942:7). The queen has a life span of up to 6 years, her primary role is egg-laying, although she is also known to excrete pheromones that control the colony. The workers are the smallest and their activities include construction, storage, foraging, feeding, guarding, caretaking, cleaning and scouting. Drones are slightly larger than worker bees and serve only to mate with new queens. ‘Brood-comb’ houses the eggs, larva and pupa of developing bees (see Fig. 8).

Specific to this study is the African honeybee (A. m. scutellata) which is the most common of its species in Southern Africa and South America (see Fig. 10) (Ellis & Ellis 2012:1). The practice of ‘honey hunting’ in African countries has resulted in a defensive bee species (Ellis & Ellis 2012:1). The African bee readily protects the area around its hive with force and has been nicknamed the ‘killer bee’ — not more poisonous but more easily provoked to sting (Ellis & Ellis 2012:3). African honeybees are also less selective of nesting locations and more prone to evacuating hives during swarming season. Although smaller than European bees, African honeybees are more resistant to pests and pathogens as they spend a shorter time confined to their cells during growth (see Fig. 9) (Ellis & Ellis 2012:5).

There are 29 recorded microbial diseases and a variety of parasites that negatively affect honeybees (see Appx. A) (UNEP 2010:7). According to Honey bee diseases and pests: a practical guide published by the FAO (1987:1) diseases and parasites are “spread by migration and sale of colonies, equipment and/or bees”; the most destructive of which, the Varroa mite and American foulbrood disease (AFD), have been distributed worldwide (UNEP 2010:7). Over the past decade Colony-Collapse Disorder (C-CD) has also become a global bee-epidemic (Lowore & Bradbear 2013:1). While the causes remain unknown experts attribute C-CD to the use of pesticides and malnutrition of the bee due to monocultures (UNEP 2010:7; Walsh 2013:32; Stokstad 2007:972).
Until recently South Africa had been unaffected by AFD, however in 2015 an outbreak is reported to have killed 40% of the bee population in the Western Cape (Kings 2015:sp). The bacteria that is transmitted through spores and ingested by larvae is notoriously difficult to diagnose and even harder to eradicate. Stored in honey from infected hives commercial honey products help spread AFD, the spores of which can survive dormant for up to 50 years (UNEP 2010:7). Further, the use of antibiotic remedies is criticised for masking the symptoms and producing drug-resistant strains of the disease (Kings 2015:sp). As a result professional inspection bodies in Europe are tasked with a ‘search and destroy’ approach to AFD. The treatment utilises the most effective method of containing breakouts which involves identifying infected colonies, burning entire hives and burying the remains, shown in Figure 11 (UNEP 2010:7; CNG 2012:21).

In their guide the FAO (1987:31) make the following recommendations for minimising the risk of colony losses: the hive must be adapted to suit the strength of the colony; the site must not be subject to strong winds and damp, unhygienic surroundings; exposure to poisonous pesticides must be avoided; hives must be clean and functioning, and positioned on stands when necessary; harvesting and inspecting hives should be done with great care to avoid disturbing the bees; antibiotics and disease-preventing-chemicals should be administered only as a last resort. The above are aided by ‘good beekeeping practice’; stipulating that by regularly inspecting hives and maintaining their health C-CD and other problems can be prevented (Johannsmeier 2001:69).

2.2.2 Local Apiculture

‘Apiculture’ refers to agricultural beekeeping, traditionally focused on the production of honey, bees-wax and propolis as saleable commodities (Lowore & Bradbear 2013:1). It is common practice for beekeepers, locally and in other countries, to transport their hives (see Fig. 12) to farms during flowering seasons to assist in pollination and take advantage of the abundance of nectar and pollen, referred to as “migratory beekeepers” (UNEP 2010:12). Due to the current scarcity of pollinators beekeepers have taken to renting their colonies to farmers, adding another source of income (Lowore & Bradbear 2013:1). The TTA says a focus on beekeeping for pollination has led to the low national average of 14kg honey produced per hive yearly (TTA 2008:82). Migratory beekeeping is also criticised for helping spread diseases and pests, a factor that underpins this study with the intention that farmers take pollination into their own hands (Stokstad 2007:972).
The industry is regulated by the South African Bee Industry Organisation (SABIO) and the Department of Agriculture, Forestry and Fisheries (DAFF) (SABIO 2013:sp). It is mandatory for all persons with beehives in SA to register them in accordance with the Government Notice R1674 of 1998 under the Agriculture Pest Act 36 of 1983 (SABIO 2013:sp). The registration is handled by the DAFF and is free of charge. The Agricultural Research Council (ARC) is committed to training and working with beekeepers to boost the industry in the second economy\(^2\). The ARC aims to establish 5000 smallholder beekeepers as part of the government’s Beekeeping for Poverty Relief™ Programme (ARC 2015:sp). The TTA found that amongst existing smallholder beekeepers the following factors limit increased production (see Fig. 13): absconding\(^3\), theft, finance, diseases, space and forage supply were most problematic; factors that directly affected the design direction of this project.

In terms of foraging and food supply for bees in SA, water availability has the biggest impact on colony productivity (Johannsmeier 2001:111). Nectar production from plants is heavily reliant on sufficient water availability. Plants have varying flowering periods and in Gauteng there are generally four ‘flows’\(^4\) per year; in early-spring, mid-spring, early-summer and mid-summer (Johannsmeier 2001:8). Colonies deteriorate during cold weather or when food sources are scarce, and if necessary beekeepers will feed the bees with nutritional supplements.

### 2.2.3 Urban Apiculture

Some city municipalities do not allow residents to keep bees, or have legislation regarding the implementation of apiaries (Carpenter & Rosenthal 2011:362). In Johannesburg it is permissible to keep a colony of bees in a hive that has access to its own water source and is located at least five meters from a boundary and twenty-five meters from a dwelling or public space (Gauteng Provincial Gazette 2004:sp; Joemat-Petterson 2013). Further legislation states that hives must be hidden from public view by a 2m barrier, with a 1.5m area between the barrier and hive (Johannsmeier 2001:256). Adding barriers around hives forces the bees to adopt a high flight path and reduces their contact with surrounding human populations (Carpenter & Rosenthal 2011:364). The beehive must also be inaccessible to children or animals (see Fig. 14) and kept in the shade (Gauteng Provincial Gazette 2004:sp).

### 2.3 Beehive Design

The beehive is the most important piece of equipment in apiculture, representing centuries of development. There are a variety of hive designs that cater to different methods and techniques of beekeeping, with the basic function of housing a colony of bees and allowing a beekeeper to harvest the honey. This study looks at contemporary hive designs as precedents; the Langstroth (see Fig. 16), Horizontal Top Bar (HTB) (see Fig. 17), Warre (see Fig. 19), Sun

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\(^2\) ‘Second economy’ is the term used to describe economic marginalization, poverty and social alienation in SA – the aim is to focus attention and structure strategies to address the socioeconomic challenges therein (ARC 2015).

\(^3\) ‘Absconding’ is the term used to describe a colony of bees that is leaving a hive and swarming.

\(^4\) Times when nectar and pollen is abundantly available and colonies of bees are highly productive are referred to as ‘flows’. 
Figure 15: Icons representing the key features of beehive design, 2015 (design by author).

Adjustability
Different space configurations for small, medium and large colonies. Colonies fluctuate in size throughout the year. During heavy nectar and pollen flows the population of a hive will increase and in colder months honey production stops the numbers dwindle. When the colony is growing there should be enough room in the hive for the bees to expand the brood area and honey stores. Colony splitting or ‘swarming’ describes a colony’s sudden evacuation of a hive; a common occurrence that is triggered by a hive becoming overcrowded (Johannsmeier 2001:88). In Europe large colonies require two brood chambers on Langstroth hives, whereas the smaller African bee never requires more than one chamber for the brood to be laid and hatched at a sustainable rate (Johannsmeier 2001:59). Expansion is also a good way to stagger the cost of a hive, starting small and buying more sections as the colony grows.

Biomimicry
‘Bee-space’ is the term used to describe a set of bee-based measurements that govern the layout of the hive, including the spacing of the frames and the openings. In the book Biomimicry: Innovation Inspired by Nature, Janine Benyus (1997:2) explains that by learning from natural systems designers can realise more effective and self-sufficient solutions to contemporary problems. In dealing with the delicate natural system of bees it is important to design in such a way that will promote their natural tendencies. It is a natural tendency for bees to build downwards, rearing brood at the base of comb structures and storing honey above (Warre 1942:147). For the "bee-space" the gaps inside the hive, where no comb will be built, must be larger than 6.35 mm to prevent the bees from sealing it with propolis and smaller than 9.5 mm to prevent them from building comb (Stubbs 2012:sp; Johannsmeier 2001:61). In HTB hives the bar width was been reduced to 32 mm to suit the smaller African bee (Johannsmeier 2001:68). This change has eliminated the problem of ‘burr-comb’ experienced with wider, European frames that would cause African bees to often build parallel combs incrementally closer and fuse a set of frames at one end of the row (Stubbs 2012:sp).
Figure 16: Analysis of the Langstroth beehive, 2015 (illustration by author).

Segregation
Forcing functions that separate brood from honey comb. Generally achieved by use of a ‘queen excluder’ in the form of a mesh screen that the queen bee is unable to pass through; thus confining the queen her egg laying activities to one compartment of the hive. Only the smaller worker bees are able to pass through 4.0 to 4.2 mm gaps in the screen and as a result the supers are only filled with honey stores (Johannsmeier 2001:61). It is characteristic of apicentric beehives to not use excluders.

Standardisation
The use of parts that can be replaced by generic versions or fitted on other hives. To make harvesting less obtrusive beekeepers often swap out frames (see Appx. B) or chambers on hives. Using frames makes harvesting easier, and comb can be kept intact during honey extraction. However reusing comb on frames typically leads to the spread of diseases and pests (Warre 1942:147).

Material
The impact of hive materials on the health of colonies as well as maintenance and cost. Modern hives are made from particle board, Styrofoam, wood and composite plastics (Johannsmeier 2001:62). Professional beekeepers argue that natural materials are preferred by bees. The use of plastic in hives causes problems with internal humidity, electrostatic discharge and the vibration used by bees to communicate inside the hive (Hauk 2002:25). The material and manufacturing will determine the cost of the hive (Johannsmeier 2001:62). In a study on the effects of beehives on honey production it was shown that new hives produce more honey when compared to traditional hives (Vural & Karaman 2009:226). However traditional hives are also described as being more appropriate in terms of cost, manufacture and availability of materials in developing countries (Vural & Karaman 2009:226). In Africa these hives are traditionally made from clay-pots, tree-bark, logs or wicker baskets coated in mud and dung (Johannsmeier 2001:69).

Thermoregulation
The ability for the hive to be ventilated efficiently by a colony of bees in order to regulate the temperature in cold and hot weather. The ideal temperature inside the hive ranges from 33-36 °C (Johannsmeier 2001:28). Bees moderate the internal temperature and humidity of hives by fanning their wings to control the air-flow. This can be aided by the use of alternating entrances for cold and warm seasons (Warre 1942:88). Insulation also prevents the transmission of vibrations that disturb the colony, usually produced by machinery (Johannsmeier 2001:28).
In a study on the effects of hive modifications that aid thermoregulation in harsh climates it was found that insulated hives outperformed those with electronic regulation devices or no modifications (Abou-Shaara, Al-Ghamdi & Mohamed 2013:45). Similarly in Ethiopia the International Livestock Research Institute (ILRI) and the Institute for Sustainable Development (ISD) conducted projects showing that insulated hives are favourable for small-scale farmers (Araya, GebreMichael, GebreAmlak & Waters-Beyer 2007:29; Girma, Ballo, Tegegne, Alemayehu & Belayhun 2008:2). The farmers were able to increase the productivity of hives by applying traditional methods of insulation (mud and dung coating) to modern hives, implications that have influenced the design direction of this study (Araya et al. 2007:31).

Harvesting/Inspection

The difficulty and disturbance levels of extracting honey from the hive. Opening a hive and removing components is a traumatic event for a colony and it is vital that the procedure can be done as quickly and gently as possible (Johannsmeier 2001:52). The colony will take longer to recover from a rough inspection or a harvest, however it is vital that beekeepers are able to inspect the hive and combs thoroughly. Beekeepers distinguish between two types of beekeeping; commercial beekeeping and apicentric beekeeping (Bradley 2013:sp). Apicentric beekeeping focuses first on the bee’s role as a pollinator and second on low-impact methods of honey harvesting (Vural & Karaman 2009:363).

Protection

Methods to limit damage from diseases and pests. Although it is understood that a strong colony will be able to control diseases and pests through their natural protective and hygienic tendencies, beekeepers use methods to assist the bees. These methods are indicated in Appendix A ‘Diseases and Pests Affecting Honeybees’, along with the causes and symptoms and control methods. Theft and vandalism is also a serious problem for beekeepers in SA (Johannsmeier 2001:57). Beekeepers often chain hives together or manufacture housing structures to protect their hives.

Durability

How the hive withstands exposure to the elements and use over a reasonable product life period, including maintenance procedures. Largely determined by the material and manufacturing technique. Hives must be maintained regularly to protect them from the elements (Johannsmeier 2001:62). Wooden hives are often damaged by fire or destroyed by honey badgers, with beekeepers adding steel covers for reinforcement.
2.4 Summary

The information gathered on UA and Apiculture helped to determine the initial design requirements of a beehive. The analysis of beehives and beekeeping approaches demonstrated the methods and techniques that could be used to produce an improved beehive design. However, a theoretical understanding of the situation and technology was not enough to ensure a successful concept direction. The reliability of the data had to be reinforced with hands-on, field-research. Understanding the realities of beekeeping in SA would require the views of local beekeepers to verifying or dismiss the theoretical deductions made here.

Portability

_Safety and ease of transportation, along with installation time and method._ Wax-comb and honey stores add a great deal of weight to hives, and the entire unit can weigh up to 25kg. Migratory beekeepers often place hives on pallets that can be lifted by fork-trucks (Johannsmeier 2001:69). Relocation of hives has been shown to have no adverse effects on the colony health although the practice directly results in the spread of diseases and pests (Riddell, Pearce, Couvillon & Ratnieks 2013:7). This is due to colonies that are packed close together during transportation and placed at feeding sites with foreign hives.
CHAPTER 3: RESEARCH METHODOLOGY

This section defines the structure and theoretical approach to this design research project through formative design research. The methodological approach, research paradigm and knowledge generation processes are identified and elaborated upon.

3.1 Methodology

In developing countries, such as SA, which are faced with socioeconomic problems an emphasis should be placed on designing for the needs of the many (Papanek 1985:5), shifting the design conversation from consumerism to humanitarianism (Pilloton 2009:8). This is clearly evident in the statement by Richard Buchanan (2001:37) in his paper entitled Human Dignity and Human Rights: Thoughts on the Principles of Human-Centered Design:

> It is true that usability plays an important role in human-centered design, but the principles that guide our work are not exhausted when we have finished our ergonomic, psychological, sociological and anthropological studies of what fits the human body and mind. Human-centered design is fundamentally an affirmation of human dignity. It is an ongoing search for what can be done to support and strengthen the dignity of human beings as they act out their lives in varied social, economic, political and cultural circumstances.

Buchanan suggests that designers should be responsible and socially productive enough to provide people with the means to support themselves. Designers can do this by adopting a ‘human-centered’ approach and applying their problem solving skills to the creation of sustainable solutions that are based on the requirements of marginalised communities, some examples of these are demonstrated in Figure 22 (Pilloton 2009:16).

Addressing the central problem of the study required that existing technology be adapted or modified to become more accessible to the end-users. As such the study falls under Appropriate Technology Development (ATD), based on Dr Ernst Schumacher’s (1975) theory of appropriate technology from his book Small is Beautiful: Economics as if People Mattered. Schumacher (1975:3) believed that products should provide a medium for social entrepreneurship. The theory offers an indirect method for easing poverty by providing marginalised communities with low tech products that support skills development and economic growth (Schumacher 1975:172). In the paper Appropriate Technology for Socioeconomic Development in Third World Countries Anthony Akubue (2000:sp) states that now:

> The appropriateness of technology is not limited only to job creation, using local resources, and utilizing renewable energy resources but it is also about being affordable, easy to maintain, compatible with existing infrastructure, efficient in the use of scarce natural resources, environmentally benign, and partial to small-scale.

5 ‘Formative design research’ where the designer determines what research techniques and methods will be implemented throughout the study (Faste & Faste 2012:7).

6 ‘Low tech’, short for ‘low technology’, is a term used to describe technologies that can be produced and implemented with minimal capital investment, specialization or compartmentalisation (Encyclopaedia Britannica 2015:sp).
Akubue (2000:sp) demonstrates that ATD has developed into a holistic approach, aimed at finding the most suitable tools to provide opportunities for development and although the technology is often simplified it must be progressive, allow for future advancement, or create progress through innovation. In the paper titled *A Framework for Sociotechnical Innovation: The Case of a Human Powered Shredder* Angus Campbell (2015:8) refers to opportunities created through ATD as ‘Capabilities’, using the enhancement of capabilities as a means to measure a technologies appropriateness. The principles of ATD were well suited to this study as the aim was to provide urban farmers with beekeeping ‘Capabilities’.

### 3.2 Research Paradigm

The core principles of ATD are defined by the axioms ‘recognition, correspondence and operation’ (Sianipar et al. 2013:3385). This study adopts a Human Centred Design (HCD) approach to ATD, based on the process set out by IDEO with the axioms reclassified as ‘Hear, Create and Deliver’ (see Fig. 24) (IDEO 2011:8). HCD pertains to the development of solutions that cater for the needs and preferences of people in their social context (Steen 2014:2; ISO 2010:1). In this approach design practitioners recognise the knowledge that users have accumulated through their experience with a challenge, compiling this valuable information through empathic and participatory research to be utilised as a resource in the design process (Maguire 2001:588). The user is seen as an expert through experience with the challenge and context. Through their participation the user also becomes more invested in the intervention, developing the important aspect of ownership (Campbell & Harrison 2015:8).

The four principles of HCD as set out by the International Organisation for Standardisation (ISO) standard 9241-210 (ISO 2010:1) are: the active involvement of users, appropriate allocation of function to the system and the user, iteration of design solutions and multi-disciplinary design. The three most important reasons for using participatory design research are to: achieve better results; create cooperation and communication during the design process; and give people the ability to influence the products and systems or services they use (Steen 2014:49). The participatory technology development done by the ISD and ILRI with rural Ethiopian beekeepers demonstrated how innovation could occur from participants that had ‘endogenous knowledge’ and were stimulated by ‘exogenous knowledge’ (Araya et al. 2007:29). Through HCD methods beekeeping technology was adapted by farmers to “fit their own reality and often improve its effectiveness, efficiency, productivity, profitability, durability, marketability, palatability, sustainability etc.” (Araya et al. 2007:29) (see Fig. 23). IZ has also produced a variety of products that are more economically and technically accessible by adapting technology to fit the requirements of urban farmers through participatory design methods (Campbell 2013:12).

7 ‘Endogenous knowledge’ is existing wisdom that exists within group/area, whilst ‘exogenous knowledge’ is new wisdom that originates outside of a group/area (Araya et al. 2007:29).
3.3 Population Sampling

In ATD the views and experience of experts in the fields concerned, including the end-user, should be enlisted as part of the design research (Schumacher 1975:129). This is a comprehensive approach to design research that uses qualitative data, gathered from users and multidisciplinary professionals for the purpose of developing appropriate, acceptable, useable and successful solutions. The participants should therefore represent the extremes of the problem or offer inspirational knowledge (IDEO 2011:41). The two sample groups from which participants were selected for this study are expert beekeepers (see Fig. 26) and urban farmers (see Fig. 27). Within the group ‘expert beekeepers’ three sub-groups were identified; urban, cooperative and commercial beekeepers. Participants from each of these groups became key-informants in the research. The participants were valuable in assessing the desirability, feasibility and viability of concepts (see Fig. 25) (IDEO 2011:7).

3.4 Ethics

This study dealt with human participants and was therefore subject to ethical considerations. During research studies the safety, confidentiality and basic rights of participants was correctly observed and adhered to (Oliver 2010:80). In this study the participants were all consenting adults who understood the nature of the study and had signed informed consent forms (see Appx. C) that offered confidentiality, anonymity and indemnity. All of the participants were also provided with a project information form (see Appx. D) that served to inform them of the nature of the project, the implications of their involvement and their rights to refuse to take part or request that the information they divulge is not publically distributed (Oliver 2010:81).

Many of the urban-farmers constituted a ‘vulnerable-group’ due to their economic positioning (Oliver 2010:87). Therefore it is important that they are aware of the academic nature of this study and not led to believe they would benefit financially from their participation. For the beekeepers and other professionals who were asked to divulge ‘trade-secrets’ during the research it was stressed that they had the right to withhold their information, and that the information they did reveal would be securely stored (Oliver 2010:89). Most importantly for the testing that involved exposing the participants to dangerous insects (bees) the consent form included a disclaimer for possible injury or bodily harm, although their safety was at all times ensured by a facilitator who was qualified to handle bees (Oliver 2010:164).

3.5 Data Collection (HEAR)

The first phase of the HCD process involves data collection and analysis through traditional research techniques (Faste & Faste 2012:7). In HCD designers collect reliable data through exploratory (observations), participatory (stories) and immersive research, using the data to understand or empathise with the situation. The data is triangulated between information from experts, on-the-ground informants and contemporary literature.
3.5.1 Exploratory Research (Observations)

At the start of a design research project it is imperative for the designer to clearly identify the problem and then become fully versed in the subject matter surrounding the problem (IDEO 2011:39). This involves the collection and identification of ‘explicit knowledge’ that is readily available and can be made use of in research. The exploratory research done at this stage is intended to develop the designers’ ‘knowledge base’ (Martin & Hannington 2012:84). From the initial research in Chapter 1 a central problem statement and an actionable research question emerged, with objectives and goals (Patton & Cochran 2002:7). A series of informal pilot-study interviews were conducted at this stage to investigate the parameters of the challenge and the scope of stakeholders involved (IDEO 2011:38). The research areas pertaining to the challenge were disseminated in a literature review that synthesised the current knowledge from contemporary writings, with conclusions drawn based on ‘deductive reasoning’ (Martin & Hannington 2012:112).

3.5.2 Participatory Research (Stories)

Participatory research gathers ‘endogenous knowledge’ through communication, experience and observation (Martin & Hannington 2012:112). The data generated during this qualitative social research was captured through audio or video recordings. Where necessary the recordings were transcribed and are presented in Appendix E. In addition first-hand observations were recorded in a Field Diary (see Appx. G). Conclusions drawn from these activities were based on ‘inductive reasoning’.

Within the identified sample groups a ‘cooperative inquiry’ was conducted by way of semi-structured, in-depth interviews featuring planned questions that could be replicated in other interviews. Systematic questions based on the exploratory research were used to uncover aspirations, requirements and problems; following with broader discussions of the project details that included inductive coding questions leading to agreements (expectations) and disagreements (explanations) (Woods 2002:3).

An important way for designers to foster empathy with the participants is to ‘walk in their shoes’ and experience the problem first hand (IDEO 2011:46). As part of the in-context immersion it was beneficial to practice beekeeping to achieve a better understanding of the technology and to produce necessary resources for testing and implementation. This required the completion of a basic beekeeping course and keeping at least one hive for the duration of the project. The data generated through this experience was compiled by the designer through self-documentation and formed part of the field experimentation research (IDEO 2011:53).

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8 Deductive reasoning is based on existing knowledge that is substantiated and reliable (Faste & Faste 2012:2).
9 Inductive reasoning is based on empirical observation (Faste & Faste 2012:2).
10 Cooperative Inquiries are used in participatory research to address topics of behaviours, opinions/values, feelings, knowledge, sensory dissemination and background/demographics (Woods 2002:2).
3.5.3 Analysis (Themes)

By synthesising the data into a basic set of requirements and opportunities the designer had a basis to begin to identify opportunities and brainstorm new ideas, concepts and solutions (IDEO 2011:79). A ‘thematic analysis’ (see Appx. F) was used to synthesise important issues from the large bodies of qualitative research (Patton & Cochran 2002:23). The data captured from the exploratory and participatory research was systematically organised through the process known as ‘Cognitive Mapping’ (Martin & Hannington 2012:30). By this process texts are read through and annotated with ‘codes’ that point out separate notions and attributes; referred to as open coding (Creswell 2007:156). The codes initially pertained to individual points which were then rearranged using axial coding and affinity diagrams to create groups based on similarities (Woods 2002:7; Martin & Hannington 2012:12). The groups helped narrow down the issues and produce potential ‘themes’ that outline the design parameters (Patton & Cochran 2002:23). From these ‘themes’ an Intervention Framework consisting of an implementation strategy was generated to guide the discourse of the ideation phase to identify possible scenarios of successful uptake (Martin & Hannington 2012:30).

3.6 Design Process (CREATE)

The second phase of HCD research is an iterative process of developing concepts based on the theoretical framework and refining them through further research (see Fig. 29) (IDEO 2011:79). The ‘Hear’ research was synthesised into a ‘creative toolkit’ to assist the designer and the participants in identifying opportunities; stimulating innovative and valid brainstorming (IDEO 2011:102). This process is used by designers to assess the potential outcomes of their concepts (Faste & Faste 2012:7). HCD makes use of a variety of tools and methods to produce and test ‘real-world solutions’ that ultimately results in tried, tested and proven solutions (IDEO 2011:79). Conclusions drawn from these activities were based on ‘abductive reasoning’.

3.6.1 Development (Solutions)

The focus of brainstorming is to produce a wide and varying range of possibilities that attempt to present every possible solution; highlighting the best possibilities (IDEO 2011:104). The initial brainstorming used concept sketches and development models to illustrate a variety of solutions. To focus the inquiry three of the best concepts were selected and analysed through participatory research that involved two separate focus groups conducted within each of the two sample groups. Focus groups are used in HCD to incite interactions and responses between people that can be measured at a group level, while the views and beliefs of the participants can be validated through discussions (Patton & Cochran 2002:22; IDEO 2011:44). The three potential solutions were presented as

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11 Abductive reasoning uses themes to determine the value of conceptual solutions (Faste & Faste 2012:2).
‘Sacrificial Concepts’\textsuperscript{12} with the results used to select an appropriate concept direction. The methods used to capture data during these sessions included ‘desirability testing’, ‘context analysis’ and ‘participant observation’ as per \textit{Universal methods of Design}, using ‘generative models’\textsuperscript{13} to facilitate the participation of the users in evaluating the concepts (Martin & Hannington 2012). The intention for the beekeeper’s focus group was to assess the technical function of the technology in relation to the intentions set out by the project. The intention for the farmer’s focus groups was to assess the feasibility, viability and desirability of the intervention framework and concepts.

