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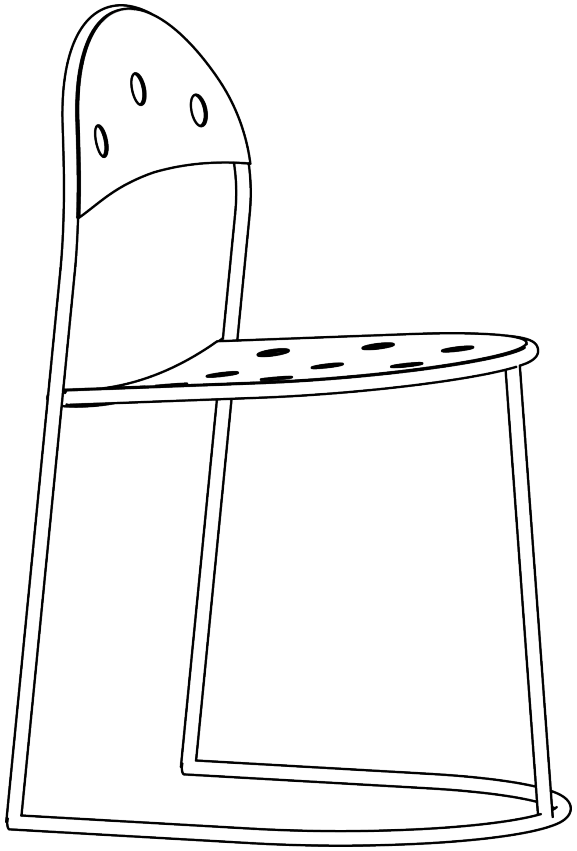

JUA KALI
INNOVATION THROUGH LIMITATION

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CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020

Department of Industrial and Material Science
Division of Design & Human Factors

Master Thesis

JUA KALI

Innovation through limitation

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Abstract

The informal sector in Kenya, locally called Jua Kali demonstrates a range of ingenious sustainable qualities in production and consumption, both when it comes to material selection as well as the mentality regarding the use and reuse of various products. On the other hand there is a lack of basic knowledge regarding production efficiency, solid mechanics and quality control, which are fundamental parts in a western product development context. The challenge lies in finding a common space for exchange, where both parties can benefit from each other's expertises. In decades, various top-down attempts on how to industrialize the sector have been conducted by the government and other external actors, but due to poor contextual understanding, wrong approaches and corrupt leadership, barely no results have been recorded.

This master thesis has therefore applied a more frugal, bottom-up approach. Through a conducted field study in Kenya, three different Jua Kali sites were investigated with the purpose of highlighting already existing qualities, as well as identifying "hot-spots" where interventions have the greatest potential to improve the ever growing sector. One of the visited sites demonstrated a higher level of quality, greater product range as well as a more clear production process, than the other two sites. The aim was then set to develop a proposal, how less developed Jua Kali sites can benefit from the support of frugal design and appropriate technology. Refined production quality and increased collaboration was identified as the two main "hot-spots", and served as the basis for later development work conducted from Sweden.

In order to explore and develop a product based on these topics, a local need at a Public Sports ground in Kisumu City has also been identified. The park runs a very popular rental service of plastic chairs for various meetings. However, these imported chairs are easily broken due to the varied climate and active usage, which entails large repair costs for the rental operators. The development work in Sweden has therefore been focusing on developing a locally produced park furniture constructed out of up-cycled materials, which not only aims to solve the problem in the park but also lift the capability of the local workforce, Jua Kali. The end result exemplifies how small changes in production can make a big difference in terms of product quality and level of cooperation.

Master of Science Thesis

Jua Kali
Innovation through limitation

Master's thesis in Industrial Design Engineering

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I would also like to thank Helena Hansson, who has acted as an external supervisor. Your energy, drive and experience in frugal innovation are the basis for the initiation of this project. I am very glad for all the pep talk and improvised brainstorming sessions we had during the development phase.

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Gothenburg June 2020
Oskar Lillo

Terminology

Informal sector
The informal sector is broadly characterized as an interconnected cluster of workers engaged in the production of goods or services with the primary objective of generating employment and incomes to the persons concerned. A majority of workers in the world are informally employed, often in emerging and developing countries, and contribute to economic and social development through various activities that are not protected, regulated, well recognized or valued by external authorities.