### 3.6.2 Refinement (Prototypes)

The chosen concept was further developed through detailed drawings and three-dimensional prototypes of design iterations and engineering considerations. The refined concept in the form of sketches, models and digital renders could then be used in a ‘key-informant interview’; conducted as unstructured interviews to evaluate the concept (IDEO 2011:55). The key-informant, an expert beekeeper (see Fig. 30) was selected to provide a final assessment of the design and point out any remaining issues prior to testing. A prototype was developed as a functional representation of the solution to test the concept in a real-world situation. The test involved furnishing the prototypes with live colonies and was conducted in an urban location. The insights from an ‘ergonomic analysis’ and ‘usability test’ conducted by the informant along with observations from testing influenced the final design iterations (Martin & Hannington 2012).

### 3.7 Final Design (DELIVER)

The final solution was the focus of this study, however the deliverables include supplementary components; a business proposal, engineering documents for patent applications and demonstration posters. The final prototype was an exact representation of the design and manufacturing intended for the components. The final concept was evaluated through a summary of the design research outcomes relating to the project requirements as set out by the themes as well as successful ATD criteria indicated in this chapter, upon which recommendations for further research were highlighted (IDEO 2011:148).

\textsuperscript{12} Sacrificial Concepts are ideas that are presented together for the participants to identify the best option, ‘sacrificing’ those that are less viable, feasible or desirable (IDEO 2011:60).

\textsuperscript{13} Generative Models are physical representations of concepts that can be manipulated by the participants; demonstrating their personal preferences or ideas.
CHAPTER 4: ANALYSIS & FINDINGS

4.1 Field Research

As per ethical requirements, all interviewees signed informed consent forms (see Appx. C) prior to their interview. The cooperative inquiry consisted of eight interviews within the sample population as follows:

<table>
<thead>
<tr>
<th>Reference</th>
<th>Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>UF01</td>
<td>Urban Farmer, Betrams Inner City Farm.</td>
</tr>
<tr>
<td>UF02</td>
<td>Urban Farmer, Izindaba Zokoudla Farm School, Soweto.</td>
</tr>
<tr>
<td>UF03</td>
<td>Urban Farmer, Izindaba Zokoudla Farm School, Soweto.</td>
</tr>
<tr>
<td>UF04</td>
<td>Urban Farmer, Izindaba Zokoudla Farm School, Soweto.</td>
</tr>
<tr>
<td>UF05</td>
<td>Urban Farmer, Izindaba Zokoudla Farm School, Soweto.</td>
</tr>
<tr>
<td>BK01</td>
<td>Urban Beekeepers, Cooperative Beekeeping, Melville.</td>
</tr>
<tr>
<td>BK02</td>
<td>Expert Beekeeper, Urban Beekeeper, Weltevreden Park.</td>
</tr>
<tr>
<td>BK03</td>
<td>Commercial Beekeeper, Carletonville.</td>
</tr>
</tbody>
</table>

4.2 Findings

Through a systematic analysis of the data, produced from the field research, codes were generated that highlighted important factors. The initial themes identified in Chapter 2’s precedent analysis were included as codes. The codes were then revised and grouped into eight main themes (see Appx. F & Fig 31 & 33). The themes are indicated in this section and elaborated on with reference to the data that informed them.

Protection

The theme ‘Protection’ incorporates critical aspects from the codes ‘Pests/Diseases’ and ‘Protection’. The value of honey and beekeeping equipment creates a serious problem for beekeepers, who stated that they experience up to 30% losses annually due to theft and vandalism (see Fig. 33) (BK03:488). Prevention methods such as cages, camouflage, chains, locks and strapping have proven ineffective in their experience. The beekeepers confirmed that AFD, ants, Wax Moth, Hive Beetles and Varroa-mites are the biggest natural problems, and that other pests and diseases are naturally manageable in strong colonies (BK01-BK03). According to the beekeepers AFD is spreading quickly in SA and beekeepers are burning infected hives (BK03:87). Wax-moth is prevented by storing the unused frames and supers in a sealed room (BK02:573). The beekeepers also indicated that Varroa-mites fall off bees inside the hives and are picked up when other bees walk across the floor at the hive entrance. Raised entrances can be used to force bees to enter the hive away from the floor (BK02:573). Ants are generally stopped by creating a moat of used engine oil around the legs of the stand supporting the hive (BK02:709; BK01:222).
Fig. 33: Vandalised hive components at commercial beekeepers farm in Carletonville, 2015, (photographed by author).

Fig. 34: Beekeepers demonstrating a hive inspection in Midrand, Johannesburg, 2015, (photographed by author).

2 Adjustability

The theme ‘Adjustability’ incorporates critical aspects from the codes ‘Standardisation’, ‘Adjustability’, ‘Cost’ and ‘Beginning’. According to beekeepers the standardisation of frame sizes is integral for the use of harvesting equipment and managing an efficient apiary (BK03:380). However the standard sizes were also noted as a standardisation and low cost (BK01-BK03). However due to declining production levels and colony mortality rates some beekeepers have begun experimenting with different hive designs and modifying features (BK03:351).

3 Inspection

The theme ‘Inspection’ incorporates critical aspects from the codes ‘Inspection’, ‘Skills’ and ‘Pests/Diseases’. By observing beekeepers (BK01) performing hive inspections (see Fig. 34 & Appendix G) the following insights were gained:

- The hive components are often sealed together with propolis and must be pried apart using a hive-tool14. This action leads to damage on the edges of the hive chambers that creates larger gaps that are then sealed with more propolis the following time (Field Diary: 30/5/2015).
- Beekeepers systematically inspect each frame, although the brood frames are seldom removed, instead the brood chamber is tilted away from the floor to inspect the bottom of the frames for swarm-cells (Field Diary: 30/5/2015).
- The removal and repositioning of Hoffman frames in hive chambers often results in bees being crushed where the parts meet, agitating the surrounding bees (Field Diary: 30/5/2015).
- Hives are often placed on stands to achieve an ideal working height (Field Diary: 30/5/2015).

Although they mentioned that the fragility of the comb makes inspection difficult in comparison to the well reinforced comb that is found on Hoffman frames (BK03:351). One beekeeper had chosen to use round entrances with rails mounted on either side to close the entrance with mesh for transport (see Fig. 35). The round entrance was observed to be easily controlled by the bees, and a 42mm diameter had been selected to deter honey badgers.

4 Sites

The theme ‘Sites’ incorporates critical aspects from the codes ‘Urban Beekeeping’, ‘Portability’ and ‘Beginning’. According to the beekeepers (P006; P007; P008) there is sufficient food in the city to make urban beekeeping successful, “there’s always food in the city… there’s not really an off season” (BK03:31). The beekeepers indicated that the space in cities limits the amount of beehives that people can keep without risking the safety of the surrounding population (BK02:188). Although having a hive will prevent wild swarms from nesting nearby, “the more hives there are then technically the less wild hives or wild swarms there’ll be” (BK01:408). Agricultural chemicals have rendered some crops dangerous or inaccessible to foraging bees, and beekeepers find that colonies return from pollination migrations weaker and with new diseases or pests (BK03:104). As such it has become more sustainable to keep hives in a permanent location where they will only be moved around the site occasionally.

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14 A hive-tool is a flat metal hand tool used to separate/pry-apart hive components, lift frames and scrape away propolis.
Local urban farmers generally work on small-plots that are partially secured by fences and are surrounded by residential and public spaces (see Fig. 36) (UF01-UF05). The farmers indicated that there were wild swarms located near their farms that they had observed through the presence of bees foraging amongst their crops (UF02). Many of the farmers share land with schools. There were concerns raised about the safety of the children and issues of getting approval from the school bodies arose (UF02).

Harvesting

The theme ‘Harvesting’ incorporates critical aspects from the codes ‘Harvesting’, ‘Biomimicry’, ‘Beginning’, ‘Pests/Diseases’ and ‘Cost’. Although the beekeepers acknowledged that queen excluders are useful in small apiaries and for beginner beekeepers, their view is that the excluders: waste time, are too costly, not durable, and are difficult to reposition (BK03:448). According to the beekeepers the brood comb should be replaced every two years as the cells become too small from cocoon deposits (BK03:419). Some beekeepers preferred to conserve the comb during harvesting, although the financial benefit of harvesting wax was noted (R100/kg). The beekeepers indicated that forcing the bees to build new comb by harvesting the wax simultaneously did not affect production levels, however the process would “lose probably 10 or 15 percent” of the honey (BK03:49). The beekeepers stated that harvesting tools and facilities are very expensive; for people with only one or two hives an established beekeeper’s harvesting services can be hired for R350-R500, referred to as ‘cooperative beekeeping’, with the provision that the beehive uses standard frames (BK01:67). Alternatively the honey can be separated through ‘low-tech’ methods such as solar-heaters.

According to the beekeepers African bees do not move their brood independently, noting that the bees also prefer to use higher openings in the hive as entrances (BK03:397). The use of thinner frames was noted to help slightly with burr comb formation, and given a choice the beekeepers would rather use 32mm frames (BK03:377). Through observation it was visible that burr comb was a problem in hives using ten frames rather than eleven, although some beekeepers were successfully using nine frames to allow the bees to build wider comb structures.

Making

The theme ‘Making’ incorporates critical aspects from the codes ‘Manufacturing’, ‘Cost’ and ‘Beginning’. The farmers generally have very little money available for investment in equipment (UF01-UF05). However many were in application processes for government funding. The beekeepers agreed that the initial investment in hives is costly, although it was indicated that “it’s a useful income and you can quickly pay for the initial outlay of buying a beehive” (BK02:341).

15 ‘Low-tech’ refers to technical skills or technology that is easily accessible and widely available.
The urban farmers demonstrated a strong interest in beekeeping, although they had little to no experience in keeping bees. As high ranking members of the Southern Beekeeping Organisation, Tom Cain and Edward van Zyl expressed interest in growing the industry to create a wider pool of skills for commercial apiculture by working to provide training workshops for marginalised communities (BK01 & BK03). The beekeepers indicated that it is beneficial for beginners to make their own hives and learn through practice or by watching a skilled beekeeper (P008:l322). However the farmers only have access to low tech construction skills and equipment.

7 Thermoregulation

The theme ‘Thermoregulation’ incorporates critical aspects from the codes ‘Thermoregulation’ and ‘Sites’. It was observed that beekeepers use insulating materials such as Allu-bubble, shade-cloth and Polystyrene to cover their hives where shade was not available (Field Diary: 30/5/2015). The participants agreed that local weather is moderate enough for the bees to regulate the internal hive temperature in winter (BK01-BK03). BK03 mentioned that the HTB hive was less effective at regulating airflow and in hot weather ‘bearding’ would occur more regularly.

8 Material

The theme ‘Material’ incorporates critical aspects from the codes ‘Material’, ‘Cost’, ‘Manufacturing’ and ‘Beginning’. The beekeepers all agreed that in their experience bees “don’t like plastic hives” and that natural materials are generally preferred (BK02:441). Plastic was said to cause internal condensation and disturb the bees due to the electrostatic discharge. It was indicated that the durability and strength of materials is a key factor for beekeepers, who preferred to use cheap, low-quality wooden hives knowing that they would be destroyed within four years (BK03:494). As an alternative beekeepers have resorted to making low-cost cement hives for permanent apiaries and using disposable cardboard ‘catch-hives’ (see Fig. 39; BK03). Beeswax is used in the cement hives (see Fig. 38) to make the interior environment more hospitable.

16 ‘Bearding’ is term used to describe the bees collecting on the hive exterior around the entrance to help fan air into the hive when the internal temperature exceeds 36°C (Johannsmeier 2001:28).

17 A ‘catch-hive’ (nucleus-hive) is a 6-frame chamber used to lure swarming colonies and house them for up to four weeks before the bees run out of space. These hives are generally made from wood, although recently disposable cardboard catch-hives have become more popular.
4.3 Intervention Framework

The themes provide guidelines for the development of a solution, with the overall aim to make beekeeping accessible to urban farmers. The analysis was disseminated into a framework for the intervention process (see Fig. 40), that follows a staggered, three-stage process starting with an entry level hive and working towards a permanent and effective apiary. The income generated from the entry-level hive would enable the transition to a permanent hive, with two options for harvesting and hive maintenance: private or cooperative harvesting. The farmers could harvest the honey themselves using low-tech equipment and methods, or pay an established beekeeper to harvest the honey for them. For private harvesting the farmer would need basic training, a protective suit, a smoker and basic processing equipment. The cooperative method would allow the farmer to delay the purchase of equipment and learn valuable skills through assisting the experienced beekeeper, although the service would incur a cost. The choice would depend on the initial available capital and the approach the farmer wishes to adopt. The choice would also influence the use of frames or top-bars in the hive.

To achieve an accessible hive in terms of cost, functionality and productivity a number of potential manufacturing approaches could be explored. Mass-manufactured components such as die-cut cardboard or injection-moulded polystyrene could reduce the individual product cost, however the initial cost needs to be compatible with the demand. Batch manufactured parts could be produced rapidly with professional machinery, with a focus on wood and reclaimed materials however the labour and tools would add to the cost. Low-tech manufacturing systems such as hand-carpentry, basic construction and moulding could be explored as a community driven method.

The entry level hive would need to be affordable enough to encourage the initiation of beekeeping and limit the portion of the investment that comes from the existing farm income. This hive would also allow the farmers to assess their capacity to keep bees over a one to two year period. The entry level hive could act as a catch hive that may also house a colony of bees for a longer time by increasing in size as the colony grows. Cardboard suits the requirements of the entry-level hive as it is an inexpensive material with which to manufacture, however the durability and strength would need to be revised. The permanent hive would also need to be low-cost although it could incorporate additional and/or beneficial features. Concrete is durable, low-cost and low-tech in terms of manufacturing, lending itself as a suitable material for the permanent hive. Concrete hives were shown to be better protected, with the added benefit of fire resistance in the case of burn treatments for bacterial infestations. The manufacture of concrete hive components could easily be community driven with minimal training and setup costs. Although the weight of the concrete components poses a potential problem to usability and would need revision. Although reconstituted, concrete and cardboard consist mainly of natural materials and treating the materials it was believed that the materials would be suitable.
CHAPTER 5: PRODUCT DEVELOPMENT

The initial ideation phase was focused on revising modern approaches to beekeeping in line with the eight central themes and the intervention framework. The design intention was to create two beehives that would support the introduction and development of beekeeping at different stages, exploring different opportunities for local urban farmers to set-up sustainable apiaries. The findings chapter highlighted a number of functional issues, design requirements and potential solutions that could be used as design parameters. Using the HCD approach, outlined in Chapter 3, the conceptual development was largely informed by participation of users and experts, utilising their experience and expertise to refine and verify the development concepts.

5.1 Initial Ideation

Through brainstorming a variety of scenarios surrounding the intervention framework emerged. The scenarios reflected the varying options offered by different beekeeping systems that could benefit the intervention. The three strongest concepts that emerged from the initial ideation phase were each based on a different system of beekeeping; Langstroth, HTB and VTB (Warre). The concepts each included a cardboard (entry-level hive) and concrete (permanent hive) design in line with the intervention framework and through application of manufacturing and design considerations the concepts were refined to a point of theoretical feasibility.

The first concept (see Fig. 41), based on the Langstroth system, explored standardisation, where the entry-level and permanent hives would follow the same system, allowing the user to develop specific operational knowledge as their beekeeping enterprise grew. The hives would also be standardised to suit existing beekeeping technology (two chamber and frame sizes), catering to cooperative beekeeping. This approach would favour skills development through mentorship over the economic disadvantage of paying for the beekeepers services.

The second concept (see Fig. 41), based on the HTB system, was concerned with the user’s initial outlay when buying both hives and the future costs incurred thereafter. The simplest way to reduce cost would be to reduce the parts required to produce a functional hive. With adjustable hives the user would have to continually buy more parts to maintain the hive, whereas if the hive was made up of one complete unit the initial price may be higher, but the user would be saved from having to travel to the retailer to purchase more parts.

The third concept (see Fig. 41), based on the VTB (warre) system, was concerned with simplification, with one chamber size, top-bars and reduced costs. The honey-comb would have to be harvested through pressing and draining, however the cost of the hives would be significantly lower. In this case accessibility and self-reliance would be increased at the cost of inspection complexity and limited harvesting productivity. The entry-level hive was reduced to a catch-hive size chamber, although it was designed to be stackable as with a regular hive.
A common design attribute across all the concepts was to improve insulation in the entry-level hive by creating a cavity between two walls and an interchangeable lid and base for the concrete hive. Other details such as the adjustability, entrance location, ventilation, etc. were intentionally varied in order to explore new possibilities in hive design. These design variations and the different scenarios were used to facilitate user participation.

5.2 Participatory Development

Focus groups were conducted at this stage to determine which concept would be taken forward. To aid the discussions posters of each concept were produced (see Appx H), demonstrating and clearly labelling the approach to each theme. Full-scale cardboard demonstration models (see Fig. 42) were also made to assist in the presentation of the concepts. In both sessions first the intervention system was outlined and then the concepts were demonstrated individually with discussions in between. The focus groups consisted of:

<table>
<thead>
<tr>
<th>FG01: Professional Beekeepers (see Fig. 43 &amp; 44)</th>
<th>UF02: Urban Farmers (see Fig. 46 &amp; 47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randburg, Johannesburg - 9th September 2015</td>
<td>Soweto, Johannesburg - 11th September 2015</td>
</tr>
<tr>
<td>• P01: Tom Cain</td>
<td>• P01: Mpho Khoza</td>
</tr>
<tr>
<td>• P02: Manfred Leitner</td>
<td>• P02: Lucky Gare</td>
</tr>
<tr>
<td>• P03: Paul Edwards</td>
<td>• P03: Israel Rakoula</td>
</tr>
<tr>
<td>• P04: Themba Khoza</td>
<td>• P04: Themba Khoza</td>
</tr>
<tr>
<td>• P05: Sibongiseni Mnqomezulu</td>
<td>• P05: Sibongiseni Mnqomezulu</td>
</tr>
</tbody>
</table>

At this stage a brand (see Fig. 45) was also developed with the intention of promoting the intervention and linking the products as one cohesive system. The name ‘Beegin’ refers to beekeeping as well as the initiation of a new offering for UA. The logo forms an unfinished hexagon, intended to represent a honey-comb cell as well as an arrow indicative of starting and progress.

5.2.1 Focus Group 1

The first concept was received well. The participants were quick to point out that internal covers should be used to prevent the lid from being sealed to the chambers (23:14). Raised entrances appeared to be a controversial idea, with the benefit of keeping bees away from the floor argued against the ability for the bees to easily carry fallen debris out of a lower entrance. It was pointed out that top or alternating entrances are only used in colder climates, as P03 stated (35:26) in SA “the bottom entrance is better quite frankly, because they (bees) clear all their rubbish out there” (33:05). Alternatively it was argued that although Varroa mites are manageable, the pests transmit diseases that cause more serious damage to colonies and a raised entrance may help (P02 18:02).

The second concept delivered mixed responses. The participants (P02 & P03 1:02:40) stated that although in principle the bees would confine the brood to the mid-section, in reality the bees would arrange the brood at the bottom of the hive. However the participants pointed out that a central entrance would reduce the distance that
foraging bees have to travel inside the hive to reach edge comb. P03 suggested (1:07:14) that a feature that transformed the hive from frame to top-bar compatible would be more important than the extra row of small frames that had been included in the design. The participants agreed that viewing windows and Varroa screens were typically unpractical as they were damaged easily.

The third concept led to a number of discussions about the value of simplification to the proposed intervention. The use of medium sized frames was dismissed as they were no longer manufactured in SA (1:26:46). Instead it was highlighted that many beekeepers use only brood chambers to reduce wasted space in the hive (1:11:26). Another consideration was that in P03’s experience (1:27:30) multiple honey-supers force bees to adopt a stop-start comb building pattern: reducing productivity. The stackable cardboard catch-hive design was favoured by the participants, although they were adamant that it should also accommodate Hoffman frames (1:28:35). Commenting on the use of bars to support the frames the participants had found that in their experience bees were less prone to building burr-comb on the edges of frames where the bee-space had been substituted for a larger gap (P02 & P03 31:13). This was also stated by P03 (29:31) and P02 (30:30) to reduce the amount of damage to the thin chamber edges when loosening frames with a hive-tool. P03 pointed out that the top-bars would need to be designed with spacers for vertical passage of the bees (2:00:00). With regard to insulation and internal humidity the beekeepers agreed that having extra ventilation via the shuttering pin holes in the concrete hive would be a good idea, allowing the bees to seal and open them naturally (P03 51:35). According to P02 (22:45) “overheating is more of a problem” and the design should focus on cooling.

The participants unanimously agreed with the intervention system of a staggered introduction to beekeeping and the suitability of the materials (P01, P02 & P03 57:50). The participants indicated that private harvesting would be a more viable option than cooperative beekeeping as the farmers would not have enough hives to make the venture attractive for beekeepers (P02 & P03 1:07:35). The beekeepers noted that a separate floor was used for cleaning mostly, with swarm-cell inspections forming part of regular brood frame inspection (P02 2:00:30). In their experience natural hive splits would only occur in hives that were left in remote locations and not inspected regularly (P02 2:01:30). When presented with the chain protection method the general consensus was that the chambers could be forced apart horizontally unless an internal join was used (P02 2:05:30).

5.2.2 Focus Group 2

The participants unanimously agreed with the intervention system, indicating that they would prefer a self-reliant model, harvesting the entire comb and collecting both wax and honey through low-tech methods (2:34). The participants queried where to acquire a swarm of bees, where to buy equipment, how to harvest the honey, when
to harvest and how the hives functioned. They were also concerned with public safety, site location and municipal regulations, going on to suggest that a beginner’s manual should be included with the entry-level hive.

The Langstroth system demonstrated appeal to the participants as the concrete honey-supers would be lighter to move during inspections and buying additional supers would be slightly cheaper. The participants pointed out that chaining the hives closed would be more valuable for protecting people than the contents, as theft would be deterred by community vigilance (18:50). It was stated by P05 that vandalism may be a problem, however through education the public could be made aware of the value of bees (25:03). P05 stated that although he would like to choose the biggest hive the cost was too great (47:37). P04 agreed that in order to build their confidence they should start with a small, beginner hive that was better suited to their environment, demonstrating that they could easily make a stand with materials found on their farms (see Fig. 46; 48:00). The participants were interested in the possibility of manufacturing the cardboard hives themselves as a DIY option (59:46).

5.3 Findings: Using the Feedback to Select a Direction

From the feedback it was apparent that the third concept was the most suitable, shown largely by the ability for participants to easily relate the beekeeping system to the intervention framework. The impression was created that concept one and two had catered more to conventional practices with complications arising where they had been modified. Whereas the third concept was understood to embody the central themes, suit the materials and simplify the system appropriately.

5.4 Concept Refinement

The simplicity and low-cost that could be achieved by having one chamber size was a key attribute, with the provision that the chambers were brood-size. Although the third concept used the VTB system the feedback determined that the top-bars would only be necessary initially and that frames should be a key feature of the permanent hive. The frames would not require wire supports, bringing their cost down substantially and although still costing about R18 each (see Appx. L) they could be added once the apiary begins to generate a profit. The cardboard as a material would lend itself to post production alterations required to swap from top-bar to frame compatibility as well as the possibility of including printed illustrations and guidelines for beginners at little added cost. The feedback indicated that the locking system for the concrete hive would have to be refined, as well as the exposure of steel components. Where the floor of the hives was sealed to the brood chamber it was evident that the entrance should be at floor level, whereas a separate, cleanable floor would allow for a raised entrance. Through hand sketching (see Fig. 48) and prototyping the design was refined in line with the findings while referring to the central themes.

Figure 48: Refinement sketches of the cardboard (top) and concrete (bottom) hives, 2015 (illustrations by author).
5.4.1 Entry-level Hive

In order to simplify the cardboard hive further it was decided that the floor would be attached to the brood-chamber, with the entrance located at the floor (see Fig. 49). This required an opening to be made in the bottom edge of the chamber, cut out of chambers post-manufacture with the aid of perforations. Using internal support-bars with for top-bars was not possible as the bees would be able to build comb beneath the bars, therefore the cardboard hive was redesigned to produce with a lip on the inner walls to support the frames. The inner walls below the lip were designed with a top-bar and frame arrangement that would rely on the user to make changes to the angle of the wall for frames to fit into the chamber (see Fig. 50). Instructions for the adjustment were included in the infographics that were designed to be printed on the parts (see Appx. K). As the edges of the hive would be at risk of being damaged by the hive tool during frame removal, different methods for loosening the top-bars were explored. It was found that by drilling a hole into the top-bar a rod could be inserted from the top and used as a lever to loosen and lift the top-bar without using the chamber edge as a pivot (see Fig. 50). Small screws were added to the sides of the top-bars (see Fig. 48) as the simplest method for spacing the bars.

Although the cardboard chambers would be lightweight the risk of dropping them during handling remained because of the use of gloves during inspection. Handles could not be added to the outer surface without risking water penetration. Instead a method of creasing and folding the chambers (see Fig. 51) was used to create facets on the corners and provide added grip. The facets would also provide added diffusion from direct sunlight or sound. Adding an inner cover to the cardboard hive below the lid provided an opportunity to support airflow. The lid could be pitched to create an open space that the bees were restricted from by the inner cover, with air flowing through ventilation holes on the inner cover and out the edges of the lid. It was decided that the bulk of the graphics (see Appx. K) should be placed on the single parts to avoid repetition, with only public safety warnings and branding displayed on the chambers. The lid was furnished with site guidelines, the inner cover with inspection directions and the inner walls with directions for changing from top-bar to frame compatibility.

5.4.2 Permanent Hive

Moulding entrances into every chamber of the concrete hive remained the most efficient method of generating airflow as the upper chambers could be inverted to create top vents and control the entrance height. The upper entrances could then be closed with mesh to stop pests while allowing air-flow. The entrance was created from a section of steel tube with the intention that a cap could be used to create the mesh seal. It was found that the frame support-bars could be used to locate and secure the parts from the inside of the chambers. The chambers were designed with four slots in each edge to hold the ends of the two support-bars (see Fig. 53). The bars could be bent at each end to protrude upwards from the housing slot and into the vacant slots in the chambers above, with slots in the lid/base to secure the top and bottom pins.
The lid/base was designed to extend over the edges of the chambers for rain protection and thus became easy to grip and lift, although the chambers still required handles. To create handles a number of options were explored (see Fig. 48) and it was decided that ideally the handle should comprise of a bar that could be clasped in the hand rather than a thin lip gripped by the fingers. The handle could not be fastened perpendicularly to the side of the chambers as the bending force would damage the concrete. Instead the handles were designed to bend upwards along the side of the chambers, evenly distributing the force along the sections that pierced the wall of the chambers. The handles were designed to be removable for safe keeping, meaning users would only need one set for multiple hives. Chamfers were added to the outer edges of the chambers to reduce the risk of chipping and recessed facets were added to exterior surfaces of the chambers to reduce the overall weight and create an aesthetic link to the entry-level hive. Facets were also added to the lid/base to complete the visual aesthetic and locate the security chain securely at the centre of the hive.

Originally four thin legs were designed to be fastened to the base, ideal for users to implement simple oil wells made from tin-cans. The complexity and cost of manufacturing the legs resulted in the design being changed to use the same cheap steel rod (see Appx. L) used to make the handles and frame support-bars. The stand was designed to still have four main legs all connected as a single frame to ensure maximum strength. The stand would not be fastened to the base but locked to each end of the security chain. Four small feet were added to the moulding of the lid/base to prevent the stand from bending outwards along the pitched surface. The feet were also designed to support the hive if a stand was not used and the hive was placed on a level surface. The stand, support-bars and handles were bent by hand focusing on low-tech manufacturing options (see Fig. 52).

5.5 Technical Refinement
To design successful products from the chosen materials research and experimentation was conducted to understand the technical requirements for manufacturing with concrete and cardboard. Appendix L provides a detailed report of the manufacturing processes, testing and costing, with the findings summarised here.

The main concerns surrounding the cardboard hive were strength and durability. It was found that triple-wall cardboard provided the most strength and could be coated with the wax-based sealant ‘Waxsol’ (used on wooden hives) for cost effective waterproofing. The thick, treated cardboard created ridged prototypes that withstood durability and weathering tests, resulting in only two design alterations. It was found that creating a lip fold from the inner walls of the chambers produced assembly complications and reduced the overall strength of the chambers. Instead a lip was created by adding a cardboard insert to each side of the chamber. The insert was designed to initially create top-bar friendly chamber space, although perforations would allow the user to easily...
remove a strip from the insert to create space for Hoffman frames. The slanted roof of the cardboard hive proved to be ineffective in clearing water and was instead pitched to match the concrete hive (see Fig. 49).

The main concerns for the concrete hive were strength and weight. It was found that steel mesh reinforced concrete of 1 part cement, 3 parts perlite (lightweight aggregate), 1.5 parts water and 0.0025 parts reinforcement fibre would produce the desired strength-to-weight ratio. The resultant weight was 10.6kg (25kg with honey filled frames) for the chamber part and 9kg for the lid/base. The lightweight aggregate would provide increased thermal and audio insulation, with the additional benefit of increasing the temperature threshold of the concrete to well above that required for AFD burn treatments. Shuttering proved to be a suitable moulding method, however wood did not withstand repetitive demoulding and galvanised sheet metal was selected for the final mould (see Fig. 54).

The mould was designed as the third product outcome for the intervention, with community driven manufacture in mind, or to be sold to organisations or beekeepers for onsite hive production. Providing a balance of strength and simple manufacturing, 8mm steel rod was chosen for the handles, support-bars and stand. Together with the tube used to make the entrance the materials could all be sourced in Johannesburg.

5.6 Testing

5.6.1 Key Informant Feedback

After producing working prototypes Tom Cain (expert beekeeper) was consulted as a Key Informant (see Appx. M). Satisfied with the design changes and quality of the prototypes Cain verified that the hives were fit to house bees. Cain also tested the usability of the hives by performing mock inspections. The weight of the concrete parts did not create much difficulty and Cain was easily able to move the components. The lid was noted to be difficult to reposition onto the top support-bars and to resolve these issues in the final design the lid/base slots were widened.

5.6.2 Field Experimentation

A colony of bees was introduced into a prototype of each hive and monitored over a four week period. The colonies performed well exhibiting no signs of distress. Comb was built in the intended manner (see Fig. 55) and the hives did not deteriorate as a result of the bee’s activity or from regular inspection. Using a digital air-thermometer the internal temperature of each hive was measured at different times throughout the day. The temperature was moderated well inside the hives during cold and hot exterior climates. Rain was not observed to create internal condensation issues although drip marks were seen running inwards under the lid. It appeared that the drips would stop at the edge of the chamber, although if contact was not achieved by the two parts the water may have penetrated the hive. To prevent this at the lid/base join a small groove was cut into the flat surface to curb the inward flow of water droplets. The bees were observed to use the main entrances on the permanent hive, demonstrating signs of building propolis structures to reduce the size of the openings (see Fig. 56).
CHAPTER 6: CONCLUSION

6.1 Closing Statements

6.1.1 Summary of the Outcomes

The lack of appropriate and accessible technology has prevented beekeeping from being adopted by local urban farmers. The beekeeping industry also operates through exclusionary practices and technologies, limiting dissemination of skills and availability of technology within communities that stand to benefit greatly. In order to provide such an opportunity and answer the central research question, “how can a beehive be designed to assist urban farmers, promote apiculture and help ensure the ongoing survival of the honey bee?”, this study developed a holistic approach to the production of beekeeping equipment and an initiation process for novices in low income communities. Using the study’s central themes to assess the success of the outcome the following insights can be gleaned (see Fig. 57 & 58):

Protection: Compared with standard hives the permanent hive is designed to be better protected from vandalism and theft, however with the right tools the hive could potentially be broken or stolen. The entry-level hive instead protects the owner from substantial property loss through its low cost. The performance against diseases and pests could not be determined from the initial testing, although the materials used as well as the design of the components should make these problems easier to manage. The solution proposes an amendment to current beekeeping practices that causes the spread of pests and diseases: offering farmers an alternative to migratory pollination.

Adjustability: The size of both hives can be manipulated in differing increments that suit their stage of use. The transition from top-bars to Hoffman frames with the entry-level hive provides opportunities for low-income beginners not otherwise available. The use of only brood-size chambers and standardised components reduces manufacturing requirements substantially, although the effect this has on productivity could not be measured conclusively.

Inspection: The difficulties associated with handling top-bar comb were minimised where possible, although a certain degree of skill is still required from the beekeeper. The access to beekeeping skills presents a potential problem, although once a network of beekeepers has been established within the local UA community the skills should become transferable. The designs minimise areas where bees typically seal components together with propolis and offer easier comb removal.

Sites: Setting up a successful apiary relies largely on the user. The basic instructions supplied with the entry-level hive will assist beginners and it is for them to choose the most appropriate methods for stands, public protection and positioning based on their specific context.

Harvesting: Although suitable systems for harvesting were selected they were not able to be tested and issues surrounding access to harvesting equipment still exist. The success of the intervention relies upon
Figure 58: Final demonstration poster of the permanent hive, 2015 (produced by author).

users being able to generate enough harvested product from the entry-level hive to upgrade their apiary, focusing on creating self-reliance within the intervention.

Making: The final production cost of the hives was substantially lower than that of existing products (see Appx. L), with improved access to materials and simplified manufacturing approaches. The permanent hive lends itself to community centred manufacture, however the entry-level hive detracts from the value of such an economic endeavour, serving instead to reduce the cost and improve accessibility through mass manufacture.

Thermoreg.: The airflow features along with the moderate local climate limit the potential temperature difficulties, although different sites will affect the performance of the hives. The chosen materials should theoretically outperform wood in this regard. The airflow systems designed for each hive should also protect the colonies from excessive heat even when kept in direct sunlight.

Material: Although the materials are not natural they will require less maintenance and are more durable than existing wooden and cardboard hives: requiring less maintenance. Problems such as weight, durability and strength were overcome, with the materials providing unforeseen benefits. Initial results were favourable however the performance of the materials will require further testing.

It is recommended that to assess a technology’s appropriateness it’s technical, economic, environmental and social performance must be measured (Sianipar, Yudoko, Dowaki & Adhiutama 2013:3418). The initial testing and informant feedback suggested that the solutions were technically successful, however the time frame of the study did not allow the performance of the intervention system to be tested with the end-users. The time frame, season and colony size also affected the results of field experimentation. The design process of iterations continued after the tests had begun affecting the accuracy of the results in relation to the final outcome. The results do demonstrate that further testing and implementation can be done without changing the final design.

The products developed through this study have the potential to create valuable skills and create additional income in the burgeoning local urban agriculture industry. The success of the intervention will largely be determined by the productivity of the end-users, relying on their motivation to improve their circumstances. The urban farmers specific to this study had already demonstrated motivation and productivity through their agricultural entrepreneurship. The interest in beekeeping demonstrated by the participants was an indication that the intervention would be received well. The focus of this study was to produce an accessible approach to beekeeping for local urban farmers and the solution provides an unprecedented method of achieving this (see Fig. 59). The outcome also provides ‘Capabilities’ for socio-economic development through community driven manufacture of the permanent hive and the creation of local beekeeping product businesses within the communities (Campbell 2015:8).
beegin

The staggered initiation process starts with users purchasing an entry-level hive and building it up until they are able to harvest enough honey and wax to fund their investment in frames and eventually a permanent hive. The process should be able to take place over one year if the environment is conducive to creating a strong colony and the user takes to beekeeping. The entry-level hive can then be used to repeat the process again until the user has an effective apiary of about 3-4 permanent beehives.

Figure 59: Final demonstration poster of the beekeeping system, 2015 (produced by author).
ATD is an indirect method of solving the needs of marginalised communities by providing new opportunities for socioeconomic development. The study demonstrated the importance of Industrial Design as applied to finding appropriate and accessible means to provide entrepreneurial opportunities through the HCD approach. The rigorous design research methods, innovative use of materials and utilisation of expert knowledge also lead to an improved beehive design, the value of which extends beyond the intended user and could benefit the entire beekeeping industry. The discourse stimulates discussion that through HCD and ATD methodologies Industrial Design has the potential to improve entire systems and benefit multiple stakeholders.

6.1.2 Recommendations for Further Study

The participation of experienced experts provided a multitude of insights throughout the research, whereas the end-users lacked the technical understanding to contribute equally to the technology development. The second group was mainly used to develop a contextual understanding and measure responses that lead to the development of a suitable intervention framework. The implementation was left open to interpretation to a certain degree, providing the opportunity for users to uncover issues and possibilities. During future implementation of the intervention the users will become experts in local UA centred beekeeping and their participation in refining the technology would increase substantially.

Extensive testing of both the performance of the hives would need to be conducted to determine the success of the outcomes. The temperature and humidity of the two hives, a control hive and the exterior environment should be measured once monthly, four times per day, over one year to assess their performance in different seasons. To increase the accuracy these tests should be conducted in multiple sites with different colonies with the productivity and wellbeing of the colonies being assessed simultaneously. This research would produce quantitative data that would serve to verify the qualitative data used to inform this study and as such the research methodology should be revised going forward.

Although the estimated retail prices of the products are quite high the cost could be subsidised by organisational involvement or community driven production. In line with the ARC’s goals to create 5000 small scale beekeepers and develop the apiculture industry in SA the organisation could be approached for involvement in the project. The beekeeping organisation SABIO could also be approached to network with expert beekeepers that could participate in training and facilitation during the intervention. The intervention should undertake a holistic approach to the implementation phase by facilitating community centred manufacture of the products as well as extensive urban farmer end-user testing.


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### Appendix A

#### Diseases and Pests Affecting Honeybees

<table>
<thead>
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<th>Type</th>
<th>Name</th>
<th>Cause</th>
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<th>Control</th>
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</thead>
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<tr>
<td><strong>Microbial Disease</strong></td>
<td></td>
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<tr>
<td>American Foulbrood</td>
<td>Spore-forming bacteria that only affects bee brood. Transferred by migrating worker bees that visit other colonies. Also found in commercially available honey.</td>
<td>Isolated capped cells from which brood has not emerged. Darker caps slightly indented. Decaying brood can be screened using the 'Stretch Test'.</td>
<td>Destroy the hives and bees through burning. Bury the remains underground and do not use the same area again for 50 years. Plastic hives must be cleaned with sodium hydroxide.</td>
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<tr>
<td>European Foulbrood</td>
<td>Non-spore forming bacterium transmitted similarly to AFD.</td>
<td>Infected larvae die at a younger stage, often before capping has taken place. Decayed larvae has a sour odour.</td>
<td>Feed bees to stimulate colony strength and natural hygiene. Remove infected brood. Replace the queen.</td>
<td></td>
</tr>
<tr>
<td>Chalkbrood</td>
<td>Fungal spore forming disease. Larvae are infected around days 3-4.</td>
<td>Initially the dead larva swells to fill the cell and are covered in white fungus. The larvae then shrink and harden turning white.</td>
<td>Same methods as per EFD to stimulate bee’s natural hygiene methods. An open hive floor can help remove falling larvae.</td>
<td></td>
</tr>
<tr>
<td>Sacbrood</td>
<td>Viral disease transmitted by nurse bees through food.</td>
<td>Infected larvae do not reach pupation stage, remaining stretched out in the cell on day 4. The larvae appears to have a skin containing white liquid, resembling a sack.</td>
<td>Remove infected brood. Stimulate hygiene and colony strength.</td>
<td></td>
</tr>
<tr>
<td>Nosema</td>
<td>Spore forming viral infection that enters active bees through food.</td>
<td>Infected bees life spans shorten measurably. Abdomens appear swollen. Movements are lethargic and bees can be seen shivering.</td>
<td>Colonies should receive adequate ventilation and protection from cold and humidity. Combs should be swapped out once every two years. Hive equipment should be decontaminated through heat.</td>
<td></td>
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<tr>
<td><strong>Parasites</strong></td>
<td></td>
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<tr>
<td>Varroa mite</td>
<td>The mites are spread in the same manner as diseases. They are found in brood cells, on combs and clinging to bees. The mites weaken the bees and make them more susceptible to disease.</td>
<td>The mites gestate inside brood cells and feed on the bee’s blood. They are visible with the naked eye, are small brown and pin-head sized.</td>
<td>Chemical fumigation of the hive. Manipulating the hive to control brood configuration and draw mites into cells that can be destroyed. Applying a mesh floor that expels falling mites from the hive.</td>
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<tr>
<td><strong>Insects</strong></td>
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<tr>
<td>Small hive beetle</td>
<td>The beetles thrive inside bee colonies. Laying eggs in fissures and crevices that bees cannot access. The larvae leave the hive to pupate in the ground near the hive. The beetle can fly and moves very quickly.</td>
<td>The beetles are dark brown and about 5mm in size. The beetle’s larvae infest brood and honeycomb. Destroying the capping and spoiling the honey. They hide in dark areas of the hive.</td>
<td>The apiary site should be kept clean and the hives should minimize areas for the beetles to hide and lay eggs.</td>
<td></td>
</tr>
<tr>
<td>Ants</td>
<td>Ant attack hives in mass to take honey, brood and the bees themselves.</td>
<td>The ants agitate the bees and eventually cause them to abscond from the hive.</td>
<td>Keep the apiary site clean, search for ant nests and destroy by burning. Supporting the hive on posts that have moats of water or oil.</td>
<td></td>
</tr>
<tr>
<td>Wasps &amp; Hornets</td>
<td>Wasps and hornets feed on honey and brood. They are roughly the same size as the bees so they are able to enter and manoeuvre inside a hive with ease. Generally they are stronger than bees.</td>
<td>Attacks occur generally when colonies are weak or small.</td>
<td>Eradicating nearby nests is the most effective solution. Killing wasps that enter the apiary site is also effective. Beekeepers will often temporarily narrow the entrance of the hive if wasps are sighted.</td>
<td></td>
</tr>
<tr>
<td>Vertebrates</td>
<td>Wax moth</td>
<td>Bees are often unable to leave their cells when they mature as they are tied up by the silk strands and webbing.</td>
<td>Fumigation is the most assured solution. However preventative methods include adjusting the hive size to suit the colony. Keeping the colony free of unnecessary empty comb. Limiting the crevices and cracks in the hive.</td>
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<tr>
<td>Amphibians &amp; Reptiles</td>
<td>The moths enter hives at night to lay eggs inside cells or in crevices. The larvae feed on honey and pollen and burrow into the comb, protecting themselves from the bees with a web. A moth can lay up to 150 eggs and within 10-15 days entire combs can be spoiled.</td>
<td>Predators’ droppings are found around the hive.</td>
<td>The hive entrance should be at least 40cm from the ground. Keep the apiary site clean and clear of dense vegetation.</td>
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<tr>
<td>Honey Badgers</td>
<td>Frogs, lizards and toads feed are known predators of bees.</td>
<td></td>
<td>Fencing off the apiary site, placing hives on high pole-stands and strapping hive boxes/lids down are all acceptable solutions. Killing honey-badgers is not to be done under any circumstance.</td>
<td></td>
</tr>
<tr>
<td>Vertebrates</td>
<td>The honey badger is a notorious enemy of the beekeeper. They destroy hives in order to feed on brood and honey.</td>
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**Appendix B**

*Analysis of Contemporary Beehives Design*

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**Conventional Hives**

The Langstroth hive is the most widely used hive in modern apiculture, representing over a century of development and refinement (Johannsmeier 2001:58). The central innovation is the frame-design (see Fig. 1 & 2) that uses biomimicry to ensure that the bees build comb in an easily manageable and extractable manner. Preferred by commercial beekeepers for its relatively low cost, portability, standardised parts and easy harvesting, the Langstroth hive is an intensive agriculture tool. The disadvantages are that the hives are difficult to work with, use industrial comb structures and are largely ineffective at preventing CCD and other issues.

The Langstroth hive (see Fig. 3) is the most commonly used hive, originally designed by Rev. L. L. Langstroth in 1852 (Stubbs 2012:sp). Rev. Langstroth discovered a system of ensuring that the bees build their comb onto separate parallel frames that can be removed and examined one at a time — minimizing the disturbance to the colony (Stubbs 2012:sp). The frames were designed based on the natural spatial measurement between the centres of two parallel combs built by bees. The Langstroth hive uses frames based on the Italian Bee (Apis mellifera Lugistica) that has a comb spacing of 35mm (Johannsmeier 2001:60). Inside the hive there are gaps left between the frames edges and the adjacent surfaces. Referred to as the “bee-space” the gap must be larger than 6.35 mm to prevent the bees from sealing it with propolis and smaller than 9.5 mm to prevent them from building comb (Stubbs 2012:sp; Johannsmeier 2001:61).
The Hoffman frames (see figs 1 & 2) are spaced by the width of the ‘shoulders’; two side-bars that connect the narrower top and bottom bars (Stubbs 2012:sp). The ‘shoulders’ create space for the bees to pass through and support the frames when gripped together (Stubbs 2012:sp). The frames can be furnished with a foundation sheet – a flat sheet of bees-wax manufactured with hexagonal indentations to stimulate the bee’s production of comb-cells. The hexagonal indentations are based on the measurements of the bees cells with both drone and worker cell size sheets available (Johannsmeier 2001:66). Foundation sheets force bees to build their comb onto the frames in the ideal formation, however the bees then have to move around the entire frame when they want to reach the other side slowing their initial process of comb building (Johannsmeier 2001:65). Foundation comb sheets are also expensive, costing R17 each, and if they are not certified organic it can affect the honey (Stubbs 2012:sp). Beekeepers often use starter strips – foundation cut into roughly 2 cm lengths, positioned at the top of the frame. Alternatively a wooden ridge coated in beeswax has been proven effective in replacing the starter strip all together (Stubbs 2012:sp). Plastic combs are also available and are beneficial as they do not break during extraction and cannot be affected by wax moth (Stubbs 2012:sp). However bees will only use them in a strong nectar flow and refuse to adopt them in the brood chamber (Johannsmeier 2001:66). Plastic frames are also highly expensive and studies have shown that using plastic inside hives can impact the health of the bees.

The frames are threaded with a thin wire that crosses horizontally down the centre in three or four evenly spaced places (see Fig. 2). The wire supports the comb, preventing it from falling out of the frame during inspection and extraction (Johannsmeier 2001:160). To harvest honey from hives beekeepers will remove frames that are fully harvested for selling whole as comb honey is also valuable for selling in its unprocessed form. Frames without wire supports and thin starter strips are used in this instance (Johannsmeier 2001:160).

Frames are manufactured with different ‘frame-depths’: a deep body frame (232 mm), a medium super frame (159 mm) and a shallow super frame (137 mm). The deep body frame fits into the deep super, also called a brood chamber. Ten frames are suspended in this chamber and provide space for the bees to build brood comb. For strong colonies of Italian bees two brood chambers are sometimes required, however the smaller African bee never requires more than one chamber for the brood to be laid and hatched at a sustainable rate (Johannsmeier 2001:59). The chambers are made from four wooden walls with a lip to support the frames. Super frames fit into shorter chambers that are stacked above the brood chamber. A mesh screen called a ‘queen excluder’ can be placed between the brood chamber and the first super to prevent the queen from entering the supers and laying eggs. Only the smaller worker bees are able to pass through 4.0 to 4.2 mm gaps in the screen and as a result the supers will only be filled with honey stores (Johannsmeier 2001:61). The supers are shorter to allow beekeepers to harvest honey more regularly. The size also makes handling easier and the extraction equipment can be smaller.

A bottom board seals the base of the brood chamber. This board extends outwards at the front of the hive by 50mm to form the ‘lighting platform’ where the foraging worker bees land and take off (Johannsmeier 2001:59). The board has a rim that meets the edges of the brood chamber on three sides with the side facing the platform left open. The board will usually have a deep side (22 mm) and a shallow side (9.5 mm), where one side provides more floor space and a larger entrance (Johannsmeier 2001:59). This can be alternated for cold and warm seasons, however beekeepers generally prefer to use an ‘entrance reducer’ – a strip of wood that closes the opening leaving a smaller gap (10-13 x 80 mm) (Stubbs 2012:sp). It is important that the floor can be separated from the brood chamber so that it can be cleaned out, however migratory beekeepers fix the floor to the brood chamber and rely on the bees natural cleaning activities (Johannsmeier 2001:59). The bottom board of the Langstroth hive is often fitted with a screen at the floor section of the hive so that falling Verroa mites will be removed from the hive (Stubbs 2012:sp). In the warm season the screen also helps ventilate the hive.

The top super is covered by an inner lid, that also has a lip to create the ‘bee space’ between it and the tops of the super frames (Johannsmeier 2001:60). There are three different outer lid types. A telescopic outer lid has a wider rim that fits over the inner lid and top super on all four sides and is usually covered in plastic, steel or aluminium on the exposed surface. A migratory lid is the same size as the supers, with a ventilation space (40mm) and gauze covered vents on the sides. This lid makes it easier to load the hives into a vehicle and provides necessary ventilation when the hive entrances are sealed during transport (Johannsmeier 2001:60). A slide-cover lid has two parallel lips that extend over the inner lid and top super and is preferred to the telescopic lid for easier removal (Johannsmeier 2001:60). The hive rests on a stand that can take any form as long as it is level and sturdy. It is advised that the stand be at least 500 mm from the floor to make working on the hive easier and to protect the brood from pests and frost. The hives are generally constructed from S.A. pine timber (Pinus patula) 20-22 mm thick (Johannsmeier 2001:61). The wood is treated with waxsol and left to air for at least one month, where upon the outside can be painted (Johannsmeier 2001:62).

In the 2008 Survey of Beekeeping in South Africa Langstroth hives were shown to be used mainly in the commercial sector, while smallholder beekeepers preferred the Horizontal Top-Bar (HTB) hive, Figure 4 (Conradie & Nortje 2008:2). Johannsmeier (2001:68) describes HTB hives as being “especially suitable for small-scale farmers and novice beekeepers with limited resources”. HTB hives range from very basic traditional versions to modern commercial designs, however the fundamental principle remains the same: a container with an open top, is fitted with wooden bars that can be removed and replaced separately. Since the HTB hive was introduced into Africa in the mid-nineties it has been widely adopted with Kenyan, Tanzanian and South African variations. Like the Hoffman frames the bars are also based on the natural spatial measurements of comb, however the width has
been reduced to 32 mm to suit the smaller African bee (Johannsmeier 2001:68). This change has eliminated the problem of ‘burr-comb’ experienced with Langstroth hives, where African bees will often build parallel combs incrementally closer and fuse a set of frames at one end of the chamber (Stubbs 2012:sp).

The bars are cut to the same length as Langstroth hive frames and finished with either a groove for starter strips or a wooden guide ridge (Johannsmeier 2001:68). The chamber is rectangular with the entrance positioned on one of the shorter sides. The bees build comb onto the bars, however because it is not supported on the sides or bottom it is fragile and must be handled delicately (Johannsmeier 2001:68). Modern HTB hives also use queen excluders that divide the inside space into a brood compartment and honey stores. Due to the fragility of the comb it cannot be kept intact during the honey extraction process. Beekeepers cut the entire honey comb from the bar, separating the honey and wax with gravity, press and sieve methods (Johannsmeier 2001:69).

HTB hives must be covered with a board for rain protection and are usually placed on a stand or built with legs. The most successful HTB hive is the Kenyan variation that uses sloping sides to prevent the bees from attaching the comb to the sides (Johannsmeier 2001:68). The bees build the comb in an arc formation that does not naturally require them to fuse it to the sides as it is strong enough to support itself. The HTB hives are positioned at an easy height to work with, uses natural comb structures and can be made very cheaply. However they are also difficult to move, make harvesting difficult, have no standardisation in parts, cannot be expanded and offer less effective ventilation (Kritsky 2010:12).

In the early 1900’s a French Monk named Abbe Emile Warre wrote a book titled *Beekeeping for All* that documented his design of the “People’s Hive” which has since been named the ‘Warre Hive’ (1942:38). The book documents Warre’s findings from over 350 experiments with different hives and techniques, leading to the development of the Warre Hive shown in Figure 5. Warre’s intention was to develop a hive that would be less expensive, require less work, sustain the colony more effectively and produce enough honey to support the average beekeeper and their family (Warre 1942:25). Warre hives are also called ‘Vertical Top-Bar Hives’ as they use top-bars instead of frames in order to bring down the cost (Chandler 2009:40). Warre (1942:147) also believed that frames typically lead to the spread of diseases and pests by using the same foundation repeatedly.