Jua Kali
The informal sector of Kenya. In this report referring to the craft sector.

IDAs
Identified Development Areas

Glocal collaboration
Development work happening in-between the interconnection of global and local issues.

Appropriate Technology
Technology that is applicable to the social and economic conditions of the geographical context in which it is to be applied

R&D
Research & Development

NGO
Non-governmental Organization

KES
Kenyan Shilling, 1 KES = 0.088 Swedish krona

Contents

1. Introduction

This chapter provides an overall background for the initiation of the project, by briefly presenting the current situation of the Jua Kali sector in Kenya. Defined challenges and possibilities will be introduced, as well as thesis aims and objectives to support and contribute to a better understanding of the report as a whole.

2.1 Background

“In the twentieth century, as North American and European economies expanded, Western corporations began to institutionalize their innovation capabilities, creating dedicated R&D departments and standardizing the business processes needed to take their ideas to market. They focused on managing innovation, just as they managed any other business activity. This industrialization of the creative process led to a structured approach to innovation characterized by, big budgets, standardized business processes, and controlled access to knowledge. But this structured innovation approach, which helped Western firms become highly successful in the second half of the twentieth century, has three clear limitations in the fast pace and volatility of the twenty-first century: it is too expensive and resource consuming, it lacks flexibility, and it is elitist and insular.” (Radjou, Prabhu & Ahuja, 2012)

This Master Thesis will investigate the opposite approach commonly found in the emerging economies, where local small- and medium enterprises (SMEs) employ a more functional approach to product and service design. In Kenya, these people are all operating under the hot sun, in the so-called Jua Kali sector. They are not in the business of coming up with cool features that appeal to customers’ wants. Instead, the Jua Kali sector aims to make and deliver a good enough solution with limited functionality rather than one with a dazzling array of features.

While walking along the streets of any Jua Kali market in Kenya, there is always a sense of innovation. The mentality of repairing and modifying products is present everywhere, to a point where almost no objects with a pristine factory finish can be seen. Economical disadvantages are not the only explanation for this phenomenon - It somehow reflects a different empowered attitude towards objects, which is becoming increasingly rare in the so called “developed” countries. If you possess the practical skills to repair something, it will seem like a waste to dispose of it, especially if there is an abundance of scrap materials available at a low price.

2.2 Challenges and Possibilities

The informal sector in Kenya is so established that it has earned itself a name: Jua Kali. Its meaning will be presented in the next chapter, but worth mentioning now is that the sector holds a great number of qualities, but also facing some major challenges, depending on the sites level of infrastructural development. In general, Jua Kali demonstrates a range of ingenious sustainable qualities in production and consumption, both when it comes to material selection as well as the mentality regarding the use and reuse of various products. On the other hand there is a lack of basic knowledge, in the less developed sites, regarding production efficiency, solid mechanics and quality control, which are fundamental parts in a western product development context. The challenge lies in finding a common space for exchange, where both parties can benefit from each other’s expertises.

According to the UN's 12th sustainable development goal, Responsible Consumption and Production, a better understanding of environmental and social impacts of products and services is needed, both of product life cycles and how these are affected by use within lifestyles. As a crucial first step the UN sees a need to identify “hot spots” within the value chain where interventions have the greatest potential to improve the environmental and social impact of the system as a whole. Another suggestion is to develop and implement tools for monitoring sustainable development impacts, that possibly could create jobs and promote local culture and products. In order to achieve such activities, the UN also calls for a global collaboration - where everyone comes together - governments, civil society, scientists, academia and private sector (UN, 2019). A Master Thesis on how two significantly different product development strategies can learn from each other, would thus possibly act as a direct action to mobilize the implementation of the SDGs.

2.3 Purpose and aim

The purpose of this master thesis is to investigate the Jua Kali sector as a whole. Highlight already existing qualities, as well as identify key areas where interventions have the greatest potential to improve the ever growing sector. The aim is then to develop a proposal, how less developed Jua Kali sites can benefit from the support of frugal design and appropriate technology. The result will be delivered through the two objectives listed below.