The hive uses no queen excluder, making use of the bee’s natural tendencies to separate the brood and honey comb during heavy nectar flows. Additional boxes are added to the bottom of the hive (under-supered) as Warre observed that wild bees tend to build comb downwards (Warre 1942:147). By moving the brood when new supers are added in spring the comb is replaced annually, ensuring that the hive does not contain old wax that is potentially contaminated (Kritsky 2010:72). The roof of the Warre hive is sloped for rainwater run-off and has a gap beneath it to diffuse direct sunlight radiation (Warre 1942:91). The roof frame is hollow and fits on top of a ‘Quilt’ box that has a fine mesh cover at its base and is filled with wood shavings or straw to help regulate the temperature and humidity within the hive (Warre 1942:91).

The floor of the hive features a simple entrance way that also forms the alighting platform, with legs fixed to the underside. By keeping the floor separate and flat it could be more regularly and easily cleaned out (Warre 1942:88). Warre also explains that during winter the combs could be oriented parallel to the entrance by rotating the hive on the floor in order to slow the air flowing in over the brood, made possible by the square chambers. In summer the comb would then be faced perpendicularly to the entrance allowing the air to flow through more rapidly (Warre 1942:88). To harvest honey from a Warre hive supers containing honey are removed starting from the top. When a super containing brood is discovered it is left along with all the boxes below it. This practice ensure that the colony will have an abundance of honey stores for winter months and will emerge from over-wintering strong and productive (Warre 1942:114). The honey and wax is then harvested from the collected supers that are cleaned and prepared for implementation the following spring.
TRADITIONAL HIVES

In a study on the effects of beehives on honey production it was shown that new hives produce more honey when compared to traditional hives (Vural & Karaman 2009:226). However traditional hives were also described as being more appropriate in terms of cost, manufacture and availability of materials in developing countries (Vural & Karaman 2009:226). Traditional hives do not use frames and are generally hollow chambers that can be opened to remove honeycomb. In Africa these hives are traditionally made from clay-pots, tree-bark, logs or wicker baskets coated in mud and dung (Johannsmeier 2001:69).

MODIFIED HIVES

Thermoregulation refers to the system bees use to moderate the internal temperature and humidity of hives. The ideal temperature inside the hive ranges from 33-36 °C, and is naturally achieved by the bees cooling or heating activities (Johannsmeier 2001:28). In a study on the effects of hive modifications that aid thermoregulation in harsh climates by Hossam Abou-Shaara, Ahmed Al-Ghamdi and Abdelsalam Mohamed (2013:45) it was found that insulated hives outperformed those with electronic regulation devices or no modifications. Similarly participatory technology development and research projects in Ethiopia by both the International Livestock Research Institute (ILRI) and the Institute for Sustainable Development (ISD) showed that insulated hives are favourable for small-scale farmers (Araya, GebreMichael, GebreAmlak & Waters-Beyer 2007:29; Girma, Ballo, Tegegne, Alemayehu & Belayhun 2008:2).

The Sun Hive (see Fig. 6) was produced by the Natural Beekeeping Trust (NBT) who based the design on the natural formation of comb structure in feral colonies (Bradley 2013:sp). Intended to maximise colony health and promote beekeeping for pollination the Sun Hive is an ‘apicentric’ design (NBT 2015:sp). The hive is manufactured from a wooden sub-frame with a woven straw basket covering similar to traditional Skep hives from Europe (Bradley 2013:sp). Queen excluders are not used, which allows the colony to position the brood based on their own criteria, which the NBT claims improves the overall colony health (NBT 2015:sp). The egg-shaped hive separates at the centre where the top and bottom baskets are joined to a supporting board. Although the curved wooden frames that the comb is built onto allow for each comb to be removed individually the size and weight of the comb would make this a difficult operation. The straw also lends itself to concealing pests and bacteria such as wax moth. The housing structure that both covers the hive and holds the support board is large and expensive. The NBT claim that the cap built into the top cover can be removed to attach a honey super during heavy honey flows, however the design of the honey super is not specified (NBT 2015:sp; Bradley 2013:sp). Although the design echoes Warre’s consideration that a round hive would be more natural, his reasons for returning to a square design remain relevant; the construction of round hives is more difficult and costly (Warre 1942:91).

The Flow hive (see Fig. 7) is a Langstroth based hive design that offers a more efficient method for harvesting honey (HoneyFlow 2015:sp). According to its inventors, Stuart and his son Ceder Anderson the hive does not have to be opened to extract the honey, reducing stress on the bees and the work required by the beekeeper (HoneyFlow 2015:sp). As a result the hive has garnered massive interest from hobbyists worldwide, raising over R150-million in a start-up campaign on the crowd-funding website Indiegogo (2015:sp). However concerns have been raised by professional beekeepers surrounding the use of plastic and potential for over-harvesting and limited colony inspections (Bradley 2015:sp).

The Flow Frames (see Fig. 8) are plastic foundations of complete cells that are formed by vertical strips of half-cell forms that are aligned on a backing board. They work by splitting the comb cells of capped honeycomb to create vertical channels for honey to drain from (see Fig. 8; HoneyFlow 2015:sp). The cells can then be reformed allowing the bees to replenish the empty cells. The end caps are largely left intact during extraction and the bees are undisturbed. Although the Flow products are marketed to customers worldwide the bee-space and cell sizes are based on the Italian Bee and will most likely create problems for beekeepers in Africa, Asia and America (Bradley 2015:sp). While in cold climates honey often crystallises in the comb and must be heated during extraction.
Professional beekeepers argue that the use of plastic in hives generally leads to problems with condensation and electrostatic discharge (Hauk 2002:25). Jonathan Powell (2015:sp), a partner with the NBT, wrote in his blog that bees use wax comb, that has a resonant frequency of 230-270 Hz, to communicate through vibrations keeping the wax at the ideal temperature to facilitate these vibrations. Adding that worker bees are also able to ascertain information about the history of the colony from wax composition and the structure of combs (Powell 2015:sp). If the combs are not inspected before draining there is the possibility that unripe honey may be harvested through the Flow extraction method. Uncapped cells containing moisture form natural yeast in the honey and lead to fermentation that can spoil the harvested honey (Johannsmeier 2001:112).

The South African designed BeePak hive (see Fig. 9) is also based on the Langstroth hive and is manufactured from a durable plastic-composite and aluminium, with the benefit of easily disassembling for transport and cleaning (BeePak 2015:sp). The BeePak is both larger and lighter than the Langstroth hive and uses plastic frames (BeePak 2015:sp). Although BeePak claim the hive would be ideal for low-income, rural communities it costs four times that of a Langstroth hive (BeeWare 2015:sp). The plastic body of the hive is insulated to help regulate the internal temperature, however beekeepers are still concerned by the humidity that has been observed in hives with plastic lids (Hauk 2002:25). The possibility that the internal air quality is affected by estrogenic and carcinogenic chemicals released by plastic has also been raised by melitologists (Bradley 2015:sp). BeePak claim that plastic hives are more sterile and make bacteria outbreaks more easy to control by simply sterilising the hive components rather than burning (BeePak 2015:sp). However the chemicals required for sterilisation are dangerous and expensive.

LOCAL INNOVATION

Due to problems with theft and vandalism commercial beekeepers in Carletonville have started manufacturing concrete beehives. With over 3000 hives located across the North West, Free State and Gauteng provinces the beekeepers are only able to inspect their apiary sites once a month. Currently working on a 30% loss annually they have made numerous attempts to protect their hives, to no avail. The wooden hives Langstroth hives that they use are easily loaded into vehicles and stolen; dismantled and robbed; or destroyed by fires, floods, wildlife and vandals. The pile of destroyed hives shown in Figure 12 represents one months’ worth of hives destroyed at their various apiaries. Compounded by the current bee mortality rates they have decided to take matters into their own hands and manufacture virtually indestructible concrete hives.

The concrete hives comprise of three parts: a brood chamber, honey super and a lid. The concrete is shuttered in moulds and reinforced with steel mesh (see Fig. 10). The brood chamber is sealed at the bottom with the hive entrances located on one of its top rims. The components are simple boxes with no embellishments and flat surfaces. The frames rest on top of one another inside the hive boxes, held upright with a tight fit (see Fig. 13). The interior walls of the boxes are coated in bees-wax to make the environment more hospitable for colonies.
The three components are joined through the centre by a threaded steel bar that is locked above the lid with a plumbing cap. The beekeepers believe that the weight of the hive will prevent people from thieves the hives, and if they want to get to the honey they will need to have specialised tools. The hives will also be safe from fires, flooding and harsh weather conditions. A completed hive had been housing a colony of bees for a month and was showing good signs of activity indicative of successful adoption. According the beekeepers the hives were costing about R250 each, weighing in at roughly 150 kilograms. Their intention was to install the hives as permanent features at their apiary sites, harvesting the frames separately.

### PRICING

<table>
<thead>
<tr>
<th>HIVE</th>
<th>PRICE</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Langstroth</td>
<td>R950</td>
<td>BeeWare 2015</td>
</tr>
<tr>
<td>Warre</td>
<td>R2700</td>
<td>BeeThinking 2015</td>
</tr>
<tr>
<td>Horizontal Top-Bar</td>
<td>DIY - R400 Materials</td>
<td>Beequip 2015</td>
</tr>
<tr>
<td>BeePak</td>
<td>R1350</td>
<td>BeePak 2015</td>
</tr>
<tr>
<td>Sun Hive</td>
<td>R3864</td>
<td>NBT 2015</td>
</tr>
<tr>
<td>Flow Hive</td>
<td>R3235-R8336</td>
<td>Flow™ Hive Shop 2015</td>
</tr>
<tr>
<td>Hoffman Frame</td>
<td>R11.10 (assembled)</td>
<td>Beequip 2015</td>
</tr>
</tbody>
</table>

![Figure 14: Comparative table of the prices of modern beehives, (compiled by author).](image)

### Sources Consulted:

- Warre, A. 1942. *L’Apiculture Pour Tous (Beekeeping for All).* London: Creative Commons.
Appendix C

CONSENT FORM

I ……………………………………………………………………hereby agree to participate in social research and the development of prototypes and final models of appropriate apiary technology for urban farmers.

- I understand that I am participating freely and that I am not being forced in any way to do so.
- I also understand that I can stop participating at any point should I not want to continue and that this decision will not in any way affect me negatively.
- I understand that this is a research project whose purpose is not necessarily to benefit me personally in the immediate or short term.
- By signing this consent, I acknowledge that I have read the project information form.
- I hereby agree to the voice and/or video-recording of my participation in the study.
- I understand that the information that I provide will be stored electronically and will be used for research purposes now or at a later stage.

Signature of participant:…………………………….. Date:…………………..

Anonymity (fill in only if anonymity is requested)

I hereby request that my identity be kept confidential in the communications emanating from this project.

Signature of participant:…………………………….. Date:…………………..

Recording Of Details for Future Communication

Names and contact details for future correspondence.

<table>
<thead>
<tr>
<th>Name and Surname</th>
<th>Telephone Number</th>
<th>Email Address</th>
<th>Postal Address</th>
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Appendix D

B-TECH MINOR DISSERTATION PROJECT:
An Improved Beehive Design to Support Local Urban Agriculture

Project Information Form

Background:
An improved beehive design to support local urban agriculture is a minor-dissertation project that has been undertaken by myself, Ivan Brown, an Industrial Design student at the University of Johannesburg (UJ). As someone relevant to the aims and objectives of this social research and design project I would like to interview you. I will explain what the implications of your participation in this project are, and this form is intended to capture your informed consent. You should understand completely the implications of your participation in this project. This should be done to your satisfaction and should you have any questions in this regard please notify me or my project supervisor that you are not completely informed or comfortable with the explanations given. Please do allow me the opportunity to explain the project to you until you are satisfied.

No obligation of participation:
Please also note that you are under no obligation to participate in this project. You may also change your mind about participating at any time during the project. You will not be penalized or disadvantaged in any way should you decide to discontinue your participation. However, I hope that through your participation I will be able to address some of the concerns that beekeepers and urban farmers/gardeners have, and this may well improve upon their interests and conditions.

Intellectual Property:
This project is dependent on funding, which will be obtained from the National Research Foundation (NRF). Therefore intellectual property rights will be dealt with in accordance with the Intellectual Property Rights from the Publicly Financed Research and Development Act No 51 of 2008. Any intellectual property that belongs to any of the participants in this research (background intellectual property) will at all times remain vested with that participant. The intellectual property of the research findings and information, as well as the content of the final publications of the social research belongs to the University of Johannesburg. I acknowledge however your participation in this project and I will acknowledge your participation (to an extent that is appropriate) in the dissemination of findings and presentation of final findings should you wish so.

Commercialisation:
The research reported on here is done for educational purposes, although I cannot exclude the possibility that this might have commercial applications. In the event of commercialisation an agreement will be concluded with you that will stipulate the terms and conditions of the negotiations between UJ and yourself.

Confidentiality:
You have the opportunity to request that no identifying information be made available by this project. I may record information that may identify you in written, oral and visual form. Should you request so, no identifying information will be made available through the communication and educational materials emanating from this project. Information that may identify you will be protected and kept in an access controlled room unavailable to others. These records can only be reviewed by others with the express consent of myself or the project supervisors. This material may also be reviewed by their superiors.

General:
Should you want to be included in future communication emanating from this project, please do include your name and contact details in the form provided so I can record that. I do not foresee any risk or harm from participating in this project, however UJ, the project supervisors and Ivan Brown will at all times be indemnified against any loss, injury or damage encountered due to the participation by yourself in this project. The risks associated with participating in this project are no greater than you would encounter in your daily business.

Communication:
Should you have any complaints about any ethical aspect of participating in this research, or if you feel that you have been harmed in any way by participating in this study please contact the Department of Industrial Design at the following numbers and addresses:

Angus Campbell (project supervisor)
Department of Industrial Design, UJ
011 559 2859
acampbell@uj.ac.za

Chris Bradnum HOD
Department of Industrial Design, UJ
011 559 1387
cbradnum@uj.ac.za

Ivan Brown (project leader)
076 980 9974
ivanleroybrown@gmail.com
Appendix E

UF01

1 Sunday 19th April
2 Bertrams Inner City Farm: A Bambanani Food Project
3 Transcription of interview between Amon Maluleke
4 (Head of Agricultural Operations and Project
5 Manager) and Ivan Brown (Industrial Design Student,
6 UJ).

7 We met at 11am, by the cricket pitch. We discussed
8 the reasons for the interview and my research
9 problem. I informed him of the ethics, had him sign
10 a consent form and began recording the
11 conversation. We walked around the farm while
12 talking and he showed me his proposed location for
13 an apiary.
14 AMON: You’re from, uh, UJ?
15 IVAN: Yeah, I’m studying industrial design.
16 AMON: Okay.
17 IVAN: Same department that Angus is from.
18 AMON: Okay.
19 IVAN: I’m doing my B-tech degree year.
20 AMON: Okay, it’s like a, like a degree?
21 IVAN: Yeah, it’s like a, like an honours degree. So
22 it’s...
23 AMON: Okay, alright.
24 IVAN: So it’s post-graduate.
25 AMON: Okay.
26 IVAN: Um, and then this year we have to, um, a final
27 dissertation project, so we could choose what we
28 wanted to do; what product we wanted to design.
29 Um, so I chose to do, um, a product for social
30 development.
31 AMON: Okay.
32 IVAN: Which means I am following in Angus’s field of
33 Urban Agriculture. I think my project is going to be
34 a, finding a solution for a bee-hive that can be
35 implemented in urban agricultural environments
36 that will be easy enough and safe enough for people
37 to use. So that’s my focus, Bee-keeping.
38 AMON: Okay, that’s the initiative we are looking for.
39 I think, uh, in, um, when we were having, um uh,
40 conversations with some stake holders in jubulani, I
41 think it was earlier this month, we did mention the
42 idea for like a, to add over and above what we have,
43 we would like to add a bee-hive. So you can advise
44 us.
45 IVAN: Okay, so you’ve already been talking about it.
46 AMON: yes, I think it’s on the pipeline because we
47 are looking at, umm, the bees are dying every day
48 because of the chemicals… or whatever
49 IVAN: Ya. Because of the...
50 AMON: Which means without the bees which means
51 our business is going to die.
52 IVAN: Because there’s no pollination?
53 AMON: There will be no pollination, uh, pollination,
54 uh, so we will be looking at introducing maybe two
55 or whatever bee-hive according to your spec and
56 then we are, from your advice.
57 IVAN: Yes?
58 AMON: Because I think, err, Dr Malan did mention
59 that he would talk to the department.
60 IVAN: Okay, yes, yes, he is also lecturing me as well.
61 AMON: Okay.
62 IVAN: Um, so he knows what I’m working on.
63 AMON: Before I came, so that I can get an idea, so
64 what is the requirements for a bee-hive?
65 IVAN: Well… um, I’ve spoken to a few bee-keepers
66 and experts and they say the requirements are that
67 they do need a water source-
68 AMON: Okay.
69 IVAN: and they need to, I think the laws are, that
70 they need to be about at least 5 meters away from a
71 building or house that, that people live in.
72 AMON: Okay.
73 IVAN: Other than that they just require food; nectar
74 and pollen.
75 AMON: Which means to ask, uh, does it have any
76 effect on like workers, you know like it is there.
77 IVAN: Well, bees can sting you, and some people are
78 allergic to bees. So, um, but there aren’t laws about
79 testing people for allergies. You need some
80 education in bee-keeping, it just about letting
81 people know that there are bees around, you know.
82 AMON: Because we are looking at introducing them
83 somewhere.
84 IVAN: Yeah.
85 AMON: Let me show you. So that it means we are
86 having sittings and showing people our food and
87 teaching them about healthy eating.
88 IVAN: Where you serve food that you have grown
89 here.
90 AMON: Yes, and then also we want to introduce this
91 herbal tea, then-
92 AMON: Okay.
93 AMON: to sweeten it we are looking at these bees
94 and honey. Natural honey, which means we want to
95 promote natural diversity.
96 IVAN: Yeah.
97 AMON: Without using sugars, you can use natural
98 like-
99 IVAN: Honey.
100 AMON: yes, in terms of honey.
101 IVAN: okay.
102 AMON: Because we want to promote healthy
103 lifestyles.
104 IVAN: So you grow, um, you grow organic vegetables
105 and herbs?
106 AMON: Yes, naturally grown, yes.
107 IVAN: Okay.
108 AMON: So you see this, um tunnel-...
109 IVAN: Yes.
110 AMON: We are looking at introducing them, or at
111 least one or even being two or three.
112 IVAN: Yes.
113 AMON: Then at least it can help us in the pollination
114 and whatever as time goes on.
115 IVAN: Yeah.
116 AMON: So at least, uh, I will rely to you too, to.
117 IVAN: Well I can advise you.
118 AMON: and then advise us, and then what is it that
119 to do, if I ever need to be in the place to get bees.
120 IVAN: Yes, well there certain things, there's, I mean
121 there's a lot of different things-
122 AMON: Yes.
123 IVAN: that apply, but there's like, certain things, like
124 if you put it under a trees its better if the trees are
125 deciduous, so that in the winter the loose their
126 leaves and the hive will get more sunlight.
127 AMON: Okay.
128 IVAN: and then in the summer it gets more shade,
129 because they like to have regulated temperature in
130 the hive.
131 AMON: Yeah, it is those advice which we will need.
132 IVAN: Yeah.
IVAN: Yeah.

AMON: Because we want actually to diversify in each and every aspect like the, uh, Industrial, uh err, gardening, err, designs; can be vertical gardening, can be container gardening, and all particular aspects because what we are envisaging, uh, in a year or two or three want this to be a centre of excellence. Whereby we are looking at replicating it all over the country. So those who would like to do similar projects like this one, and we can tell them the challenges they will face, because the garden itself have taught us so many things. Like I have been here since it was six months old and then-

AMON: It was initially in September 2006. So in March I was walking around just relaxing during my off day as a security guard, back then, then I saw ladies digging, here and then I said oh, there's something that I left at home. Let me at this day get inside and ask how can I be of help to them or can I participate.

AMON: So now I have got seven years that I have been in the project.

IVAN: Okay.

AMON: It was initially in September 2006. So in March when I qualified for that. I came across a college called Oxbridge Agricultural Management. For there the subjects I found me. Even though I didn't believe much in it because I was not what have learnt from here. For me to bridge and then do the National Diploma in Ornamental Horticulture, then, uh, yes I still need to have more resources.

IVAN: Okay.

AMON: Because of the land and whatever. Ya. So you have to look after those particular things, if they are not there let's take one cow is missing you can miss one week or two weeks till you get it. Cause you know it is a source of your, uh, your, err, your supplement.

IVAN: Your education?

AMON: The reason why you have to go to school. Even though we didn't understand by that time. Uh, I, err, when I grow up I tend to realize that my father loved us so much that some of our peers didn't make it even to standard five.

AMON: You're, wha, whoa, let me take this chance' and then I took that chance, 2011, the whole of 2011 until 2012. So, uh, in that course, uh, I, uh I did make it five distinctions, 3 B's and one C. But I got a cum-lade when I qualified for that.

AMON: So it taught you the value of and food?

AMON: Farming, and then yes. And then when I came home and participating, then it made me to, to rethink and say, uh, this, err, this farming has loved me so much that it have followed me back from Limpopo. Seven tears working in the town-houses cleaning and working security and whatever. When I came here after retrenchment then I thought have worked for seven years to follow me then it have found me. Even though I didn't believe much in it because I was not what have learnt from here. For you to participate in, so along the way it was teaching me, and then it have, uh, whispered in my ear that, uh, for you to make it in this you have to, uh err, to add something, uh, like study further and whatever. So, answering that question I umm, twenty years, uh 2007, and then four years down the line I have seen that there is a gap. Which needs to be closed because we don't know what is administration how to it is record keeping and whatever. And then things are changing day in day out. So I decided while sitting, uh, at the, uh, other farm for cricket, uh where we farm cricket talent. So, uh, I decided that let me do something. So I decided to register a skills diploma in Farming Management. Because I went to Unisa, wanting to do Agricultural Management. For there the subjects I did at school doesn't allow me to do that, because it requires someone with physical science and maths. And I didn't do that, I did Geography, Biology and Agriculture at school, they don't balance. So, uh, while I was doing the shopping, window shopping, then I came across a college called Oxbridge Academy, so those, uh, offer a Farming Management Diploma. Hh, I said, 'wha, let me take this chance' and then I took that chance, 2011, the whole of 2011 until 2012. So, uh, in that course, uh, I, uh I did make it five distinctions, 3 B's and one C. But I got a cum-lade when I qualified for that.

IVAN: Okay.

AMON: For ICT is that I was not having the sources, I was not having access to WIF, because you have to do an online sort of thing and then learning technology and then doing and online. You need somebody who has at least a background. So I'm, I'm trying now to, to learn. Then when I go back I think I will get it with, um, with high marks ya. Because it's only submitting those particular things. It is only submitting those particular things no exams, in its, ya. So let's, let's talk about what we are doing in this particular conversation ya.

IVAN: Okay, um, I just need to ask a few questions about the farm itself.

AMON: It's plus or minus a hectare.

IVAN: Okay.

AMON: Okay.

IVAN: Um, how big is the, the farming area?

AMON: Uh, it depend to the season. Like now it's very cold, here in Joburg, We, we venture into the Brassica family. Uh, you're vegetable, like Brassica means cauliflower, um, kale, uh, broccoli and then ya, ya, those family.

IVAN: Okay.
AMON: Because other things like spinach it grows, uh, very slow, it doesn't give you big leaves, uh, but solution to that is on the way. Very soon it can be a way, for it can be another week and I can be signing an enterprise development through service the company I'm still working at which I worked for the past seven years.

IVAN: Okay.

IVAN: So you will have eight hot-house for?

AMON: So they will be putting like interest in like hot-houses. Which will add six, over and above our two, which means we will have having eight all in all.

IVAN: Okay.

IVAN: But back at Limpopo you can grow them all year round.

IVAN: Cause the climate is moderate.

AMON: The climate is moderate ya. We want at least for business to sustain because we are still at the imaging even though we got seven years down the line with no resources then we are still in imaging because if I however can that I think now will graduate not to be in the imaging we'll be sustaining our self. Because if you combine all the leafy vegetables and the food bearing plants then you get more money to sustain. Which you can be able to hire other labour and then do other things which you would like to at least promote urban farming.

IVAN: So the Brassica family is the leafy, the leaf plants

AMON: Ya, well the Brassica family one challenge they have is, uh, except the kale the kale is a cut and grow, but the rest cut once and then they are finished, and then you have to wait for, for a cabbage you have to wait 120 to 150 days, which is five months. And then for broccoli is four months, you see which means you don't have business during that period. But if we can be able to grow like spinach, spinach is cut and grow. Every week you will be harvesting something which means there is cash flow. Better cash flow, then that you have to put the input that you put in is sometimes you don't get out of that, cause they are having seriously actually when we group them into categories of uh, uh, categories of, of, of plants.

IVAN: Okay. Alright. And so during the summer you can grow tomatoes?

AMON: At least during the summer you diversify, you grow tomatoes, green peppers, yellow pepper, red pepper, and all those things. And then you have got three months, actually here in the urban area you have three months to grow and then two months to sell and then two months to sell, and then seven months down the line... you got nothing. So you can imagine that if you got only five months not half of what, because the six months it's where you get, err, not sufficient. Then at least seven months down the line you don't have anything to do, then you get you are looking at sustaining the, uh, the, the, the, the business.

IVAN: Okay. In terms of the bees. Do you have any experience in bees, um, did you know anyone in Venda that had bees?

AMON: No actually, we, we, err grew up, uh getting the honey from the bees naturally.

IVAN: Stealing it.

AMON: No, no, from in the vegetation.

IVAN: Okay.

AMON: That's something which now from May we start to go and then looking for the, the hives and enjoying the honey. So maybe we for a part of it is for a business, part of it is to remind me of my upbringing. I don't have any, any knowledge ya. We used to go and then to sometimes to go late at night when they are sleeping its better they don't sting you.

AMON: Or we go and do the, we during the day and then we make the fire and we kill it.

IVAN: Chase them away.

AMON: Instead, of, uh, having more then we find that we have killed a lot of, of bees.

IVAN: And then the next year?

AMON: The next year you find they are gone. So that's the concern now I want to pay back my sins.

IVAN: Okay.

AMON: Which I did maybe making fire and then, um, uh, I want to get an innovative way of getting honey, instead I mustn't get honey by killing. I must get honey in a way that it can sustain, uh, year in year out, and then the coming generation also get the pollination. Because if I however join the army of those who, who are having their firearms killing the bees which agriculture cannot sustain itself without bees. Then I will not be doing justice then I will not be doing justice. Also when I say I'm growing things naturally which means I may be writing that on the book but not practicing it. So I want to practice what I'm preaching.

IVAN: Okay.

AMON: If however we have been taught how, to, to look after, the, the language of the, of the bees and then whatever, then we, we think that that this can be part of whatever we are looking at and then part of, of, of our future plan is that we must have a kiddies garden. Kids must know where everything is, uh, uh, err.

IVAN: Coming from.

AMON: They mustn't be like a modern man who believes that, uh, the solution is in the super market.

As part of it as an Urban Farmers we have got a lot of things to teach. Actually these, err, particular project can form part of eco-tourism whereby teaching people part of the importance of growing they're vegetables and harvesting and knowing where they're vegetables come from. That's the part of education which we need to, to, to mobilize. And then part of it we must, uh, we must, uh err, tell them the importance of knowing where their vegetables come from in terms of nutrition that is health. We are promoting health at the same time. When we working with them around here. Us health wise because they are working and exploring and getting some, uh, uh fragrance from different whatever. Which according to the Homeotherapists
Transcript 001: Amon Maluleke

IVAN: What is the biggest expense? Is it water?

AMON: It take, it takes a period of time to be certified.

IVAN: Which is higher than what we are anticipating. For the past seven years I haven't even got a reward from what, all my hard work. So it needs not, uh, uh, sissy's heart. It need a big heart to accommodate this particular initiative. And also in, in, in the reality, uh, to for a business to sustain you need five years to model if you got resources. To, to, to be able to, to get, uh, the return.

IVAN: Alright. Um, I also just wanted to ask in terms of selling the vegetables? It goes to Bamabanani, Bamabanani is the retailer or farm?

AMON: Bamabanani is the name of our co-operative.

IVAN: Okay. It's just because there are with some of the things which maybe may honesty don't see that there is something which is been stolen. But, uh, to answer that question yes, we got twenty-four hour security but he's not guarding our vegetables, but is part of the premises which is here. Correcting.

AMON: Actually maybe we grow too much that we don't see that there is something which is been stolen. But, uh, to answer that question yes, we got twenty-four hour security but he's not guarding our vegetables, but is part of the premises which is here. Correcting.

AMON: Amon. Ya the young generation. That's why we are looking at partnering with another organisation that came and approached and I liked the idea that they want to open a kiddies club, uh, every Monday they call and meet free every Monday. And in that at least we will like to, to get the way how we can work with them. Maybe it can also attract the children around, and then we, we, we, get children to play with and then part of what we are playing with will be part of teaching.

AMON: Because even myself like I have mentioned that, like I have been exposed to subsistence farming at the early age that's why even now it's not a problem to me even if I'm in the urban area.

AMON: It takes a period of time to be certified.

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AMON: It takes a period of time to be certified.

AMON: I am the city of gold.

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AMON: AMON: Because even myself like I have mentioned that, like I have been exposed to subsistence farming at the early age that's why even now it's not a problem to me even if I'm in the urban area.

IVAN: Okay.

AMON: Which is higher than what we are anticipating. For the past seven years I haven't even got a reward from what, all my hard work. So it needs not, uh, uh, sissy's heart. It need a big heart to accommodate this particular initiative. And also in, in, in the reality, uh, to for a business to sustain you need five years to model if you got resources. To, to, to be able to, to get, uh, the return.

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IVAN: Okay.

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AMON: Yeah, that’s where I come in. Maybe I can design a solution, you know, so that it can be safe regardless. You don’t need more people to watch it, or. But also I wanted to ask, um, and thieves in terms of animals and pests and things eating the vegetables?

AMON: No, no problem you are more than welcome, you got me there.

AMON: OK, no problem you are more than welcome any time you want to. And then I will uh, it’s a plea to me that when you think of that bee hive, eh, when you design those, uh, let us explore together and then I got a youth who are doing plant production level three of which they are finishing next month.

AMON: Maybe, we can engage them in helping in the design and then maybe some we can catch from them and then, then we, we create something.

AMON: Uh pests is not much a problem because we have got a group which if you need, uh, extra hands and also passing this knowledge to they are there. As long as you do it not, uh, later than end of, er, end of May.

AMON: Ants I haven’t seen because most ants what they’re realised is that when the soil is acidic it is so fertile that, we, err, it doesn’t attract more ants, but also we cannot say they are not there because it’s a big place I can’t scout every row.

AMON: Ya, so at least I will go home, and uh, when I die, when change my address to the other one I won’t turn and tos.

AMON: Well that’s where I come in. Maybe I can design a solution, you know, so that it can be safe regardless. You don’t need more people to watch it, or. But also I wanted to ask, um, and thieves in terms of animals and pests and things eating the vegetables?

AMON: So, so to keep them and then motivated them any time you want to, I’m assuring you that we got a group which if you need, uh, extra hands and also passing this knowledge to they are there. As long as you do it not, uh, later than end of, er, end of May.

AMON: Eh, maybe we can lay the plastic, and there is even if a person want to steal then he cannot steal.

AMON: If you want to steal, uh, for, for application to the service providers that we are accredited, of which even us, as well money, we are looking at even this year when they open there window we will apply we are looking at the way how we can be the service provider. Uh, then these as, we are, we will call it we want to create a centre of excellence.

AMON: Something that has been exposed to marketing, human resource, and then all those particular management things.

AMON: When we introduce technology like what we are conducting, uh, in Ghana when they had a youth summit, uh, they say if there, they for us to attract youth, it’s when we introduce technology like what you want to do, to design a beehive in a way that even if a person want to steal then he cannot steal.

AMON: And then introducing the hot house, whereby technology have to work. Maybe we can operate it in, uh, in an electronic way and then at least that makes the use to, to have a dream.

AMON: To give them, uh, as a source of staple, because they have identified a staple. They, they attend class for three, three hours a day.

AMON: Okay, it’s the end product, that how to handle it.

AMON: We want to conduct formal and informal, uh, training to the, to the people, to everyone who wants to learn, cause part of the infrastructure that serviced will put, it will put office work, and uh, a container which is a place where we will, uh, we will be conducting our, uh, training and everything. Currently we will be relying to those who are accredited by AgriCity, by we are looking at the way how we can be the service provider. Uh, then these as, we are, we will call it we want to create a centre of excellence.

AMON: Because this baton was uh, given to me from the other generation who didn’t have, uh, a, a sophisticated education. That was the knowledge which was passed from generation to generation which was not recorded anywhere, so actually, uh, for me I want to pass this baton to those who have got something, who have got, who, who have got, uh, some skills and whatever and then they have got a background of current educational system which I want them to pass top my children. Because they are still growing, yeah, and when they are grown they must find people who will guide them like I have guided them.

AMON: You know that there is someone looking after your interests.

AMON: You mentioned AgriCity as sponsoring these, these youths that you were training. Do they sponsor a lot of educational?

AMON: And then give similar which is there by intensive. Because in the hot houses we can turn it to be, we can, can lay the plastic, and then there is no more hard work, it’s just monitoring and scouting and whatever. For those, uh, whom I’m mentioning I’ve taught them every, every aspect of, uh, from when you identify a plan, a place for farming, plant propagation. Currently they are doing, uh, the last level. How to, uh, because they have identified a farm, then they will learn plant propagation then now it’s the end product, that how to handle it. What is the requirements, required for you to, to, to do those particular things. And then part of it is unlike when I do my certificate in horticulture. Cause only related to horticulture, and then these, they have been exposed to marketing, human resource, and then all those particular management things.

AMON: My, my, my, my question now is where are they going from here cause I have kept them for, for eight months here, I’ve accommodated them for eight months. So the question is are they also going again and then uh, add number of unemployed and unskilled people? Actually they are skilled now because the, the level they are learning now is, uh, is which they can be able to start. It’s only that they need my, my mentorship, or other peoples mentorship for them to be strong because all what is needed can be food handling, can be whatever.

AMON: I think I have asked pretty much everything, uh, I needed to know and uh, you’ve given me a lot of extra information as well.

IVAN: Okay, that would be cool as focus group too.

IVAN: Oh, no problem you are more than welcome, you got me there.

IVAN: Aha, I needed to know and uh, you’ve given me a lot of extra information as well.

IVAN: What is that you say that there’s only old people in farming and above sixty-five.

IVAN: Okay. So, so to keep them and then motivated them any time you want to, I’m assuring you that we got a group which if you need, uh, extra hands and also passing this knowledge to they are there. As long as you do it not, uh, later than end of, er, end of May.

IVAN: Ants I haven’t seen because most ants what they’re realised is that when the soil is acidic it is so fertile that, we, err, it doesn’t attract more ants, but also we cannot say they are not there because it’s a big place I can’t scout every row.

IVAN: Uh, it’s the end product, that how to handle it.

IVAN: We want to conduct formal and informal, uh, training to the, to the people, to everyone who wants to learn, cause part of the infrastructure that serviced will put, it will put office work, and uh, a container which is a place where we will, uh, we will be conducting our, uh, training and everything. Currently we will be relying to those who are accredited by AgriCity, by we are looking at the way how we can be the service provider. Uh, then these as, we are, we will call it we want to create a centre of excellence.
Appendix E
UF02

1 Saturday 1st August
2 Soweto UJ Campus: Izindaba Zokudla Farmers School
3 Transcription P002 of Interview of Edward E. Maake (Urban Farmer) by Ivan Brown (Industrial Design Student, UJ).
4
5 We met at 13h00, outside the lecture halls during the lunch break. We discussed the reasons for the interview and my research problem. I informed him of the ethics, had him sign a consent form and began recording the conversation. I had just presented my project to the farmers and EDWARD approached me out of interest in the study.
6
7 IVAN: Um, so EDWARD you were saying that you, you farm.
8 15 EDWARD: Where is your farm?
9 14 IVAN: Where is your farm?
10 13 EDWARD: Uh, its in Soweto, uh, the primary school is called Inshaneen, uhh, what we doing there is uh, its in Soweto, uh, the primary school farm.
11
12 We have been doing but we haven’t had problems.
13
14 IVAN: And.. But we’ve never had problems.
15
16 EDWARD: Yes, while I was harvesting. So it could have been the fact that I started while it was busy with its pollination.
17
18 IVAN: Yeah.
19
20 EDWARD: So.. But we’ve never had problems.
21
22 IVAN: Okay.
23
24 EDWARD: Ya, right.
25
25 IVAN: And-
26
27 EDWARD: They, They, They, We work there while they are around.
28
29 IVAN: Ya.
30
31 EDWARD: And I was only stung once while I was harvesting.
32
33 IVAN: Okay, and you know where the hive is?
34
35 EDWARD: We have never seen the hive but we believe they are still there.
36
37 IVAN: Okay.
38
39 EDWARD: See, see we usually leave around 3, but still the bees will be there, and we’ve never really got the time to say let’s sit and see where they go after they’ve done there you know.
40
41 IVAN: Okay. What err crops do you mostly grow?
42
43 EDWARD: Uh, we grow vegetable crops, but now we’ve started with strawberries. Uh we also have granit. I don’t know what they call it.
44
45 IVAN: Granadilla? No that’s a tree.
46
47 EDWARD: No. It’s a fruit that has many seeds inside. Uh, it, it.
48
49 IVAN: Pomegranate.
50
51 EDWARD: P, Pomegranate. Thank you.
52
52 EDWARD: Okay.
53
54 IVAN: Okay. Well, have they been stung, but myself only when I went to harvest and then the flowers on my ear I didn’t see the bee.
55
56 IVAN: When you were harvesting the plants?
57
58 EDWARD: Yes, while I was harvesting. So it could have been the fact that I started while it was busy with its pollination.
59
60 IVAN: Yeah.
61
62 EDWARD: So.. But we’ve never had problems.
63
64 IVAN: Okay.
65
65 EDWARD: Ya, right.
66
66 IVAN: And-
67
67 IVAN: Okay.
68
68 EDWARD: So we gonna bring them out afterwards, while the trees have grown. Cause we have to take them, care of them regularly you know, feed them the right nutrients.
69
70 IVAN: Okay, how big is the farm?
71
71 EDWARD: Its huge, its about 100m long and 35m wide.
72
72 IVAN: Okay.
73
73 EDWARD: But we’ve also uh, proposed another space which is much bigger than that.
74
74 IVAN: Okay.
75
75 EDWARD: It’s about acre, uh, maybe a hectare and a half also.
76
76 IVAN: Alright.
77
77 EDWARD: Uh the one that we’ve currently proposed 83 ya. So we only waiting for the director of education to approve our proposal.
78
78 IVAN: Okay.
79
79 EDWARD: Ya tape. Its amarenthus, we also have that amarenthus? seedling of this. Whats this… Tape, uh, ama. Is it amarenthus?
80
80 IVAN: Okay.
81
81 EDWARD: Uh the one that we’ve currently proposed to the director of education to approve our proposal.
82
82 IVAN: Okay.
83
83 EDWARD: Ya.
84
84 IVAN: So it’s a collaboration between..
85
85 EDWARD: Uhh, no its one co-operative.
86
86 IVAN: Okay.
87
87 EDWARD: But we’ve, uh, we’ve applied for two spaces because we need to. We need to do all the vegetables. We don’t want to do specific, you know.
88
88 IVAN: We wanna try everything so that we can know what, what we are best at.
89
89 IVAN: Okay.
90
90 EDWARD: But we’ve, uh, we’ve applied for two spaces because we need to. We need to do all the vegetables. We don’t want to do specific, you know.
91
91 EDWARD: We have been doing but we haven’t planted it yet. Uh, but the strawberries we have. So also the only fruits that we have currently that are planted. And then we also have apple trees but they are not yet there. We still, you know what this thing, uh, this past, uh black plastic bags, I did them at home.
92
92 IVAN: Okay.
93
93 EDWARD: Ya cause we only started last year in August and so far we have Chinese spinach, we have spring onions, we have got strawberries, uhh we have Swiss chard spinach, we have beetroot, we have cabbages. Kale, you know kale?
94
94 IVAN: Yeah. Kales a friend of the bees.
95
95 EDWARD: Yes, while I was harvesting. So it could have been the fact that I started while it was busy with its pollination.
96
96 EDWARD: And then.. ya there’s a whole lot of vegetables there but then we still have more seeds to plant, then we still have seedling like Chinese spinach, its seedlings are already here. We’ve been transplanting them during the week. Then we have seedling of this. whats this… Tape, uh, ama. Is it amarenthus?
97
97 IVAN: Yeah, yeah.
98
98 EDWARD: Ya tape. Its amarenthus, we also have that but its only seedlings.
99
100 IVAN: And is it all open, or do you use tunnels?
101
101 EDWARD: Its open. We don’t have tunnels. We don’t have because uh, we haven’t done anything like a proposal or I haven’t asked any department for anything.
102
102 IVAN: Okay.
103
103 EDWARD: So we only got a certificate in may but we registered last year, so the certificate came late. Uh so I think that but I think we can have…
104
104 EDWARD: Ya kale. We have lettuce, but not the commander lettuce. This one other it looks like a butter lettuce.
105
105 IVAN: Okay.
106
106 EDWARD: Ya but its another one, there are three types of lettuce.
107
107 IVAN: Oh?
108
108 EDWARD: Yes, while I was harvesting. So it could have been the fact that I started while it was busy with its pollination.
109
109 EDWARD: Ya, cause we only started last year in August and so far we have Chinese spinach, we have spring onions, we have got strawberries, uhh we have Swiss chard spinach, we have beetroot, we have cabbages. Kale, you know kale?
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117
117 EDWARD: So we only got a certificate in may but we registered last year, so the certificate came late. Uh so I think that but I think we can have…
118
118 IVAN: But it’s in the plans?
119
119 EDWARD: Ya, but now we have that certificate we’ve also done a basic clearance. We also want to do a whole lot of things like our business plan, a proper one you know and do a funding proposal that’s proper. Because we don’t wanna try something and then fail because we didn’t do things the right way.
EDWARD: Um.

IVAN: Yeah.

IVAN: It’s the same for bees. You have to get a certificate for the hive and the person that manages the hive.

EDWARD: Alright.

IVAN: But it’s easy and it’s free. It’s just to run and organise it.

EDWARD: Okay it’s not like, it’s not like the fishing one.

IVAN: No.

EDWARD: Because the fishing one I know it’s expensive.

IVAN: No this is free. It’s just to keep track of where all the bees are.

EDWARD: Okay.

IVAN: Um, so you would be interested in keeping bees?

EDWARD: Yes we are, we are interested because as we were listening to your, uh, to your, eh, delivery there, you know your, uh.

IVAN: Presentation.

EDWARD: Yeah. Presentation, I’m sorry. Uh, we were speaking amongst ourselves that we really need bees there because, uh most of our plants may not have flowers but those which have, they need pollination.

IVAN: Yeah.

EDWARD: And with bees we’ve seen that this Chinese spinach is growing very well since the bees have been around.

IVAN: Yeah.

EDWARD: Um.
EDWARD: Yes the supports.

IVAN: Okay, so you’re using wood and...

EDWARD: Wood and this wires that you hang your clothes on, we just combine them.

IVAN: Oh clothes hangers. And the materials you find?

EDWARD: Ya some of it we find in the streets, some of it we ask from those guys who sell veges.

IVAN: Okay.

EDWARD: Ya, and then some of them we take from those guys who do constructions on the road. Because they also have nets that they keep on the streets.

IVAN: Yeah, yeah, yeah. Okay so it’s whatever you can find?

EDWARD: It makes sense ya.

EDWARD: Ya whatever we can find cause with this cash we have now we don’t wanna use it for anything on the farm until we have the proper papers and know how to keep your invoices and stuff like that, bookkeeping as well.

IVAN: Alright, um, let me just make sure I’ve asked all the questions I needed to. Oh um, is there, is the farm quite secure? Like in terms of crime? And people stealing plants?

EDWARD: Ya I would say its secure because it has a fence and its, it’s, it’s a fence like that one (points to palisade fencing) but it’s huge, it’s like, it’s high up, so it’s about this size (indicates a 2.5m height) uh, its in a school yard so there are securities there at the school and at night and at day security.

IVAN: Ya even in winter.

IVAN: So you said we would skip those days but then go on weekends you know, if it’s okay.

EDWARD: Alright, um, let me just make sure I’ve asked all the questions I needed to. Oh um, is there, is the farm quite secure? Like in terms of crime? And people stealing plants?

IVAN: Alright.

EDWARD: Yeah, ok.

EDWARD: Oh they are?

EDWARD: Ya, we only used them on kale, because of those Aphids, you know Aphids?

IVAN: Okay.

EDWARD: We are working on the farm full time. Even though we don’t go there everyday. But we try to make it five days a week at least, even on weekends.

IVAN: So you’re working on the farm full time?

IVAN: Ya so we would skip those days but then go on weekends you know, if it’s okay.

IVAN: Okay.

IVAN: Okay.

IVAN: Okay.

IVAN: Okay. Alright, so you say there’s seven of you? There’s one he’s coming. It’s four guys and three ladies. Ya.

IVAN: Okay.

EDWARD: It started off with ten, but these three other guys got jobs somewhere else. The other one got a job at school, an administrator there, and the other one just got a job in, at retail stores you know.

And then we asked them ‘are they going to come back?’ And they didn’t so we asked them to give us their resignation letters so that we can aim to move on.

IVAN: Okay.

EDWARD: Because it’s hard to get fundings while people are appearing on the certificate, but they’re not there.

IVAN: They’re not there full time.

EDWARD: When they gave you that funding they have to get sure of that.

IVAN: So, so, you’re working on the farm full time?

EDWARD: Everything else is organic. The compost is organic, the manure is organic.

IVAN: The cigarette buts are for the nicotine?

EDWARD: Ya, we only used them on kale, because of those Aphids?

IVAN: Okay.

IVAN: Okay.

IVAN: Okay. Alright, so you say there’s seven of you?

IVAN: Okay?

EDWARD: Ya because we only used it once and only on one bay just to try it out, so we started to see its not that much effective, or we didn’t use it well, but whatever we’ve been using now its organic.

IVAN: Yeah.

IVAN: Okay.

EDWARD: Okay.

EDWARD: That we can use. Ya

IVAN: Garlic and onions. Okay.

EDWARD: That’s why I think it’s more important for people that are doing organic farming and permaculture to, to be the ones that are getting bees. Whereas the big farms are the problem at the moment.

IVAN: That’s why I think it’s more important for people that are doing organic farming and permaculture to, to be the ones that are getting bees. Whereas the big farms are the problem at the moment.

IVAN: Oh they are?

EDWARD: Yes.

IVAN: Okay.

EDWARD: Not using pesticides?

IVAN: Okay. But, your own, your own, your own recipe.

EDWARD: Uh, pesticides yes, we maybe, we started to maybe use a cigarette buts, cigarette buts, ya and whatts it, dishwashing liquid.

IVAN: Alright, um so going forward uh, I’m gonna use these interviews to um, to evaluate how I’m going to design the, the beehive, to make it more usable, or more appropriate for the farmers in Joburg. But then um, so I’ll, I’ll come up with a few designs and then I’ll need to show them to the people that I’ve interviewed so I’ll contact you and then probably we can make a meeting time, or maybe I could come to

the farm and interview you all together and then I could get input from everyone.

EDWARD: Yeah, exactly. We also, it also will be visible to you that what kind of environment is it for the bees, you will know what we’re talking about.

IVAN: Okay. Okay. Ya that’s enough for the interview.

EDWARD: Yes the supports.
IVAN: They were giving out bees to farmers here?

HERBERT: When I gave up my job and the opportunity when the department of agriculture was giving out bees. Because I didn’t have, uh, a, uh space, a confined space so I was, uh, lost out.

IVAN: Okay, and do you know anything about the, the honeycomb?


IVAN: Okay.

HERBERT: So for you it’s more the interest then it’s the, trying to get more crops, more crop yield, or would you say it’s both? You want to make, make some more money as well?

IVAN: Okay.

HERBERT: He took the bees away.

IVAN: I did the inspection of the, the frames. Ya.

HERBERT: Passion, that’s what I’m saying.

IVAN: Okay.

HERBERT: Once you have passion then you can look after that.

IVAN: And you’re not afraid of bees?

HERBERT: No, no, no.

IVAN: Okay.

HERBERT: He took the bees away.

IVAN: Okay.

HERBERT: For instance the current job that I’m doing becomes money making, uh, route measuring and I’m one of the third, you know, highly qualified in the South Africa. So by, by, by learning and, you know, it brings more of attention to, to the project and eventually grow, grow, grow until we make money.

IVAN: But you have to be passionate about it is what you’re saying?

HERBERT: Yes.

IVAN: Alright, and, and, um, your farm, you would want to keep the bees on your farm that you have now?

HERBERT: Ya.

IVAN: Alright, and, so, um, your farm, you would want to keep the bees on your farm that you have now?

HERBERT: Totally, I think I want to keep that.

HERBERT: And then till if there, you know, you know you are able to cope with that, you can look at the place and, and you can have more.

IVAN: Get more.

HERBERT: More ya.

IVAN: Okay, so you wanna grow it into a, a big business.

HERBERT: Yes, sort of keeping that I want to grow it to, uh, to a, a bigger business per say.

IVAN: Okay.

HERBERT: Ya.

IVAN: And do you have access to materials or machinery and tools?

HERBERT: Yes, I think we have access to that.

IVAN: Through the agricultural research and?

HERBERT: I think through the, the, the, uh experiences and expertise or contacts.

HERBERT: Ya. We can be able to access those.
Appendix E
UF04

Transcription of interview of Sibongisiwe Mngomezulu (Urban Farmer) by Ivan Brown (Industrial Design Student, UJ).

We met at 13h30 outside the lecture halls during the lunch break. We discussed the reasons for the interview and my research problem. I informed him of the ethics, had him sign a consent form and began recording the conversation. I had just presented my project to the farmers and Edward approached me out of interest in the study.

IVAN: Alright so you’re farming here in Soweto.

SIBONGISIWE: Yes.

IVAN: How big is your farm?

SIBONGISIWE: Um, we are in a school, um, so I think maybe I can say...

IVAN: You’re also in a school.

SIBONGISIWE: One hectare, ya, let me say one hectare, in a school yard.

IVAN: Is it-

SIBONGISIWE: It’s just there’s a space by the other side, its one and a half hectares, ya.

IVAN: Okay, and how many of you, is it just you three that work on the farm? (Points to group).

SIBONGISIWE: For me ya I’m working on a separate project and the brothers also working on a separate project.

IVAN: Okay.

SIBONGISIWE: But I’m also having a, a, a wetland where I’m planting so there’s no fence and stuff, but it’s just near a wetland whereby if it can atleast be fenced then it can...

IVAN: Yeah.

SIBONGISIWE: The beehive can start working there.

IVAN: Ya, cause, um, it needs to be secure so people don’t steal it.

SIBONGISIWE: Yes.

IVAN: Okay, and the, the school is it a primary school?

SIBONGISIWE: Okay the school we’re working at is already closed now, it’s actually used as a sp, a space for projects.

IVAN: Okay.

SIBONGISIWE: For people that working on a garden, carpentry, welding and stuff like that so people hire classes to, to do their projects and then they pay rent to the school.

IVAN: Okay.

SIBONGISIWE: So we also, we’re entered through the garden side, you know like this big community project.

IVAN: Okay.

SIBONGISIWE: Okay, and the, the school is it a primary school?

IVAN: Okay.

SIBONGISIWE: So ya.

IVAN: Okay.

SIBONGISIWE: So ya.

IVAN: Okay.

SIBONGISIWE: So there’s no children, not, not a lot of children?

IVAN: Okay.

SIBONGISIWE: The problem is that there’s no fencing, like on the other part of the school there’s no fencing, so we just have a problem of that. But children they do come because there are still those that have a play-

IVAN: Ya.

SIBONGISIWE: You know like, a playing-

IVAN: A jungle gym.

SIBONGISIWE: Play area, like that, so children do come and they play around.

SIBONGISIWE: For people that working on a garden, carpentry, welding and stuff like that so people hire classes to, to do their projects and then they pay rent to the school.

IVAN: Okay?

SIBONGISIWE: To grow. Ya and, and, and-

IVAN: Okay.

SIBONGISIWE: And sell it also.

IVAN: Alright, and what kind of foods do you grow on the farm?

SIBONGISIWE: So far we have vegetables, uh, we have spinach, cabbage, onions, lettuce and stuff like that. And I was just saying inside that we also growing avocado trees you know like-

IVAN: Ya.