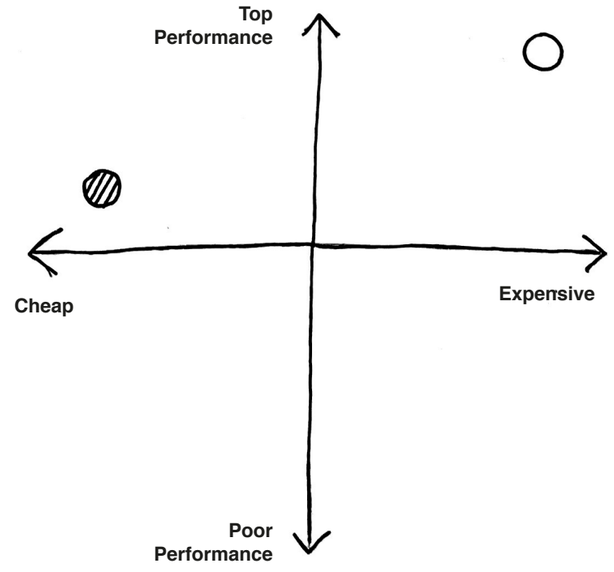
2.4 Objectives

- Map materials flows, product segments and involved actors in order to Identify one or several “hot-spots” within the value chain where interventions have the greatest potential to improve the Jua Kali Industry.
- Develop a product and manufacturing method based on the identified “hot-spots” as well as a local need, by using and modifying existing infrastructure.

2.5 Approach

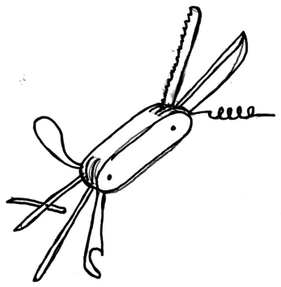
Conducting a field study in Kenya means a lot of impressions. Some view the Jua Kali as the driving force behind indigenous innovation, while other see them as anti-development (Daniels, 2010). In order to understand what is happening in the informal sector, the approach of keep asking the question why, before proposing how, has thus been an essential part of this master thesis.

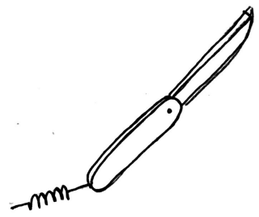
The research questions generated before departure were many, far too many to be presented in this report, but will in some way or another find its answers in the result. Developing a product for people living in developing or emerging markets is challenging. In order to frame and manage such a broad project scope the thesis has adopted the approach of Frugal Design: a paradigm of innovation that considers resource constraints as an opportunity to develop novel, locally relevant interventions to local problems (What Design Can Do, 2020). How this approach has been put into action is presented in the development phase in chapter 4. The General definition is illustrated on the next page based on the conclusions from the book Jugaad innovation (Radjou, et al., 2012).



Controversial Design
Highly engineered products serving the wants of the people at a high cost.

Frugal Design
Good enough solutions that meeting the needs of the people at a low cost.





Key words
Top-down, global, expensive, complex and highly machined

Key words
Bottom-up, Local, affordable, simple and User Centric

2.6 Limitations

To keep the project within a reasonable scale, the research will mainly focus on the metal industry, where most ingenuity in production of products could be found. However, other divisions within the Jua Kali sector will be mapped out and briefly described in chapter 3. Following the mindset of Frugal Design, the project will be focusing on the possibilities of already existing materials and production infrastructure characterized by the Jua Kali sector. Larger infrastructural questions, such as how to industrialize the sector, improve health- and working conditions or integrate formal- and informal institutions, are highly dependent on various policy makers' wills and visions and will thus be too complex to deal with within this thesis.