SIBONGISIWE: Ya, so we just need space, a protected space where we can planting them and have an orchard whereby we know that our trees are growing somewhere.

IVAN: Okay.

SIBONGISIWE: We’re looking for, for, for a proper place.

IVAN: Okay.

SIBONGISIWE: Yes, for planting those trees.

IVAN: Okay, and then you want to incorporate the bees into that hopefully?Into that project?

SIBONGISIWE: Ya, well I think it’s different projects.

IVAN: Yeah.

SIBONGISIWE: I would say, you know, but since we have already said that they also need plants-

IVAN: Yeah.

SIBONGISIWE: what grow around there. I think ya it can work together.

IVAN: And avocados are a big one for the bees.

SIBONGISIWE: Serious?

IVAN: Ya, its avocados and almonds. Are good, good trees.

SIBONGISIWE: So we’re not, we’re not, I think they can work together also.

IVAN: Okay. And, um, at the, the community centre are resources like tools and materilas.

SIBONGISIWE: Yes, we’re working with the department of agriculture there so they have already provided tools like rakes and shovels and stuff like that.

IVAN: Okay. And, um, at the, the community centre are resources like tools and materilas.

SIBONGISIWE: Alright, and what kind of foods do you grow on the farm?

IVAN: Okay. And, um, at the, the community centre are resources like tools and materilas.

SIBONGISIWE: Alright, and what kind of foods do you grow on the farm?

IVAN: Okay. And, um, at the, the community centre are resources like tools and materilas.

SIBONGISIWE: Serious?

IVAN: Alright, okay, and you, let me just check my questions. Okay I think that’s fine for now.

Transcript 004: Sibongisiwe
IVAN: Fly over. whereby the bees will just—heard you speaking about it. You create a wall we have kids. It’s a primary school so we, are, are the bees going to bee a problem because we school. So we want to know whether the bees are, we have currently now is, a back space behind a farm? Are there… THEMBA: Shall I start from the beginning? THEMBA: Ya (laughs). IVAN: 1852. THEMBA: Ya, so, ya. IVAN: Okay so it’s about five meters. Alright, and the children, do they use that area as well? THEMBA: They normally don’t come that side, but you know how kids are. IVAN: Yeah. THEMBA: Cause even, cause even now most of the times, cause on Monday, Wednesday and sometimes even on Friday we invite kids to come and assist us. IVAN: Yeah? THEMBA: On how to build it. IVAN: Yeah, but it’s, it can be a lot simpler. THEMBA: But you can make it simpler. IVAN: Yeah, so that’s the goal and cheaper. THEMBA: (laughs) Ya. IVAN: Cause those hives are thousands of rands and, so, so the farm you have, um how big is it? 

Appendix E UF05
IVAN: Okay, and then on the other sides of the fences are there other houses and things? And buildings?

THEMBA: There’s another school that side, but there’s maybe we can say fifteen or twenty meters wide and then after the school there’s a, there’s a gate and then houses are not that far from the school but I don’t think that will be a problem because, because you said that if maybe the bees can go and farm, farm, farm then they can come back there.

IVAN: Yeah.

THEMBA: So I don’t think that will be a problem.

IVAN: But it’s, it’s mostly the, the immediate surroundings of the hive, where the bees are flying quite low and then afterwards they fly quite...

IVAN: Do you also have, whatsapp, cause we have, have pictures, I think maybe I can send you pictures tomorrow.

IVAN: Yeah, send me pictures on whatsapp, my numbers on there (points to project information sheet).

THEMBA: We can use those numbers for whatsapp as well?

IVAN: Yeah, yeah my phone number (points to phone number). Um, and then I just wanted to ask uh, so have you ever considered keeping bees before? Before today?

THEMBA: No we’ve never cause, I saw, I saw, I saw a show on, on SABC 1, I think it was hundred percent youth where the lady was keeping bees in, in his farm. That thing. That’s where I got the understanding of how bees live and how they interact with people and plants and stuff. That’s where I think I, I had an idea of how bees live and how I can actually bring them. But I never had a clue of me bringing them to that farm of mine, to that piece of land, I think ya.

IVAN: Okay.

THEMBA: Ya I think that has been an issue for me.
I was referred to Sam and Donovan by another beekeeper. They keep beehives on their property in an intra-urban environment.

We met at 18h00, at Sam and Donovan’s home in Melville. Sam showed me their bee hives while we waited for Donovan to arrive. We discussed the reasons for the interview and my research problem. I informed them of the project details and ethics, reasons for the interview and my research problem. Melville. Sam showed me their bee hives while we

Transcription of interview of Scarlet Dymond and Donovan Dymond (Urban Beekeepers) by Ivan Brown (Industrial Design Student, UJ).

Appendix E

Extract 006: Scarlet & Donovan Dymond
SAM: So we, paying him costs me about 1200 rand every year, just to come and check on the boxes and swap them out and process honey and stuff.

IVAN: Alright, that’s interesting.

DONOVAN: (sits down and groans).

SAM: Ya generally, I’ve gotta buy all that gear and store it you know, which is a pain.

IVAN: Ya. For the processing and the spinners are very expensive or not?

DONOVAN: Yes.

IVAN: Ya. For the processing and the spinners are very expensive or not?

SAM: Uh stray bees ya (laughs). Cause a swarm like, mean swarms.

IVAN: OK.

DONOVAN: Ya it must be in a sealed room.

DONOVAN: Old engine oil.

DONOVAN: Oil.

IVAN: Alright, and you don’t find the ants kind of making bridges across it?

DONOVAN: And I tell you, when I first put the oil in it was like, the ants used to, you know they were going in and out of the hive all the time and on that like square ring the, the, the oil, the well for the oil. I mean they were standing on their back legs.

DONOVAN: It really messes them up.

DONOVAN: It was like really quite a weird scene hey.

DONOVAN: We put the stand underneath with the um, well in the um, centre to stop ants. Cause the ants are really a big problem.

IVAN: Herding them, ya.

DONOVAN: And I tell you, when I first put the oil in you know.

DONOVAN: Ya but that, if it rains the stuff goes away first time since you put that oil in you know.

DONOVAN: It was like really quite a weird scene hey.

IVAN: Alright, that’s interesting.

DONOVAN: So the bugs then couldn’t fly and got stuck in the oil and eventually it was enough for a bridge for the ants, ya.

IVAN: The ants could walk across the bugs.

DONOVAN: Ya I see that there’s, but I must top it up though.

IVAN: And then of course we didn’t have old engine oil in and sort of irrigated it. You know. Sort of flooded it.

DONOVAN: So I just sort of put old engine oil in and sort of irrigated it. You know. Sort of flooded it.

IVAN: Herding them, ya.

DONOVAN: Ya but that, if it rains the stuff goes away first time since you put that oil in you know.

DONOVAN: So I just sort of put old engine oil in and sort of irrigated it. You know. Sort of flooded it.

DONOVAN: I did that about a year ago and it looks terrible.

DONOVAN: Ya they just steal all their honey and that’s terrible.

DONOVAN: Old engine oil.

DONOVAN: Oil.

DONOVAN: Ya they just steal all their honey and that’s terrible.

DONOVAN: Yo. And how often do you have to replace it, or do you ever?

DONOVAN: Ya it must be in a sealed room. Dirty old engine oil.

DONOVAN: The ants could walk across the bugs.

DONOVAN: Ya they just steal all their honey and that’s terrible.

IVAN: Yeah?

DONOVAN: So I put in a cup full yesterday just to um stop them, so I’ll top it um again tomorrow.

DONOVAN: Old engine oil.

DONOVAN: With the engine oil. Dirty old engine oil.

DONOVAN: Alright.

DONOVAN: Ya. We, otherwise you just put that ant poison powder, which is not wonderful.

DONOVAN: Yes. Ya, the powder that I saw around the hives.

DONOVAN: Ya but that, if it rains the stuff goes away and the ants, and the ants are very gung-ho for honey hey.

DONOVAN: Ya I see that there’s, but I must top it up though.

DONOVAN: Ya they just steal all their honey and that’s terrible.

DONOVAN: Old engine oil.

DONOVAN: Old engine oil.

DONOVAN: Old engine oil.

DONOVAN: With the engine oil. Dirty old engine oil.

DONOVAN: With the engine oil. Dirty old engine oil.

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DONOVAN: With the engine oil. Dirty old engine oil.

DONOVAN: With the engine oil. Dirty old engine oil.
Appendix E

BK01

Transcript 006: Scarlet & Donovan Dymond

266 made a bridge across with other dead ants, walking
267 across their fallen friends.

268 DONOVAN: They, I tell you they if you had seen the
269 ants in the oil.

270 SAM: Oh god it was ridiculous.

271 DONOVAN: It was like a scene out of lord of the rings,
272 really hectic hey. Ya.

273 IVAN: Okay, um have you ever tried any othe hives
274 or is it you’ve always used the Langstroth.

275 SAM: I use that one because Stuart works with
276 Manfred who, who is, is he Austrian?

277 DONOVAN: Yes.

278 SAM: He’s been keeping bees for a million years and
279 that’s his hive, standard hive.

280 IVAN: Okay.

281 SAM: And he’s the guy who supplies me with the
282 supers and brood boxes and frames and whatever so
283 it doesn’t make sense to try a different um, size.

284 IVAN: Okay, alright um.

285 DONOVAN: There’s a bee meeting tonight isn’t there?
286


288 DONOVAN: Is it tomorrow night in Bryanston?

289 SAM: Ya. Look on that thing it’s the Bryanston
290 Country Club.

291 DONOVAN: Bryanston Sports Club.

292 SAM: Is it the Sports Club?

293 DONOVAN: Ya.

294 SAM: It’s the Country Club. They sport there, they
295 play tennis and drink, yeah.

296 DONOVAN: Oh ok I thought it was just the Bryanston
297 Sports Club. Ya it’s quite, it’s interesting to go cause
298 you know you’ve got guys that have got like 700 hives
299 you know they, they, it’s a business.

300 IVAN: Yeah.

301 DONOVAN: And they scoop what is it, about eight
302 tons a year?

303 SAM: Ya it’s crazy.

304 DONOVAN: Or what is Keagan getting? Is it about 10,
305 11 tons of honey a year.

306 IVAN: Shees.

307 DONOVAN: But that is like 700 hives hey. Um, it’s a
308 lot of work I mean they’re-

309 IVAN: Yeah, they’re, they’re uh, migratory
310 beekeepers, where they move around, take, take
311 their hives to the, the farms.

312 DONOVAN: Well not, they’ve got generally areas
313 where they keep them and then you know they will
314 also do the pollination thing, so they will actually
315 take a whole lot of them. But I think the majority of
316 their hives are sort of all over the place. And then
317 you expose yourself to a hell of a lot of problems,
318 badgers and theft.

319 IVAN: Okay, cause.

320 DONOVAN: Cause where hives used to be painted
321 white, because the bees like white hives, they now
322 paint them brown and whatever because the Af’s
323 (Africans) see them in the veld and they see the
324 white hives and they go and they just smash the
325 hives and take the honey.

326 IVAN: Take the honey. Ya.

327 DONOVAN: It’s like such a fruitless exercise.

328 IVAN: So they’re camouflaging them to-

329 DONOVAN: So there’s a lot of theft. Big, big problem.

330 SAM: Ya, in KZN you can’t have hives anymore
331 because they just get stolen.

332 DONOVAN: Ya there’s that couple that had 37 hives
333 or something, old, elderly, you know old couple.

333 SAM: Not like us (laughs).

334 DONOVAN: (laughs) not like us, older and they got
335 held up and mugged and the people stole their hives,
336 they had 37 hives.

337 IVAN: They got held up for their hives? Shees.

338 DONOVAN: Ya, the people got robbed and they took
339 all the hives.

340 IVAN: That’s crazy.

341 DONOVAN: And I think you’ll see more, you know,
342 it’s like cars and hijacking, I think you’ll see more,
343 you know as the wonderful economy of this country
344 goes down it’ll be a bigger problem you know.

345 Especially with the guys that have got you know,
346 here having two hives in the back yard, fine. But you
347 know anybody, like let’s say you’ve got a small
348 holding and you know, because you want to keep it
349 out of the way you generally got your hives sort of
350 the other end of you ten acre plot or whatever. But
351 they all you know whatever they good people.

352 DONOVAN: But that is like 700 hives hey. Um, it’s a
353 lot of work I mean they’re-

354 IVAN: Yeah.

355 DONOVAN: And I think you’ll see more, you know,
356 it’s like cars and hijacking, I think you’ll see more,
357 you know as the wonderful economy of this country
358 goes down it’ll be a bigger problem you know.

359 IVAN: That’s crazy.

360 DONOVAN: It’s lousy but you know and then they,
361 they just smash them that’s the thing.

362 DONOVAN: And I think you’ll see more, you know,
363 it’s like cars and hijacking, I think you’ll see more,
364 you know as the wonderful economy of this country
365 goes down it’ll be a bigger problem you know.

366 DONOVAN: Generally it’s just smash the honey, smash the hives
367 grab the honey and run. You know.

368 IVAN: Ya.

369 DONOVAN: What a mess.

370 IVAN: Shees it’s terrible. Um, I must ask, do you have
371 any other friends in Johannesburg that keep hives,
372 in kind of their back yards?

373 SAM: Ya only people I know from the bee club, like
374 Manfreds got like twenty.

374 DONOVAN: Ya, or what’s his name down the road
375 here.

376 DONOVAN: Ya, or what’s his name down the road
377 here.

378 DONOVAN: His bee hotel man.

379 SAM: Oh Paul.

380 DONOVAN: Paul.

381 SAM: Pauls bee hotel. His got, oh he must have.

382 DONOVAN: Ya his got hives in his hotel, ya. So his in
383 his back yard got hives.

384 IVAN: And it’s a hotel?

385 DONOVAN: No, he’s got, cause he built a fancy thing
386 for his hives you know.

387 IVAN: Okay.

388 SAM: His the joke of the bee community.

389 DONOVAN: They Joke about Pauls Bee Hotel.

390 IVAN: Oh a luxury apiary.

391 SAM: Well he built a cement plinth, cause of the
392 ants, and then he put poles with a sh, uh, tin roof.

392 DONOVAN: Ya a proper roof on it.

393 DONOVAN: Ya cause they quite inventive the bee people,
394 they always coming up with gadgets and things.
IVAN: Ya it’s fascinating.

DONOVAN: Um, and if people don’t keep bees where do the bees go? You know, the bees what will only fly two and a half k’s or three and a half k’s.

SAM: Um, they can go, ya a couple of k’s.

DONOVAN: Like they’ll go further for water.

SAM: But there, I mean there’ve been a lot of projects on um, developing like yours, like yours you know, maybe not in an urban environment but there’ve been a few ventures in the past. And then they all seem to fizzle out and I’m not quite sure why.

IVAN: Where there’s quite a big r, space.

DONOVAN: Ya, so, the bees you know they, they haven’t got any, they not structured so they get into people’s rooves, they get into the top of robot poles (traffic lights) you know they’re there with everything else and it’s a hiding to nowhere because uh, the honeys not harvested and at the end of the day the landlord or whoever just says poison them, you know, kill the bees.

DONOVAN: Ya, so, and uh, I, I, I’m not sure what the public opinion is but I mean certainly from being part of the bee thing, you know it’s not a dangerous thing to do providing you’ve got a little bit of, you know kind of...

IVAN: Knowledge about it.

DONOVAN: Cause they get smoked out and poisoned and whatever-

IVAN: Ya.

DONOVAN: So, and uh, I, I, I’m not sure what the public opinion is but I mean certainly from being part of the bee thing, you know it’s not a dangerous thing to do providing you’ve got a little bit of, you know kind of...

IVAN: Knowledge about it.

DONOVAN: Ya, you can stop swarming. I mean there, there conditions that make the bees swarm.

IVAN: Ya.

DONOVAN: And if you don’t allow those conditions to occur then it’s fine.

IVAN: Yeah, so you would say that’s one of the most important things, is preventing the swarming.

SAM: Yeah, bee management, ya I’d say.

DONOVAN: Cause they’re not dangerous, I mean.

SAM: They’re flipping dangerous man, what do you mean they’re not dangerous?

DONOVAN: Well because they’re everywhere to start off with so instead them being in a, in a telephone pole and then a car hits the telephone pole you know then you’ve got a swarm of bees all over the place and you know you’ve got a problem. You know, if you’ve got a hive uh, and it’s maintained or whatever then you know that’s the way to go surely.

DONOVAN: And that’s not necessary. And a lot of the swarming bees are, are bees that are, I would say, I don’t know you probably know more but if there’s a swarm, they don’t, it’s not generally a hive that’s swarming, it’s probably a wild-

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IVAN: Mhm.
SAM: They, when they tryna swarm they, they not in.
DONOVAN: I mean and it’s, it’s just this black mass
just came over the house, this swarm ya. And I was
outside and they were, there’s a couple of things
about it. When, when you’re inside a storm it’s really
hot ok. The bees make a lot of heat. It’s hot and the
second thing is when you’re in, I mean when you
can’t see it’s just black. It’s noisy, I mean it’s really
like a Jumbo jet next to you hey. And uh, I just stood
still I mean I thought ya let me, what else can you
do?

IVAN: Wow.
DONOVAN: And I just stood still because they decide
to attack you-

IVAN: Jump into a swimming pool.

DONOVAN: And I just stood still because they decide
to attack you-

DONOVAN: No.
DONOVAN: Don’t jump into water. Um, you know
you’re a goner, so I just stood still and closed my
eyes. And the heat and the noise, I mean they were,
It was just this mass hey! And then they were like
waaaarmm, and then they went over the house
mniyaawm, and then they came around and over the
tree woraaaamm. It was massive! And then a
few, it was gone and it disappeared.

IVAN: And you didn’t get stung?

DONOVAN: And I didn’t get stung at all, ya.

IVAN: Wow.

DONOVAN: And they were taking honey out (points
at SAM), and a bee came and buzzed me and then I
ran away and I was waving my arms, fuck that bee
naked me.

SAM: (laughs).

DONOVAN: You don’t wave your arms.

SAM: They, when they tryna swarm they, they not in
attack mode, it’s just when you disturb them they
get really cross.

DONOVAN: very pungent, sweet smell, and the bees
go absolutely berserk for them. I mean they, you
can, it’s so bad you can hardly see the cactus you
know. And I’m talking about you know, not a little
thing in a pot plant. But I’m talking about a big fully
grown-

DONOVAN: Big fully grown one, ya. And they will,
and I mean they just love it, they just... ya. It was
just behind the house we had once and the fucken
tenants chopped it down because the bees cam, you
know, agh.

SAM: (laughs)

DONOVAN: And it takes that pour thing about-

IVAN: Twenty year old cactus...

DONOVAN: Ya about sixty years for it to grow that
size.

IVAN: Shees

DONOVAN: And I mean when it flowers it’s a
magnificent thing, you know, but people destroy it.
You know, oh-wa-wa bees, cut it down! It uh ya I
supposed education is the thing really. I mean bees
are a great thing, you know, because you know all
the, the, first of all in the, the good old days honey
had four different grades, you had whatever, and
your choice grade was really good pure tested honey,
everything. Hell then due to change of government
they decided no all our honeys fantastic, there just
can only be one grade of honey and that’s called
choice grade honey. So they import honey which is
sugar water with the essence of like two drops of
essence of honey in it. I mean it’s so bad that, that,
that some honeys have only got like seven percent
of honey in it. It’s all choice grade.

DONOVAN: But it’s the, the price of it’s too competitive
for our honey that we produce here-

DONOVAN: Ya.

SAM: Here god we had this gardener. Shame!

DONOVAN: And within ten seconds they get stung you
know.

DONOVAN: Ya but he was standing there waving his arms,
and saying ‘the bees are attacking me’. I said ‘ya,
stop do, just walk away and if you do this (waving
DONOVAN: Really, it’s more like a tornado.

DONOVAN: I mean and it’s, it’s just this black mass
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sugar water with the essence of like two drops of
essence of honey in it. I mean it’s so bad that, that,
that some honeys have only got like seven percent
of honey in it. It’s all choice grade.
DONOVAN: It’s easy to see cause the bee hives always get a couple of guard bees around, and when you get up close and ‘mrrrrmmm’ one will come and check you out a bit and carry on sort of pretending that he’s sort of not really interested I you. And then, well, so you read the signs you see one has kind of like picked up on me and his seen me, you know and you kind of like stand there. But if you get closer you might notice like you know it comes again and gets a little bit more in your face and then goes away. You know so when you, you should read, if you see what’s going on, and be in tune with it’s easy not to get stung, it’s actually difficult to actually get stung after a while, you know you actually have to kind of go looking for it.

DONOVAN: While we talking about bees.

IVAN: Alright I’ll, I’ll maybe call him and tell him I’ll be there.

DONOVAN: Ya, it’s five meter from the wall and twenty-five meters from a uh, building. So we got lucky, they were in a corner and, and bee business in New Zealand.

DONOVAN: And he went, him and Hans had the 700 hives and were doing that sort of 11 tons per year and stuff.

SAM: I’ll give you his phone number.

DONOVAN: And he’s a main bee guy, he’s got bee paraphernalia.

DONOVAN: Ya I think he’s the, the, the treasurer of the Southerns Bee Association.

DONOVAN: Ya something like that. You’ll meet him tomorrow.

DONOVAN: Ya no their all very involved.

DONOVAN: We once (laughs) at the old house which was a huge two acre property next doors a mirror image and they built Tuscan mansions double story. And one day the neighbour-

DONOVAN: Oh the electrician.

SAM: We need to feed them?

IVAN: Do you ever have problems with like the amount of food available for the bees, do you ever-

SAM: Ok, yes so obviously we abide by that, but I mean I’m quite nervous, like we operate with must keep your bees.

SAM: No, but I mean ya.

DONOVAN: Bryanston was lush-

DONOVAN: She’s five meter high. We even had Telkom coming one day with the high. We even had Telkom coming one day with the

DONOVAN: Ya I think he’s the, the, the treasurer of the Southerns Bee Association.

DONOVAN: Okay.

DONOVAN: And he went, him and Hans had the 700 hives and were doing that sort of 11 tons per year and stuff.

DONOVAN: Yeah a he’s, he’s quite, ya he used to be with, there’s a guy called Keagan and he got offered a position in New Zealand to do major bee work, and, and bee business in New Zealand.

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DONOVAN: you’ve got all of the, what do you call it, herbaceous borders around, so hey we got really nice honey, beautiful clear, very clear.

SAM: Tons.

DONOVAN: Beautiful honey. Lots of it. And I think from the move, cause we’ve only taken once here. They weren’t, we got very little so we didn’t take out before winter, we thought they needed it.

SAM: I’ll send you the picture.

DONOVAN: You know cause a lot of the farmers, bee farmers, they will take all the honey and then give like a coca-cola bottle with a hole in it, sugar water for the bees for winter, oh no, that’s not the way to go.

IVAN: Not so cool.

DONOVAN: Ya that’s not so cool. You know so we didn’t think there would be a lot of honey so we didn’t take it.

IVAN: Ya.

DONOVAN: Rather let them get through winter.

IVAN: And get used to the area.

DONOVAN: Get through the cold and then see if we get a decent crop. I mean you know they...

IVAN: Alright.

SAM: Ya that one hive nearly died. Remember?

DONOVAN: Mhm.

IVAN: After the move? (Bryanston to Melville)

SAM: Ya, it didn’t like the move.

End of interview 34:12.
Saturday 8th August
2 92 7th Avenue, Weltervreden Park.
3 Transcription of interview of Tom Cain (Beekeeper)
4 by Ivan Brown (Industrial Design Student, UJ).
5 We met at 18h00, at Tom’s house in Weltervreden Park. We discussed the reasons for the interview and my research problem. I informed him of the ethics, had him sign a consent form and began recording the conversation.

TOM: Uh, it’s the same throughout the world. Same here, same in the states. Slightly different in the UK, so it, it’s gonna be difficult to introduce something radically different from what’s already in use.

IVAN: Yeah.

TOM: I thought... they never used it but it was just research I think.

IVAN: For an article?

TOM: Mmm, well they asked and I gave them some information um, it was for an article that’s about... beekeeping rules basically.

IVAN: OK.

TOM: Oh I have to sign this, have you got, can I use your pen (consent form).

IVAN: Yeah.

TOM: (clears throat). Uh, I’ve done quite a lot of radio interviews, with ten different radio stations and two or three TV things, I’ve got a disk with the TV interview.

IVAN: Recently or...?

TOM: Well it was about three years ago.

IVAN: Okay. There’s quite a lot of interest in beekeeping at the moment, in terms of the problems that are affecting the bees worldwide.

TOM: Um, well ya um, me I sign here?

IVAN: Ya, and...

TOM: It’s the seventh today isn’t it?

IVAN: Ya, 8th sorry.

TOM: OK.

IVAN: Uh, that’s anonymity, it’s only if you don’t want your name...

TOM: Uh I don’t mind.

Appendix E

BK02

Transcript 007: Tom Cain
TOM: Well most of my hives are on my own sites.

IVAN: Okay.

TOM: But I have about four which are at, single hives in other people’s gardens.

IVAN: In and around town here?

TOM: In and around town, suburban hives but uh, ya like Old Ed’s, ya various places. Usually with big gardens not, not, you can’t keep bees in high dense, densely populated townhouse situations.

IVAN: Yeah.

TOM: Well you can but it’s a bit risky, but I wouldn’t like to.

IVAN: Just to people and, and-

TOM: In close proximity, you need space, and bees are like people in many ways cause some people are good tempered and others are bad tempered it’s the same outlook. Some bees can be quite docile but others can be quite aggressive.

IVAN: Mhm.

TOM: And you don’t want aggressive bees where, where people are.

IVAN: And, but even so the ones that you have in town do you uh, try and minimise the, the kind of, when you, when you um inspecting the hives do you try and do it at night?

TOM: Yes, I do it in the middle of the night because the bees are resting then.

IVAN: Okay.

TOM: I can guarantee you the municipality won’t know what the regulations are and will have to look them up. Uh, ya.

IVAN: But that’s mostly for if a neighbour complains on something.

TOM: Ya, suburban beekeeping can work but it also can be problematic. Um and a lot depends on the temper of that particular lot of bees and many times people will not know bees have moved into somewhere on the property, into a cavity or a, some, some space until the gardener goes around cutting the lawn and they don’t like the smell of cut grass (clears throat). It’s not so much that, the high pitched noise that they don’t like either.

IVAN: The frequency-

TOM: I, I’ve had an experience where the guy was cutting grass about a hundred meters away from where I had a beehive, out in Honeydew. And he was cutting the grass with a scythe and it wasn’t making any noise. The bees went for him.

IVAN: Okay, so-

TOM: Ya uh, suburban beekeeping can work but it also can be problematic. Um and a lot depends on the temper of that particular lot of bees and many times people will not know bees have moved into somewhere on the property, into a cavity or a, some, some space until the gardener goes around cutting the lawn and they don’t like the smell of cut grass (clears throat). It’s not so much that, the high pitched noise that they don’t like either.

TOM: Weather, weather permitting. People forget that beekeeping’s a branch of farming and it’s weather dependent.

IVAN: Okay.

TOM: It, it was the smell. It’s the smell of the cut grass, cause instinctively if something, if an animal uh, breaking their way through, through underground uh, there’s, in many cases they will come across a wild bee hive and perhaps trash it, whether it was a bear or whatever it was, depending on what part of the world. The disturbance near the hive where the vegetation is disturbed, you know from the, it gives off a smell then it agitates the bees.

TOM: Okay, so your, the bulk of your hives are those kept out of the city?

IVAN: Okay, so-...
IVAN: In terms of quantities, how much would you say you're getting from the hives?

TOM: Well it varies from year to year, I mean as I've said beekeeping's a branch of farming, it depends on the weather, and the rainfall, and if the flowers of where the bees are working are open you don't need heavy rain every day, you need nice sunny weather, not too windy um, so that the nectar is, is in the flowers and the bees can collect it. So uh, a good, strong hive you should be able to get two supers of honey. A super will hold perhaps twelve kilograms of honey. So two supers, you're looking at getting twenty-five to fifty hives from one hive.

IVAN: Per year?

TOM: Well, per year, that depends. Well honeys now, I sell my honey for R55 a kilo at the present time so it uh, it's a useful income and you can quickly pay for the initial outlay of buying a beehive and more frames and things that you need for the hive, and you gotta have the gear and equipment so you can carry on your beekeeping and-

IVAN: and grow the business.

TOM: Ya well, I mean the, the big guys employ lots of people. People like me with up to fifty hives (R68 000 per year) can manage on their own. But once you go much beyond that you will need help.

IVAN: Okay and then those guys are kind of, usually migratory and move their hives around?

TOM: Ya, I mean virtually all the big commercial beekeepers do migratory beekeeping because they get paid, I mean their income in many cases, I mean they've told me, some of the big guys half their income is from pollination fees.

IVAN: Renting their hives to the farmers?

TOM: Ya, well the farmers are fairly specific when they want the, the hives there. Uh, because that means loading the bees up at the end of the day uh, it's a night job and you may have to drive two or three hundred kilometres from where you've loaded and then you've gotta unload them when you get there which is like at midnight or something like that.

IVAN: 'Kill bee'.

TOM: Killer bees spreading around, because I think in this book it's got a, a diagram of the, how it progressed through South America and they-

IVAN: Yeah, I've got a diagram from last year that shows how it's spread all the way halfway through the United States.

TOM: Yeah so um, well then ya this is what I recommend people to read.

IVAN: Okay.

TOM: And then they progress to the Blue Book which is wonderful. I've got a whole collection of beekeeping books, lots of them of course were related to beekeeping in, in the UK and their quite dated now, cause some of them, a lot of them were written fifteen years or longer ago, most of the authors will be dead (coughs).

IVAN: And would you say the consensus is just that the Langstroth is the ideal hive?

TOM: I don't think anything is ideal, but it's proved to be practical for beekeepers all over the world. Um, and there's been some quite drastic new beehives, this, the people splitting the things and harvesting it without having to spin it but that's very expensive and I can't see, it's a gimmick in a way, it will work but it wouldn't be practical for big commercial farms, I don't think so.

IVAN: Hygienic.

TOM: So in theory light weight, easy to handle-

IVAN: Hygienic.

TOM: Well they don't like plastic hives, I mean there's a guy, in fact I've got to go and see him because his wife bought him this beautiful new plastic hive uh, white thing and it all fitted together and he, they weren't beekeepers and there was a little lot of bees living in the ground and they put the hive next to it and the bees didn't go in and they wondered why, and I said 'well they won't go in, they there, they made their home here, and their not gonna move from there into your hive which has got no wax foundation, nothing in it, doesn't smell like a bee hive'. I said 'no' so I took the bees out and put them into a little nucleus hive, but it was a tiny little small thing, but they absconded, they didn't stay for longer than a day so I've got to go back and see them, now spring is about to, to be here and they will want me to put, what I'm going to do is take an old catch hive, put it where they want the bee hive to be, and when the bees go into my catch hive I can then show them how to transfer it, the bees into that plastic hive. We'll have to get some wax foundation and all that sort of thing. But I, I'm almost, I'll be surprised if the bees make their home happily in this brand new plastic hive. The manufacturers say they're going to make millions of these things and it'll bring prosperity to local communities-

IVAN: But they're expensive...

TOM: I know, they didn't ask, they, they didn't ask the bees 'do they like plastic?' and they don't.

IVAN: Ya.

TOM: Cause I mean a guy came uh, Andy Harding, he showed us the plastic hive about two years ago at the beekeeping meeting, and I asked him about six-months ago 'how are the bees doing in the plastic?'. He says 'they don't like it, they abscond'.

IVAN: Okay.

TOM: So in theory light weight, easy to handle-

TOM: Hygienic, well it's no good if the bees don't like it.

IVAN: Ya, and um, in terms of other hives um, and materials like clay or-

TOM: Well I think any, I mean before, long before the, the Langstroth only discovered the, the, this moveable frame thing and Bee-space, that was the, he, he, his big discovery was the Bee-space.

IVAN: Mhm.

TOM: And that was only like a hundred years ago or something. So the bees for millions of years have
I'm not familiar with the Warre hive.

IVAN: Okay, and the Warre hive, um?

I'm saying.

you can't, you gotta keep it vertical uh, you should

round and it's not easy to do with a top bar hive.

And that and whether there's any problems with the brood.

or the Warre?

TOM: Uh, I’ve, I’ve been and opened Top-Bar hives uh, their very common in rural uh, East-Africa uh, because it’s simple and easy to make um, you can

sort of make one with your own locally obtained materials. So for rural communities that works. Uh, but it, it’s not suit commercial beekeeping because it’s, it’s not, the moveable frame hive, it’s the moveable frame which is the big plus factor, because in Top-Bar hives uh, the bees will fix it to the Top-Bar and they may also fix it to the sides, the sloping sides. But it’s not, it’s more fragile to, to lift out so you gotta keep it nice and straight uh, ten leaves behind a uh, a cocoon. It’s very, very thin, but in time that cell will get smaller. So it’s good practice to replace all the brood frames say every uh, use them for up to four years. But beyond that you should have a routine in the spring time like now, I’ll open my hives, which I haven’t done yet, I’ll do it around the middle of August. Um, and taking out two brood frames and replacing them with new sheets of foundation, or half sheets of foundation, so the bees, it gives the bees something to do and uh, then you have decent quality frames which uh, cause one thing you don’t want is crooked frames, and if you’re, if some new beekeepers they, you should have ten frames in brood trap uh, in a brood box, you only put nine. The spaces are too big and then you’re likely to get the bees building the comb across from one frame to another and that makes the management difficult.

I'm not familiar with that.

IVAN: and you keep adding empty ones at the bottom.

TOM: I'm not familiar with that.

IVAN: Okay um, and have you ever had any experience with other hive designs like the Top-Bar or the Warre?

TOM: Uh I've, I've been and opened Top-Bar hives uh, their very common in rural uh, East-Africa uh, because it’s simple and easy to make um, you can sort of make one with your own locally obtained materials. So for rural communities that works. Uh, but it, it’s not suit commercial beekeeping because it’s, it’s not, the moveable frame hive, it’s the moveable frame which is the big plus factor, because in Top-Bar hives uh, the bees will fix it to the Top-Bar and they may also fix it to the sides, the sloping sides. But it’s not, it’s more fragile to, to lift out so you gotta keep it nice and straight uh, ten leaves behind a uh, a cocoon. It’s very, very thin, but in time that cell will get smaller. So it’s good practice to replace all the brood frames say every uh, use them for up to four years. But beyond that you should have a routine in the spring time like now, I’ll open my hives, which I haven’t done yet, I’ll do it around the middle of August. Um, and taking out two brood frames and replacing them with new sheets of foundation, or half sheets of foundation, so the bees, it gives the bees something to do and uh, then you have decent quality frames which uh, cause one thing you don’t want is crooked frames, and if you’re, if some new beekeepers they, you should have ten frames in brood trap uh, in a brood box, you only put nine. The spaces are too big and then you’re likely to get the bees building the comb across from one frame to another and that makes the management difficult.

IVAN: Okay, and in terms of pests and diseases in this area what would you say are the biggest problems?

TOM: Uh, I, I’m not bothered with pests and diseases in my beekeeping operations, um any beekeepers will tell you that wax-moths are a problem but that really is a, it’s really directly reflecting the management, or mismanagement or storage of your equipment. When you’ve extracted the honey um, in the summer there’s two wax moths, the smaller one and the big one. The bigger one, the larvae of the big one can destroy honey combs very quickly uh, so you um, that’s the biggest problem to me is controlling the h, the storage of your empty supers over winter. It’s alright in the middle of winter cause it’s very cold, and the wax moths aren’t active. Until the temperature drops you’ve gotta be very vigilant in checking, and I use uh, wax moth crystals. Lots of beekeepers do, uh some people may argue that that’s not good for um, the flow of your honey in the following year but it’s been a practice, it’s been going on for over a hundred years and as far as I know it hasn’t had any negative effects on my honey.

IVAN: Okay, and um, I know some people say that it’s just better to harvest the wax as well to avoid that entirely and let the bees reproduce the, the comb the next year.

TOM: Well when you uncap, well when you uh, I wouldn’t agree that to harvest the whole frame, I mean the, they were talking today about uh, a brood frame you should use perhaps for up to four years as long as it’s in good shape. But generations of bees being hatch out of the um, the cell, each one leaves behind a uh, a cocoon. It’s very, very thin, but in time that cell will get smaller. So it’s good practice to replace all the brood frames say every uh, use them for up to four years. But beyond that so you should have a routine in the spring time like now, I’ll open my hives, which I haven’t done yet, I’ll do it around the middle of August. Um, and taking out two brood frames and replacing them with new sheets of foundation, or half sheets of foundation, so the bees, it gives the bees something to do and uh, then you have decent quality frames which uh, cause one thing you don’t want is crooked frames, and if you’re, if some new beekeepers they, you should have ten frames in brood trap uh, in a brood box, you only put nine. The spaces are too big and then you’re likely to get the bees building the comb across from one frame to another and that makes the management difficult.

IVAN: Impossible.

TOM: Difficult. You then have to sort of scrap them and that’s a waste of time and energy on the bees’ behalf. So if you get them nice and straight uh, ten frames in the hive, and keep them straight then it’s much better.

IVAN: Okay.

TOM: I inherited a couple of hives and they were a total disaster cause the guy didn’t know what he was doing. Or maybe his, they may be have been vandalised it may not have been his fault. But there was only about five frames and there’s comb here, there and everywhere and yes there was a colony of bees but it wasn’t manageable. Or not easily manageable and it was a huge problem.

IVAN: Is-

TOM: Cause you don’t want to waste a lot of time, you want to be able to do, look quickly and not spend half an hour trying to sort problems out.

IVAN: Is colony, I mean uh, vandalism and theft a big problem?

TOM: Uh, well it is, that’s the biggest problem, vandalism and theft. Um, so I mean I, I got some hives from a guy that had stopped beekeeping, they were painted white and you’ll see lots of photographs of beeshives painted white but they stick out like a sore thumb.

IVAN: Mmh.

TOM: But I, most of my hives are not painted they, I used to use Crescote but that’s now not in favour, so I use Waxoil or paint the hive, paint the hives either green or brown so they’re not visible at a distance. When some potential vandal, he would see a line of white ones but he probably won’t notice ones that are the same colour as ground, or in winter the brown earth.

IVAN: Yeah, okay so it’s mostly just camouflaged to prevent it?

TOM: Well ya and also you, you put them, if there’s anywhere where you can put them where they were not visible from passing public is the secret. Um, fortunately most of my hives are in, on plots of land which are away from uh, where there’s a lot of people living. SO there isn’t, it’s uh, fairly secure land so I haven’t experienced problems with vandalism myself, only minor issues which haven’t been a problem. They big problem I had was honey badgers. Honey badgers in the Buffelspoort valley, five hives were trashed there last year and all the, there were no bees left. The, the frames were scattered around for about fifty meters away from where the hives were. The bees themselves were okay, but the frames were broken, some of them I could repair, but the bees were gone. So you have to, I’ve now got single pole stands, high up.

IVAN: I think the, it’s more about the system where
there's at least, at least about a meter and a half, I have to take a little ladder because once you start putting supers on you can't reach them from standing on the ground. But you've gotta have a single pole so the honey badger cannot climb up. So it has to be more than a meter off the ground.

IVAN: Yeah.

TOM: So that's what I've done and it seems to work.

IVAN: And um, ants? Do you have a problem with ants?

TOM: I've never had a problem with ants um... Oh I did, on one site, I must tell you about that, on one site which there was a beehive I was looking after for somebody else, there was huge ants, big ants and the hive was on the ground and I went in the spring about three years ago, and when I got there was no bees in the hive and I'll not exaggerate but there was a shovel full of gravel on, in, on the bottom floor of the hive which had been taken in by the ants.

IVAN: Shees.

TOM: No they were big ants, I've actually taken hives back to that same site three months ago and I put, put them on four, the two hives on a four legged stand, and I saw the ants there, big ants, so what I did was I put the legs into tins with oil in, in the tins to stop the ants, hopefully, climbing up into the beehive. But they were on the ground before so they were vulnerable. But hopefully now I've made them secure.

IVAN: The cardboard one?

TOM: Ya the cardboard one. Well that is only short lived thing, it, it's not designed for long term use, but at least it catches bees and then they can-

TOM: It seems like the moat, the moat of oil is a, the um, solution for most people.

IVAN: Yeah, well I think the, the aim, the goal is to make a more accessible hive in terms of cost and usability and to assist in kind of the initial, or beginning stages of beekeeping for these people.

TOM: Ya, well I think think catch hives, well Mike Miles, the guy that was, was there today, he's got um, a cheap one, have you seen it?

IVAN: The cardboard one?

TOM: Oh Eddie, yeah.

TOM: What else can I tell you?

TOM: If you come up with a design that the beekeepers think is great you'll become a millionaire.

IVAN: Well I'm more in it for the bees than the money.

TOM: (laughs) Well ya, it, it's good to know that the uh, people are looking at the beekeeping industry and uh, I mean not only you but other people that come up with these, these new plastic designs. So something should come positive out of it in the long run, so I don't quite know what but uh, nothings perfect and everything can be uh, improved, but I think you've taken on a difficult task. Good, good luck.

TOM showed me his honey processing room and his garage workshop before I left.
Thursday 14th August

To 107 Eerste Laan, Randfontein.

Transcription of interview of Commercial Beekeeper by Ivan Brown (Industrial Design Student, UJ).

I met BK03 (anonymity requested) at the Southern Beekeepers Association meeting and he invited me to come and see his operation. BK03 and his brother have about 3000 beehives in the Low-veld and High-veld areas of Gauteng, the North-west and the Free-state provinces.

We met at 09h00, at BK03’s house. We talked about beekeeping and hives for about 30 minutes before I was given a tour of the workshop and honey processing plant.

BK03: Yeah, good for insulation and things like that, but I think it’s better (speaking about plastic hives).

IVAN: Ya, and a few people have mentioned that um, there’s problems with condensation inside um, plastic hives.

BK03: Various sites-

IVAN: Yeah. Would you say that the diseases and bacteria like that is spread as well from moving their hives around to farms for pollination?

BK03: It can yes, you see what happens is on, on pollination your bees now normally breaks down to a very small swarm, and that swarms can be robbed out. Or what happens is you lose the swarm, you know you, you whatever the reason is and the, the hive gets robbed out. Then the, the feral bees in the other hives and things go into that hive and they rob the-

IVAN: Take the honey.

BK03: They, ya collect the honey and then you can, can either mark it as raw honey or you can sell it to somebody like me.

IVAN: Okay.

BK03: You know the, the one specific guy I spoke to yesterday he’s already destroyed 150 hives and he says himself it’s going to spread because of the system that is used where you go out and you take a hundred or seventy supers off, you extracting, you take it back. So you can, can uh, but it’s up to you what, what you...

IVAN: Yeah. So you’re not swapping-

BK03: But the moment there are three or four or five separate sets so the possibility is there of spreading the disease. I spoke to the beekeepers yesterday in uh, in uh, in the Western Cape uh, some of them have already destroyed quite a few hundred hives.

IVAN: Shees.

BK03: Various sites-

IVAN: Okay.

BK03: The other benefit he will have is he won’t have to move his beehives.

Ed was called away for a moment by one of his staff).

Ivan: Um, ya I’ll just start off with how long you’ve been beekeeping for?

BK03: 35 years.

IVAN: Okay shall we start.

BK03: The other benefit he will have is he won’t have to move his beehives.

IVAN: Okay.

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BK03: The other benefit he will have is he won’t have to move his beehives.

IVAN: Okay.
BK03: No, no, no various sites country, from Tzaneen to Free-state to North-West. You know you need a hell of a lot of place to put the bees.

IVAN: Okay.

BK03: There’s quite a lot here in the Carletonville area if you want to look at that.

IVAN: A lot of your hives here?

BK03: Ya look it’s my hives his just farming it for him, so the 55 that I’m doing now is just to keep busy again. Cause what happened is I’ve sold my business and I got a trade restriction on me so I can’t really sell honey and on small scale I can sell but not, I’m not may not go into the shops and things like that.

IVAN: Okay.

BK03: So uh, that’s why I’ve got time. Okay.

IVAN: So at the moment you’re working on projects for bees?

BK03: Ag just for myself. Specifically yeah, how to uh limit the spread of, of AFB and how to make a beehive more profitable.

IVAN: Okay.

BK03: On small scale. That’s what I’m looking at.

Cause I, myself I just want to, to keep about 200 hives and see what the production can be on that.

IVAN: And do tests on the-

BK03: Ya, what, whatever comes along on that uh, that uh, that I can do on the Varroa’s and on the American Foulbrood and-

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IVAN: Okay.
people that’s got that skills, but they can actually
buy the beehives, and then after that it is just uh, in
the uh, people must endure you know they must uh,
how can, how can I put it. They must continue on
with the thing, because its night work, I don’t work
with the, especially urban beekeeping you can’t
work during the daytime. Its night work and people
don’t like it. It’s just one of those enterprises that
people don’t, the hours is not conducive to social
life, so lose a social life on beekeeping. But
otherwise I don’t have any problems with the people
of understanding the bees and things like that. That
is fairly easy and when it comes down to, to uh,
understand the plants, the seasons of the plants and
things, that is what people don’t understand,
because they don’t understand it’s seasonal.

BK03: They think it is you take honey off all the time
and that’s not like that, it’s seasonal. That is the
biggest thing to, to teach people.

IVAN: Okay.

BK03: For me, that uh, that’s a problem that I had.

IVAN: Okay that’s interesting. Um, and um, the
beehives that you’ve used, do you just use the
Langstroth hive?

BK03: I’ve used a uh, up till now I’ve used the
Langstroth hive, now I’m experimenting with quite a
few things. I use the Top-bar hive, I use the Top-bar
hive with frames, I use it uh, just the hive with just
the, call it maar top bar. I’ll show you there my
brother is making cement hives, so for theft and
things, so, but I prefer to work with uh, with
Langstroths hives. Because it’s, it’s easy, you can
buy it anywhere and it’s a general size and you can
make it yourself it’s not difficult.

IVAN: Standardised?

BK03: It’s standardised, ya.

IVAN: Okay.

BK03: And it works, that is, for me it works, it’s not
uh, that I uh, I’m frustrated with uh, this doesn’t
work and that doesn’t work, it works, it is a good
size for our bees.

IVAN: Okay.

BK03: Okay.

IVAN: The size you’re talking about, the frame size
and the bee-space.

IVAN: Okay.

BK03: It doesn’t work.

IVAN: Part, part of the idea behind it was that you
replacing the brood frames as well to keep
refreshing the, the comb and you, you mentioned
that you, you just replace two or three frames per
year...

BK03: For me uh, there were, there were, easiest
way to work with things is I work from left to right,
I take one of the frames uh, a good frame I put it on
the side and then I put two frames next to it, empty
frames. And then I just work it through all the time.

IVAN: Okay.

BK03: For me it works because I can remember it, I
don’t have to look at every frame and check every
frame and things like that. Obviously you’ll have to
check sometimes for the drone brood cause you
can’t have too much drone brood in your hives and
if you’ve transported hives with uh, watch out for
breakage cause uh, fresh uh, fresh combs normally
break but it’s just your system that you work with.
So every beekeeper will work, he’ll put two in and
where, wherever he puts them in the hive.

IVAN: Upwards?

IVAN: Okay.

BK03: But uh, it makes it, for me the easiest is either
work from left to right or right to left and you know
where you are cause then you just keep on moving
them, the things in and it takes you about a year
maybe eighteen months then all the combs has been
replaced (in the brood).

IVAN: Okay.
BK03: Theft, vandalism, badgers, theft, and your beehives are not really protected because you’re using, because in, in uh, urban beekeeping you can maybe secure it but in rural beekeeping it is very difficult cause you use this site and you use that site and you use that site.

IVAN: Yeah, there’s not much protection on a farm cause the guy gets a gate and he drives in and he gets his beehives. But you’re looking at urban so ten beehives I can see the benefit of a uh, a uh, queen excluders.

BK03: It will be easier, but theft and vandalism will be your, will be you biggest problems.

IVAN: Alright. Um, ya um, so are there other, any other modifications that you use to prevent pests and diseases?

BK03: And they, and they break your hives, that is the problem it’s not only, they’re really damaged.

IVAN: Alright, um, a lot of people have mentioned that theft is quite a big problem, and vandalism?

BK03: Normally the bees are destroyed (becoming quite upset) I would say eighty percent of the time your bees are destroyed because they got no respect, they break the combs, they break it, they take it away, they leave the hive open, all that type of things. So, eighty percent of the time you’ll lose your hives. But once again my brother is doing a concrete hives, so he’s hoping to, that that’ll solve his problems. You can have a look at that.

BK03: If, if you’re available I’ll come back.

IVAN: Alright.

BK03: To that problem.

IVAN: Alright.

BK03: Okay ya, that’s quick. Okay.

IVAN: Okay, um, next stage is just I’m compiling all the research and I’ll start doing concept development, and then once I have a few refined concepts then I’ll probably, if, if you’re available I’ll come back.

BK03: Mhm.

IVAN: Alright.

BK03: Alright. Um, so next stage is just I’m compiling all the research and I’ll start doing concept development, and then once I have a few refined concepts then I’ll probably, if, if you’re available I’ll come back.

BK03: I’ll always be available it’s just that time, you know normally my Thursdays and Fridays I, um, I’m doing a little bit of deliveries and I drink coffee at the coffee shops. No I deliver to restaurants and then we become friends so when you come there…

IVAN: You get a coffee.

BK03: A koffie or a cappuccino and you chat and things like that, so, but I think for the, for the, for you that Paul Smit will be a uh, interesting guy to talk to, but uh, sorry um, Form your own opinions and you’re going to talk to quite a few beekeepers.

IVAN: Yeah, and in terms of material would you say that wood is the, the best.

BK03: Wood is the best at the moment. I would say uh, I haven’t tried the composite hive, I would like to see, I know the moisture story but I think that can be prevented because in Canada, in and uh, America and in uh, England they started to use these foam hives.
Appendix G
Field Diary

1. Egg coats
   - 30 May
   - Medium
   - Medium-sized beeport expert
   - Opinions: inadequate or unhygienic
   - Managed sites
   - All after 2pm

2. New bees that are settled
   - Don’t take to new hives
   - Plant those to save bees
   - Police of flowers for bees

3. Brood-crop
   - No bees, no pollen
   - No bees, no propolis
   - Bees are prepared for winter
   - Predominantly wax

4. Colony bees in a hive
   - Bees outside feeder flow.
   - Can’t see a feature
   - What bees do in a colony
   - What needs to be done
   - At a particular time
   - At this time of year
   - Have bees to collect
   - Move from Royal jelly to honey
   - Move from beeswax to honey
   - Move from nectar to honey
   - Move from nectar to propolis
   - Move from propolis to pollen
   - Move from pollen to nectar

5. Pollen
   - Bees, can fly 1-2 miles (not good)
   - 1.5 miles is best

6. Bee tray
   - Lots of nectar
   - Bee tray, but only 3 cells
   - Bees, can fly 1-2 miles (not good)
   - 1.5 miles is best

7. Propolis
   - Resin, should five rising sun
   - Bee tray, can fly 1-2 miles (not good)
   - 1.5 miles is best

8. Propolis
   - Bees, can fly 1-2 miles (not good)
   - 1.5 miles is best

9. Propolis
   - Bees, can fly 1-2 miles (not good)
   - 1.5 miles is best

10. Propolis
    - Bees, can fly 1-2 miles (not good)
    - 1.5 miles is best

- Propolis
- Bee tray
- Beeport
- Propolis
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Appendix G
Field Diary

11. Home Sours on top or super to get bees off.
12. Honey is thick due to little honey that is left.
13. Beehive was left to die.
14. Beehive was put in a box.
15. Beehive was put in a box.

16. Permanently: location phone number
17. Produced: registration
18. Bees cannot see red light.
19. They are attracted to white light.
20. Permanently: location phone number
21. Produced: registration
22. Beehive was put in a box.
23. Beehive was put in a box.

1. August 2015
2. Interview with Tom Carne
3. Start with 10 hives.
4. To force bees to form comb correctly
5. Book: Beekearing by March and April
Appendix G
Field Diary

Interview With Eduard Van Zyl - 7 August 2015

- Recommendation for further study of the height of the hive entrance & the refusal of bees to move downhills with brood boxes placed beneath
- Concrete hives
- Dead boxes with sealed floor & top entrances
- Squeeze supers
- Glue lid
- Need to join all boxes together

- Use steel covers rather than aluminium to last longer.
- Swarms are worth R1000
- Wax is worth R100
- Hives in cages get burnt
- 30% loss each year from theft, vandalism & diseases/pests.
- Concrete hives coated with bees wax inside
- Concrete hives weigh 210 kg & cost R250 to make.