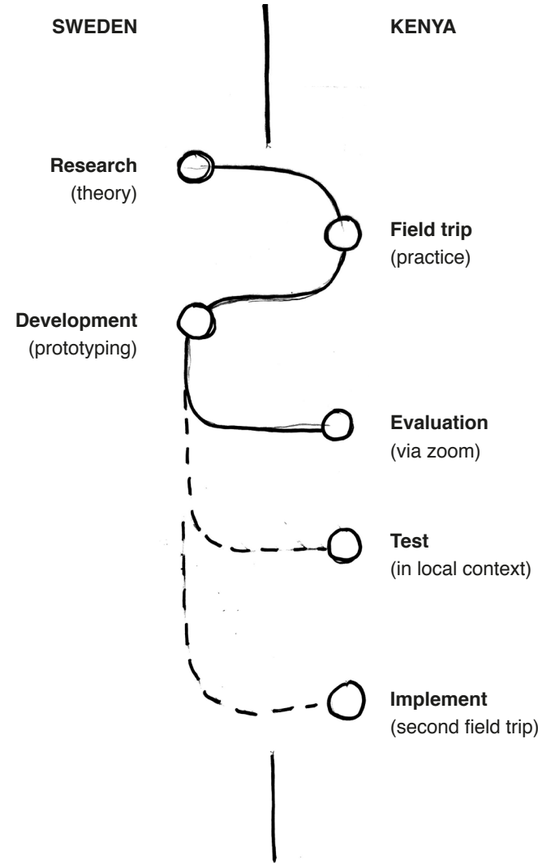
2.7 Ethical considerations

As a foreigner, conducting a field study in a developing country comes with some difficulties. The physical journey is not just a geographical movement, but also a quick journey in social status; from "poor student" suddenly belonging to the upper class of society is a fact. The challenge lies in directing the perceived dissonance to a desired resonance with the local population in order to achieve acceptance and understanding. Culture, language and ethnicity are major factors that can create dissonance, but underlying aspects such as norms, values and traditions may also affect the experience of a field trip.

The field trip presented in chapter 3 involves various documentary activities with local actors. All participants, whether photographed, interviewed or observed, have all agreed to be part of this research. Interviewees have either directly been contacted by myself or through local guide and friend, Evance Odhiambo, Founder and Head of Zingira Craft Community, Based in Kisumu.

2.8 Project process and report structure

The report is divided into five chapters (including this one) and are preferably read in a chronological order, as they together build up the story of the project. However, each chapter can also be read separately, as they all start with an opening text describing its content and purpose. Chapters involving Information gathering (Research and Field Trip) also begins with presenting methods used to obtain the various insights. Methods used in Chapter 4 (Development) will be fluently found in text, when appropriate. At the end of the report, the project result will be evaluated and discussed in Chapter 5 (Discussion and Conclusion). As the various activities during this thesis have been conducted in two countries, Sweden and Kenya, the illustration below will clarify the project process, and possible next steps:



2. Research

The initial research chapter aims to obtain an overview and understanding of the informal sector in Kenya by first historically looking back and trace key events that possibly have contributed to the rapidly growing sector we are seeing today. The chapter will also describe the main characteristics of the Jua Kali sector, with a particular focus on its frugal mindset. With an contextual understanding of the sector as a whole, linkages will be made with the broader concept of Emerging Markets, a term that is becoming increasingly popular within the field of innovation in a global context. Gained insights will create a foundation for the upcoming field trip described in the next chapter.

Methods

The methods used during the Research have mainly consisted of various literature reviews, museum visits, interviews and my own reflections from previous experience in the context.

The literature was mainly found online, but also borrowed from Gothenburg City Library. The chosen literature was first skimmed to find the relevant content, and secondly reviewed with the idea of the upcoming field trip in mind. A chart was later created in order to analyze and find interesting connections among the chosen literature. How the actual literature was chosen hinge on the topics presented in the introduction. All literature is highlighting important aspects to consider before the actual field trip, giving a broader understanding of the term, ‘Jua Kali’, before actually experiencing it.

2.1 Historical Timeline

Almost all Sub-Saharan African nations have dual economies - formal and informal. And The World Bank report (2016) states that 70% of total employment in Sub-Saharan Africa is from the latter one. In Kenya, the report observes that the informal sector represents 95% of businesses and 83.4% of the total Workforce. How come the informal sector is the largest employer today? Here is a historical overview:

Pre colonial period

The informal economy in Africa dates back to the pre colonial era. Actually, one could say that the informal economy was the economy, before the Europeans conquered the continent. Kenya consisted (and still does) of a large number of fairly small ethnic groups, all competing over natural resources such as, water, land and pasture. Trade in Kenya happened on three levels; locally, regionally and long distance. Local trading refers to exchange of goods among members of a community, while regional trade happened in between neighboring communities. Long distance trading was carried out in caravans along well defined routes between East African interior and coast. Long distance trading led to the development of towns and strengthened international relations with Arabian traders, which naturally led to the birth of the Swahili language. Mombasa, which still today is a major trading hub, gained even more importance during the 19th century, as the East African coast now also participated in global trading with countries such as Britain, France and USA. The exposure to the outside world nourished the wealth among Kenyan traders as more and more commodities were introduced to the system.