Field Experiment

Live Hives - 16 Oct.
Concrete hive
- Manel could not needed & interferes with locking D/H5s
- Temperatures
  - 12.00 - 28°C outside
  - 33°C inside
  - 20.00 - 16°C outside
  - 69% inside
  - 24.00 - 13°C outside
  - 27°C inside.

Peels using MAV main entrance
- No landing pad
- L/W on top of box side
- Hive tool easy to use.
- Frames realigned together not to lid or floor.
- Lid cracking.
- Handles
  - Easy to insert
  - Need flat surface to place hive.

Leaves
- Wiggles in hives
  - Causes chipping & unboxed hive

Site Visit

Moran - 1st September
Hans Steenpoort
- Plastic hives
- Electrostatic discharge problems
- Condensation forms lid with water.
- Burn comb & wafers on plastic frames.
- Bees will burn comb on wooden frames first.

Alterations
- Rounded entrances
- 48mm
- Rails for closing with mesh or flat sheet
- Inner frame support bars rather than lips to protect edges.
- No hives larger than 3 boxes.
- Vandalsm problems

23 Oct
Holes in lid
- Heat holes in lid
- Top cover reduced
- Temperature from
  - 33°C to 29°C.
Appendix H
Initial Concept Posters

LANGSTROTH
CARDBOARD
R200

HANDLES WILL HELP THIEVES.
RAISED ENTRANCE FOR VARROA
PROTECTION. SLANTED WALLS
INCREASES RAIN PROTECTION.

SMALL SUPERS WILL BE
CHEAP TO BUY & EASY TO MOUNT.
ALTHOUGH FRAMES WILL BE EXPENSIVE.

TOP-BARS & WEIGHT MAKE
INSPECTION DIFFICULT.
FLOOR OPENS TO ALLOW FOR
SWARM-CELL CHECKS.

STAND CAN BE SIMPLE AND SMALL.
HIVE MUST BE STRAPPED TO THE
STAND.

SLANTED INNER SIDE WALLS HELP
WITH REMOVING OF TOP-BARS.
LIPS TO HELP GRIPPING & LIFTING BOXES.

FLOOR IS ATTACHED TO THE
BROOD BOX MEANING THERE ARE
THREE UNITS.

ALTERNATING ENTRANCES FOR
WINTER & SUMMER.
INSULATED WALLS & LID.

DOUBLE-WALL CARDBOARD
WATERPROOFED ON OUTER
SURFACE.

IVAN BROWN
Appendix H
Initial Concept Posters

Langstroth
Concrete

- No handles to deter thieves. Can be chained closed.
- Raised entrance for Varroa protection.
- Small supers will be cheap to buy & easy to mount, although frames will be expensive.
- Separate floor allows for swarm-cell checks & cleaning.
- Built-in steel legs can be easily placed in cans with oil.

Standard frames. Heavy boxes to move.

Three simple moulds required.

Alternating entrances for winter & summer. Concrete has thermal mass. Condensation must be prevented.

Concrete with lightweight aggregates. Wooden frames.
Appendix H
Initial Concept Posters

HORIZONTAL FRAME HIVE

- **CARDBOARD**: Mesh floor below the brood section for falling varroa, can be closed in winter.
- **R250**: Interior space is divided by two separator boards. Frames can be bought two at a time.
- **INSPECTION WINDOWS CAN BE ADDED TO THE FRONT WALL HANDLES ON THE SIDES.**
- **STAND NOT INCLUDED. MUST BE TIED DOWN. PERMANENT SIDE FOR SIT.**
- **WORK DONE FROM ONE HEIGHT UP TO 24 HONEY FRAMES POSITIONED ON THE SIDES. STANDARD FRAMES.**
- **ONE UNIT WITH LESS MOVING PARTS FOR INCREASED DURABILITY. LOW-COST MANUFACTURING.**
- **INSULATED LID AND WALLS. TREATED CARDBOARD WILL PREVENT CONDENSATION.**
- **DOUBLE-WALL CARDBOARD WATERPROOFED ON OUTER SURFACE.**
Appendix H
Initial Concept Posters

**HORIZONTAL FRAME HIVE**

- **Concrete**
- **R500**
- Mesh floor below the brood section for falling Varroa. Lids can be chained shut. No handles to deter thieves.
- Interior space is divided by two separator boards. Frames can be bought two at a time.
- Catchment trays on the sides, with gaps that can be used to check for swarm-cells.
- Stand not included. Permanent size for sitr.
- Work done from one height. Separate lids for easy opening & closing standard frames.
- Only two moulds required. Although size is difficult transport.
- Concrete has thermal mass. Condensation must be prevented through ventilation holes.
- Concrete with lightweight aggregates. Wooden frames. Wooden space dividers.

**IVAN BROWN**
Appendix H
Initial Concept Posters

**VERTICAL TOP-BAR**

- **CARDBOARD**: Raised entrance for Varroa protection. Comb harvesting reduces rise of diseases & pest proliferation.
- **R12D**: Slanted lips make positioning the boxes easier; hive expands vertically.
- **TOP-BARS MAKE INSPECTION DIFFICULT; ALTHOUGH A VIEWING WINDOW COULD BE INCORPORATED.**
- **SMALL SIZE CAN BE SUSPENDED FROM A TREE FOR LURING SWARMS.**

**SLANTED INNER SIDE WALLS HELP WITH REMOVING OF TOP-BARS. STANDARD FRAMES CAN ALSO BE USED.**

**ONE CHAMBER SIZE & ONE LID REDUCES THE OVERALL COST.**

**INSULATED WALLS & LID; FLOOR CAN BE REPLACED WITH A MESH SCREEN EASILY.**

**DOUBLE-WALL CARDBOARD WATERPROOFED ON OUTER SURFACE; DOWEL STICKS TO SUPPORT THE FRAMES.**
Appendix H
Initial Concept Posters

VERTICAL TOP-BAR

CONCRETE

R500

HANDLES WILL HELP THIEVES. HIVE CAN BE CHAINED & LOCKED.

LIP HELPS POSITION THE BOXES UPON ONE ANOTHER.

TOP-BARS & WEIGHT MAKE INSPECTION DIFFICULT. SEPARATE FLOOR ALLOWS FOR SWARM-CELL CHECKS.

STAND NOT INCLUDED. CAN BE USED TO RAISE WATER CONTAINERS OR PROTECT GOODS.

SLANTED INNER SIDE WALLS HELP WITH REMOVING OF TOP-BARS. HANDLES TO HELP MOVING BOXES. STANDARD FRAMES CAN BE USED.

IDENTICAL LID & FLOOR WITH ONE CHAMBER SIZE MEANS ONLY TWO MOULDS ARE NEEDED.

BASE CAN BE FLIPPED FOR DIFFERENT WINTER & SUMMER FLOOR FLOOR DEPTHS.

CONCRETE WITH LIGHTWEIGHT AGGREGATES. WOODEN FRAMES.

IVAN BROWN
Appendix K – Entry-level Hive Printed Illustrations Layout Poster
APPENDIX L
TECHNICAL REPORT: MANUFACTURING AND COSTING

1 - INTRODUCTION
Concrete and cardboard were selected as the materials for producing beehives developed during this study. The focus of the research and testing was determining a suitable process for manufacturing the beehives successfully in accordance with the requirements. This report illustrates the findings of the technical research and testing that was conducted during the design stages of the project.

2 - ENTRY-LEVEL HIVE
2.1 Corrugated Cardboard
Corrugated cardboard sheeting is used to produce packaging for a variety of products. The material is lightweight, recyclable and cost effective. In recent years beekeepers have started using cardboard catch-hives to lure wild swarms. Colonies of bees can typically be kept in these hives for up to four months before running out of space, however during the rainy season the boxes deteriorate quickly. Existing cardboard catch-hives are not adjustable and are designed to be used once. In order to improve durability, usability and functionality in the cardboard hive it was necessary revise the manufacturing and design approach in order to produce a more successful outcome.

2.2 Manufacturing
Corrugated cardboard sheeting is convoluted paper that has been laminated onto flat sheets of paper to produce rigid fluted board. The flute and paper lining is produced in different weights forming different grades (PrimaBox 2015:sp). The direction of the fluting makes the sheets more rigid in one direction and prone to bending along the fluting. To prevent this multiple layers of fluting are laminated onto one another and extra liners can be added between the layers, with the cost increasing in proportion to the grade (PrimaBox 2015:sp). The most common board grades used by packaging manufacturers are:

- Single Face Board (SFK) – 1 liner and 1 layer of fluting
- Single Wall Board (SWB) – 2 liners with 1 layer of fluting
- Double Wall Board (DWB) – 2 -3 liners with 2 layers of fluting
- Triple Wall Board (TWB) – 2-4 liners with 3 layers of fluting

Cardboard products are manufactured in large quantities through die-cutting, a process for cutting, creasing or perforating flat sheet material. The process caters to low-volume production as the tooling is relatively cheap (Thompson 2007:266). A die-cutting tool is made by attaching ‘steel-rules’ and ‘creasing bars’ to either a roller or a stamp (Thompson 2007:266). Die-cutting is a fast process with cardboard sheets fed into the tools and up to 4 cut parts ejected every second (Thompson 2007:270). The tool can produce a high number of parts as the blades wear slowly and can be replaced regularly with little added cost (Thompson 2007:267). Manufacturing a rolling-wheel jig or a stamping-board jig depends on the size of the parts and the production speed required, with rolling-dies costing much more but producing parts at a much faster rate. Rollers and presses can also be used to print
ink graphics onto cardboard products (Thompson 2007:400). The cost of the printing and stamp manufacturing is reduced if only black ink is used. Screen printing can also be used for small batch production (Thompson 2007:401).

2.3 Characteristics
Cardboard products become weak and lose their form when exposed to water. It is common for packaging manufacturers to use wax impregnation for water proofing, applying a thin layer of molten wax to the surface of the sheet prior to cutting (PrimaBox 2015:sp). The durability of the product is substantially increased through this process, although the cardboard cannot be recycled. Wax impregnation increases the cost of the products substantially (PrimaBox 2015:sp). Other methods such as plastic lamination are also used, however the cost is much higher. Cardboard is a good insulator due to the air-pockets created by the fluting and papers non-conductive properties. Sound and temperature can be reduced significantly by thicker grades of cardboard, however flat surfaces are typically poor diffusers.

2.4 Testing
Strength and durability were the main concerns surrounding the entry-level, cardboard hive. Initially DWB and TWB were selected as potential grades. To determine the exact requirements both board grades were used to make full size prototypes that demonstrated the realistic strength. Waterproofing methods were also tested on the prototypes, using wax-based wood sealers as a cost effective alternative to wax-impregnation.

During prototyping it was found that both cardboards were easy to manipulate, however the surface quality of the thinner cardboard was visibly lower. The thicker cardboard also proved to be easier to assemble accurately, where the thinner cardboard was prone to creasing on flat surfaces or tearing at bends. When a coat of wax-sealant was applied to flat sheets the DWB warped severely whereas the TWB only deformed slightly. When the sealant was applied to the prototypes post-assembly deformation only occurred with the thinner cardboard. The prototypes were then sprayed with water, revealing that one coat was not adequate. Through repeated testing it was found that two coats of sealer produced waterproof cardboard, however with the second coat the SWB warped further. The slanted roof design was observed to retain water on the surface due to the rough surface texture of the board. By pitching the roof at the centre this problem was reduced substantially.

Creating a lip fold from the inner walls of the chambers caused assembly complications and reduced the overall strength of the box. Instead a lip was created by adding a cardboard insert to each side of the box, with the added benefit of making the interior space transformation simpler. The faceted form that was designed for the exterior surface of the chambers had the added benefit of reinforcing the flat faces and improving the diffusion of sunlight or sound.

### 2.5 Costing
Based on the following figures a potential production and retail cost for each part was equated:

<table>
<thead>
<tr>
<th>BILL OF MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATERIAL</td>
</tr>
<tr>
<td>Waxsol Sealant</td>
</tr>
<tr>
<td>Paint Brush</td>
</tr>
<tr>
<td>Die Cutting Tools</td>
</tr>
<tr>
<td>Printing Tool</td>
</tr>
<tr>
<td>Full sheet</td>
</tr>
<tr>
<td>6 x brood chamber</td>
</tr>
<tr>
<td>6 x super chamber</td>
</tr>
<tr>
<td>10 x lid</td>
</tr>
<tr>
<td>12 x inner cover</td>
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<tr>
<td>12 x floor</td>
</tr>
<tr>
<td>18 x insert</td>
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<tr>
<td>Wax Foundation Sheet</td>
</tr>
<tr>
<td>10mm S. Tap. Galv. Screw</td>
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<tr>
<td>Wood Glue</td>
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<thead>
<tr>
<th>ASSEMBLY</th>
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<tbody>
<tr>
<td>PART</td>
</tr>
<tr>
<td>Brood Chamber</td>
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<tr>
<td>Super Chamber</td>
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<tr>
<td>Lid</td>
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<tr>
<td>Inner Cover</td>
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<tr>
<td>Brood Frames</td>
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<tr>
<td>Top Bars</td>
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</table>
3.1 Concrete
Concrete is a remarkable material, with amazing properties of strength, durability and adaptability (Lefteri 2014:212). There are a range of techniques available to achieve different visual effects and impart a variety of intrinsic qualities based on the requirements of different projects (Owens 2013:5). The practices used in all stages of concrete construction affect both the appearance and structural performance of the concrete.

3.2 Manufacturing
Cement is used to make concrete which consists of aggregate (sand and gravel), water and cement. The proportions of the aggregates used in the mixture affects the properties of the product (Owens 2013:8). When mixed the aggregates form a liquid slurry that undergoes a chemical reaction that causes the mixture to bind and harden. The slurry is generally poured into a cavity that shapes the hardened product using the following methods:

**Formwork:** Formwork utilises shuttering to create the casting space for the concrete product (Owens 2013:10). The shutters are the surfaces that have contact with the concrete, held in place by external beams and columns. The materials required to cast this way are quite cheap, however there are long set-up times and limited shaping possibilities. Tolerances are difficult to maintain in this process.

**Re-usable Moulds:** Moulding makes use of a manufactured negative of the product to cast the concrete into (Owens 2013:9). This can be done with a reusable mould or a one-off that is broken or disintegrated during removal. Reusable moulds are usually cast from silicone and fiberglass using a master pattern (Lefteri 2014:212). This means that the design must be releasable. Materials that can be used in casting include plastic, wood, metal and paper. Surfaces that will come into contact with the concrete are lubricated with a substance that will assist in mould release. Aside from commercially produced release agents cooking oil, petroleum jelly and motor oil also work well. The contact surface of the mould creates the surface finish of the concrete casting. Concrete castings are vibrated to removed air bubbles and distribute the slurry into the cavity (Owens 2013:11). Although wetter concrete is easier to pour the excess water reduces the strength of the concrete, therefore plasticizers (chemical additives) are often used to improve the fluidity of the mixture.

3.3 Characteristics
**Strength:** Concrete has an extremely high compressive strength and a low tensile strength. Steel is commonly used to reinforce concrete, by embedding a support structure within the concrete during casting. Concrete structures are usually reinforced to add strength and absorb stresses and forces. Metal is generally used for its strength and durability. Large flat surfaces can be reinforced by welded steel mesh, and long thin sections such as columns are reinforced by rebar. Hollow steel sections are sometimes used to decrease the overall weight. External frames are often used to increase the durability of the concrete, where sharp corners and exposed edges may become chipped over time. This involves adding flat steel edges or L-sections during casting, which become permanently affixed to the concrete. Fibres are often added to reduce shrinkage and prevent cracking, they also add tensile strength (Owens 2011:9). Fibres used include polypropylene, nylon, polyvinyl alcohol and alkali resistant glass. Fibre reinforcement can also help absorb impact and contact forces, protecting brittle edges.

**Density:** The high density of concrete results in heavy products that are thermally conductive. The average density of standard concrete is 2400 kg/m$^3$ and 1750 kg/m$^3$ for lightweight concrete (Dorf 1996:22). Lightweight aggregates are added for their insulating properties and can reduce the cost and weight of concrete mixtures. The most common materials are vermiculite, perlite, pumice and polystyrene beads, although the materials should be pre-treated to reduce water absorption (Lefteri 2014:212). Adding lightweight aggregates can reduce the concretes strength, although resistance to temperatures of up to 400 degrees Celsius is produced.

3.4 Testing & Casting
Achieving the desired strength-to-weight ratio relied on finding the correct cement composition. Initially small concrete sections (see Fig. 1) were cast to test the strength and weight of different compositions and thicknesses:

<table>
<thead>
<tr>
<th>COMPOSITION</th>
<th>THICKNESS</th>
<th>WEIGHT (1-10)</th>
<th>STRENGTH (1-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1cement:2sand:2vermiculite</td>
<td>30mm</td>
<td>5</td>
<td>2</td>
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<tr>
<td></td>
<td>40mm</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>1cement:2sand:2stone</td>
<td>30mm</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>40mm</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>1cement:2sand:1stone:1vermiculite</td>
<td>30mm</td>
<td>6</td>
<td>4</td>
</tr>
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<td></td>
<td>40mm</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>1cement:1sand:3vermiculite</td>
<td>30mm</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>40mm</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>1cement:3vermiculite</td>
<td>30mm</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>40mm</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

Figure 1: Test blocks of concrete cast with varying aggregate content, 2015, (produced by author).
It was found that lightweight aggregates could substantially reduce the weight, however the strength would also be diminished. Combining lightweight aggregate with sand or stone did not increase the strength significantly enough to justify the added weight. Through testing it was found that a mixture of cement, vermiculite and water produced a strong and lightweight 40mm concrete sections. However the surface finish was affected by the grade of vermiculite used. The vermiculite was observed to float if too much water was added, while reducing the water content created a denser mixture causing air bubbles to become trapped. The vermiculite was replaced with a fine grade perlite to produce a more homogenous mixture, however the edges were still brittle and prone to chipping. By adding chamfers and polyurethane reinforcement fibres to the second casting the strength of the edges was significantly improved. The fibres also had the added benefit of reducing shrinkage and potential surface cracking. A wooden shutter mould was used to manufacture the first two prototypes (see Fig. 3), however by the third casting the mould had deteriorated substantially. It was decided that a sheet metal shutter mould would be more effective. When casting the prototypes steel mesh was also added for further reinforcement.

For the handles and frame support bars 6, 8 and 10mm steel rods were tested, with 8mm proving the easiest to bend by hand while still providing the required strength. The original legs (see Fig. 2) were designed to fasten to the base. Through testing it was found that the legs were prone to pivoting and cracking the concrete slab at the entry hole. The threaded rod and bolts also added a high cost. The handles and frame support bars were successfully manufactured from 8mm steel bar, using a hammer and table-mounted vice-grip. The low cost of the bar made it a more attractive option for a stand to replace the legs, however the strength was a concern. A prototype stand was manufactured using 10mm and 8mm bar, demonstrating that the 10mm bar was more difficult to bend by hand and that the 8mm bar was strong enough to support the concrete hive.

### 3.5 Costing

#### BILL OF MATERIALS

<table>
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<tr>
<th>MATERIAL</th>
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<th>CONVERSION</th>
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<tr>
<td>Cement</td>
<td>50kg</td>
<td>R63.00</td>
<td>R1.26/kg</td>
<td>Chamberlain</td>
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<td>Round Steel Tube 42x2.0</td>
<td>3m</td>
<td>R74.00</td>
<td>R4.05/cm</td>
<td>NJR</td>
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<tr>
<td>Round Steel Bar M8</td>
<td>3m</td>
<td>R10.11</td>
<td>R0.034/cm</td>
<td>NJR</td>
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<td>Galv Nut M8</td>
<td>10</td>
<td>R13.12</td>
<td></td>
<td>NJR</td>
</tr>
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<td>Set Screw Bolts M8</td>
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<td>50mm Steel Mesh</td>
<td>5m x 1.6m</td>
<td>R460.00</td>
<td>R0.00575/cm²</td>
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<td>R130.00</td>
<td>R13/kg</td>
<td>Stanley</td>
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<td>1</td>
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<td>/100 = R13.34</td>
<td>PBeulich &amp; JKN</td>
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<td>/100 = R10.44</td>
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<tr>
<td>Demoulding Oil</td>
<td>25l</td>
<td>R1000.00</td>
<td>R2.50/100ml</td>
<td>Chamberlain - Sika</td>
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<tr>
<td>Bees Wax</td>
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<td>R240.00</td>
<td>R24/100g</td>
<td>Beeware Shop</td>
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<tr>
<td>Wood Glue</td>
<td>5l</td>
<td>R550.00</td>
<td>R11/100ml</td>
<td></td>
</tr>
<tr>
<td>Unassembled Brood Frame</td>
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<td>R12.00</td>
<td></td>
<td>Beeware Shop</td>
</tr>
<tr>
<td>Labour</td>
<td>Minimum Wage</td>
<td>R25/hour</td>
<td>R0.42/minute</td>
<td>SA</td>
</tr>
<tr>
<td>Allububble</td>
<td>1m²</td>
<td>R27.15</td>
<td>R0.0027/cm²</td>
<td>Allububble SA</td>
</tr>
</tbody>
</table>

#### ASSEMBLY

<table>
<thead>
<tr>
<th>PART</th>
<th>COMPONENTS</th>
<th>COST</th>
<th>TIME</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brood Chamber</td>
<td>Cement 7kg</td>
<td>R8.82</td>
<td>60min x R0.42 = R25.20</td>
<td>R130.36</td>
</tr>
<tr>
<td></td>
<td>Perlite 2kg</td>
<td>R1.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steel Mesh 26x150cm</td>
<td>R22.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Demoulding Oil 50ml</td>
<td>R13.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mould/100</td>
<td>R20.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>50mm x Steel Tube</td>
<td>R12.00</td>
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<td></td>
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<tr>
<td></td>
<td>Bees Wax 50g</td>
<td>R0.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>60min x R0.42 = R25.20</td>
<td></td>
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</tr>
<tr>
<td>Lid/Base</td>
<td>Cement 7kg</td>
<td>R8.82</td>
<td>60min x R0.42 = R25.20</td>
<td>R107.80</td>
</tr>
<tr>
<td></td>
<td>Perlite 2kg</td>
<td>R26.00</td>
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<tr>
<td></td>
<td>Steel Mesh 58x40cm</td>
<td>R13.34</td>
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<tr>
<td></td>
<td>Demoulding Oil 50ml</td>
<td>R12.00</td>
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<tr>
<td></td>
<td>Mould/100</td>
<td>R10.44</td>
<td></td>
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<tr>
<td></td>
<td>Bees Wax 25g</td>
<td>R6.00</td>
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</tr>
<tr>
<td></td>
<td>60min x R0.42 = R25.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handles</td>
<td>50cm Steel Bar</td>
<td>R1.70</td>
<td>10min x R0.42 = R5.90</td>
<td>R5.90</td>
</tr>
<tr>
<td>Brood Frames</td>
<td>Wood Glue 100ml</td>
<td>R11.00</td>
<td>45min x R0.42 = R18.90</td>
<td>R149.90</td>
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<tr>
<td></td>
<td>10 x unassembled</td>
<td>R120.00</td>
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<tr>
<td>Stand</td>
<td>3m steel bar</td>
<td>R10.11</td>
<td>10min x R0.42 = R4.20</td>
<td>R5.56</td>
</tr>
<tr>
<td>Frame Support Bars</td>
<td>40cm steel bar</td>
<td>R1.36</td>
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</tbody>
</table>

*Figure 2: Prototype of lid/base part with vermiculite aggregate concrete, 2015, (produced by author).*

*Figure 3: Wooden shutter release mould, 2015, (produced by author).*
4 - CONCLUSION

The initial concerns surrounding the materials were overcome by determining the correct manufacturing approach. The production costs and projected retail price of the beehives as compared with existing beehives is shown in the table below:

<table>
<thead>
<tr>
<th>PART</th>
<th>COMPONENTS</th>
<th>PRODUCTION COST</th>
<th>RETAIL PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beeeware</td>
<td>Wooden box and lid</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 brood frames</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beequip</td>
<td>Cardboard box and lid</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 brood frames</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beeware Langstroth Hive</td>
<td>Brood Chamber</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Lid</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Base</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 x brood frames</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEEGIN Entry-level Hive</td>
<td>Brood chamber</td>
<td>R189.8</td>
<td>X 200% = R379.60</td>
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<tr>
<td></td>
<td>inserts x 2</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Lid</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inner cover</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Top-bars x 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEEGIN Extra Cardboard Chamber</td>
<td>Brood chamber</td>
<td>R106.50</td>
<td>X 200% = R213.00</td>
</tr>
<tr>
<td></td>
<td>Inserts x 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Top-bars x 6</td>
<td></td>
<td>X 200% = R213.00</td>
</tr>
<tr>
<td></td>
<td>Frames x 6</td>
<td>R144.5</td>
<td>X 200% = R289.00</td>
</tr>
<tr>
<td>BEEGIN Permanent Hive</td>
<td>Brood Chamber</td>
<td>R558.91</td>
<td>X 200% = R1127.20</td>
</tr>
<tr>
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<td>Lid/Base x 2</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Stand</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Handles x 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frame Support Bars x 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brood frames x 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEEGIN Extra Concrete Chamber</td>
<td>Brood Chamber</td>
<td>R291.38</td>
<td>X 200% = R 675.24</td>
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<tr>
<td></td>
<td>Frame Support Bars x 10</td>
<td></td>
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<td></td>
<td>Brood Frames x 10</td>
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<tr>
<td>BEEGIN Permanent Hive Moulds</td>
<td>Lid Mould</td>
<td>R1900</td>
<td>X 200% = R 3800.00</td>
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<td>Chamber Mould</td>
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<tr>
<td></td>
<td>Fasteners</td>
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</table>

The retail costs for the beehives are significantly higher than those presented by existing beehives. However the cardboard hive offers features not available in existing catch hives such as adjustability, durability, directions for beginners, top-bar/frame compatibility and improved thermoregulation. The concrete hive also provides the opportunity for community centred manufacturing enterprises without the need for machinery. If the hives could be made available at cost price through organisational funding or subsidies based on sales to commercial beekeepers or hobbyists the cost would then be substantially lower than existing beehives. If the entry-level were also sold flat-packed to be assembled by users the cost could be reduced.

Sources Consulted:


Accessed: 11 October 2015