Colonial period

When Europeans arrived to conquer Africa, they introduced the idea of money that Africans soon embraced as part of the trading system. Trading among Africans was however highly restricted, as making business now required a formalized registration. Unregistered business was punished with jail and torture (Njoroge, 2019). Traditional trading through the barter system was now no longer an option if you wanted to be part of the larger system. In other words, society began to be divided. Those who remained in the old system, the majority of the native population, were now considered to be outside society, operating “informal”. However, according to King (1996), this term was not used until 1971, when anthropologist Keith Hart conducted a study in Ghana on urban unemployment.

Post colonial period

During the 1960's, East African countries started to gain independence. However, the new governments (established by the leaving Europeans) continued with the concept of formalization through registration of business, resulting in further corruption and harassment of those who still run their business outside the new system. As people in the formal sector started losing their trust and confidence in the operating governments, societies were now facing high unemployment. The formal sector could no longer sustain itself and many formally employed saw themselves joining the informal economy. Once inside the sector, these people discovered major structural deficiencies and decided to set up their own small governing groups (Njoroge, 2019). All kinds of small business activities were established and refined (most in agriculture), but the area most prominent for this report was the establishment of a professional crafts sector, later to be referred as Jua Kali.

In a panel talk organized by Africa Research Institute (2016), Kate Meagher, Associate Professor at the London School of Economics states that all African countries have different independence histories. But they all share one particular experience: The implementation of institutional reform programs in the 1980s. These resulted in a significant contraction of the formal economy, driving an even greater proportion of the population into informal economic activities. Also, during the end of the Cold War in the 1990s many African countries stagnated, resulting in an additional influx of people into the informal sector. The few Africans who still actively worked under the governments or foreign organizations (which downsized or left Africa) also had to join the informal sector, and so the informal sector continued to grow (Njoroge, 2019).

During the field trip I met Fred Omindo, the founder and chairman of Kibuye Jua Kali Association in Kisumu. He explained that already in 1987 every Jua Kali area in Kenya was told to form an association. Kisumu City was the first to be registered under the cooperative ministry, and Fred was the man behind it. At that time they were called Kibuye Jua Kali metal- and wood workers cooperative society, and very few people were registered.

During the election year 1992 things started happening as Kibuye Jua Kali Association was identified as one of the potential areas which could benefit from the infrastructural development program, funded by the World Bank. In 1994, $1.2 billion was given to the Government to help build an infrastructure around the development of Jua Kali, for the whole population of Kenya. Craftsmen were able to get training in various skills through different exchange programs to more developed, but rather similar places such as India. Unfortunately the infrastructural development was not done properly. According to Fred, the money was mismanaged - since it only benefited the people on top of the pyramid, so eventually the world bank recalled the money.

Today

The informal sector is no longer about agriculture or small-scale industrial production, but today we also see breakthrough innovations in various banking services, telecom and public transport. As it all happens on the ground, these people are experts in identifying societal trends and the needs of the local inhabitants. Today it is also common among small business owners to join so-called SACCOS (Savings and Credit Cooperatives Societies). The idea behind these societies is to bring people together with similar social and financial backgrounds. It has emerged as the dominant micro-financing solution within the informal sector as it cheap and easily helps people structure their savings and investments. Although the growth of the sector is enormous, the government does not seem to see its potential, at least if you are asking the people operating in it.

No matter who you ask in Kenya, most will say that there are no jobs. But according to the 13th edition of Kenya Economic Update (World Bank, 2016), there is not a shortage of jobs, but a shortage of high productivity jobs. In order to increase productivity of jobs in the informal sector it suggests policies geared towards an increased access to broad skills beyond formal education. Policies that could create linkages between formal and informal institutions, helping small scale businesses enter local and global value chains. The report also highlights the importance of reducing the cost of doing business, to create a more robust private sector.

In modern times, visionary efforts by external economists and technologists, on how to formalize the ever-growing informal sector have been presented. But according to Steve Daniels (2010), the author of the book Making Do: Innovation in Kenya's Informal Economy, no one has yet found the right path. In other words: traditional methods of industrialization are not working. Instead, Daniels is calling for a new approach of industrialization, of which begins with recognizing the potential of informal sector entrepreneurial producers. This approach advocates appropriate technologies, of understandable and adaptable interventions for the existing setting, rather than highly technical solutions or pricey investments. He believes that this approach: "has the potential to rework globalization in the favor of the informal sector, allowing them to grow on a foundation of indigenous innovation that both provides for the needs of the local economy and brings in new capital through investment and export."

2.2 Jua Kali

Origin

Little is known about ancient Kenya's technological advances except that they were good at cultivation. Before the term "recycling" became an international catch-word for conservation, children in Kenya and other parts of Africa were already engaged in such a process. They scavenge the rubbish dumps for tins, boxes, bottle tops, wires, old socks, strings, ropes and many other items they require as "raw material" for making toys. This practice might seem like the only option if you cannot afford toys from the shop, but according to the National museum of Nairobi, children make toys because the experience of making is richer than buying. By choosing the materials, observing the common shapes and activities around them and transforming the raw materials into an object is part of an important creative process which is deeply rooted in the Kenyan culture. Making toys was therefore an important part of the Kenyan childhood and its perpetuation in the contemporary settings is a reflection of children's creative engagement with their surroundings. In modern times, children's creativity has gained more recognition and various toys are now collected and widely displayed as "art" objects in museums all over the world. In pre colonial times various communities throughout Kenya were also into making metal ornaments. Since metal ores were hard and expensive to extract, they mainly used recycled materials. Copper was obtained from telephone lines, whilst iron and aluminum were mainly from old cooking pots, or Sufurias as they are called in Swahili. The modern form and continuation of the metal work and recycling is represented by the Jua Kali sector, whose characteristics will be described below.

Overview and Characteristics

The informal sector in Kenya popularly referred to as Jua Kali or hot sun in reference to the harsh conditions in which the micro entrepreneurs and their employees operate. According to the Business Daily (Business Daily, 2018), It is one of the major employers in Kenya, with approximately 14 millions people operating, equivalent to about 80% of the whole country's working force. The Jua Kali sector in Kenya comprises handymen and women who make, fix and mold anything you may need. Mechanics, masons, carpenters, tailors, welders, plumbers and beyond. In short, they hold up East Africa's largest economy in their talented hands.

Its emergence resulted from the inability of the formal and regulated industries to absorb new entrants or school leavers. It features small scale entrepreneurs and workers who lack access to credit facilities, proper rights, training and good working conditions. Initially the term was restricted to artisans but today it encompasses a number of professions such as auto mechanics, market vendors and various fabricators of household goods. Their livelihoods are constantly threatened by arbitrary seizures and other forms of harassment by civic authorities. The sector contributes a percentage of the gross domestic products (GDP) and provides goods and services, promotes creativity and innovation, and enhances entrepreneurial culture.

Niti Bahn, a research-driven design and strategy consultant, currently based as a full time doctoral student at Aalto University, has made extensive research about the hidden opportunities of the informal economies in Sub Saharan Africa. In her TED talk (2017) she describes that the informal markets of Africa are stereotypically seen as chaotic and lackadaisical. Her research shows that nobody in the literature really distinguishes between illicit- and legal businesses within the informal sector. And after weeks of field work, she found out that an even more crucial problem is the lack of recognition of skilled occupations found within the informal sector. SMEs, who keep daily records, put food on the table and send their kids to university, could be found all over Kenya. Sadly these people are mashed together with the vast informal sector of smugglers and tax evaders, due to the share of operational space. If these people were recognized, customized doorways could be designed for them to enter or integrate with the formal.

But If formal institutions hold their assumptions that the Informal sector is an unified group of criminal workers, left in the shadows, there will be no attempt at integrating the informal economic ecosystem with the formal or even the global. So, there is a need to recognize these skills and hidden occupations, and allow them to enter a larger system. The Informal Economy has a long history of misinterpretations. There are preconceptions saying that developing countries simply should apply western modes of innovation and production (Daniels, 2010). However, today several researchers are calling for an opposite action, where the Global North could learn and apply the frugal mindset characterized by the emerging markets in the Global South.

Household goods in Gikumba, Nairobi

2.3 Emerging markets

The Authors of the book, Jugaad Innovation (Radjou, et al., 2012), note that we are living in a time of increasing complexity and greater scarcity of resources. Western corporations can no longer rely on the old formula, characterized by top-down engineering and massive R&D budgets. A formula which has sustained innovation and growth for decades. Radjou et.al (2012) are calling for a new type of innovation engine that allows companies to innovate faster, better and cheaper. The essence of this engine is already found in the so-called Emerging Markets. Emerging economies like India, Brazil and Kenya are all running with similar engines, but configured to their local context. In India the engine is called Jugaad, a Hindi word meaning an innovative fix; an improvised solution born from ingenuity and cleverness; resourceful. Jua Kali is the engine of Kenya. According to Radjou et al. (2012) there are six principles that connect them all together; Seek Opportunities in Adversity, Do More with Less, Think and Act Flexibly, Keep it simple, Include the Margin and Follow Your Heart. In a TED Talk (2014) Mr. Radjou summarizes the concept as Frugal Innovation; The art of overcoming harsh constraints by improvising an effective, good enough solution using limited resources.

Kenya have exemplified this frugal mindset in several products and services. Helena Hansson, Doctoral student at the School of Arts and Crafts in Gothenburg (HDK), has been engaged in frugal Innovation for many years. Her research has been focused on East Africa and elaborated upon the opportunities that could be found within the Jua Kali sector. In the article, ‘To Do More With Less for Many’ (2016) she writes that a basic prerequisite for an innovation to work is that it is rooted in the local culture and perceived as valuable for all actors involved. History has shown that Africa’s innovation culture is characterized by recycling innovation, in which existing solutions are reworked and adapted to better meet local needs. Externally designing solutions, as an attempt as relief efforts, have many times proved to be unusable well in place. With great creativity, and through the support of informal clusters and networks, the unwanted or useless has been transformed into something valuable through small-scale production and access to simple means. One such re-innovation is the Toyota’s Hi Ace minibus, which has been redesigned into a private public transport vehicle, locally called Matatu. It is an attractive alternative in Eastern Africa, in the absence of a public transport infrastructure.

Matatus in Kenya / Photo: Justin Ravcraft / Flickr Creative Commons

2.4 Design vs making

Design as a profession is today seen in several different working areas. What all design fields have in common is the constant change or development within their field. New demands require new solutions etc. But there is one field that presents this phenomena very clear: Fashion Industry (Lawson & Dorst, 2009). The fact that new trends in colors, material and brands changes every year, makes the industry alive, but in a larger perspective dying.

Designers in the west are generally working within labyrinths of limitations. Briefs, clients, schedules and budgets. All coming together in a chain reaction following the logic of ‘supply and demand’. But what if no one knows what to supply, because no one really knows what to demand? Design as a profession is in crisis because we no longer know what is necessary. Hours are put into expensive R&D to make sure every single detail is perfectly designed. People think that if a product is selling well, it is proof of good design, but this kind of mindset leads to great confusion about the actual value of things. Jua Kali on the other hand, which at first glance may seem to be just a matter of usual cobbling together of recycled pieces, is a powerful parallel economy made up of products created and replicated on the basis of the true law of supply and demand. The mindset behind these innovators is represented in the photo, on next page.

This image could just as well have been taken in Kenya, where products are created according to perceived needs and manufactured on site. I truly believe this umbrella was invented by the actual driver, or at least not by a design office. The beauty of such innovations is that they are cheap and often familiar looking. You can easily understand its construction and usability, but also imagine that the manufacturing process was not too difficult. There are many similar examples in Jua Kali, and the best part is that they are not even called designs, but solutions! For the curious reader, nine other examples, including my own reflections can be found in Appendix I. All documented during the field trip.

“We have all seen an umbrella, a common everyday object that simply does the job. But who would have thought that we one day would need one specifically designed for motorcycle taxis? Well... at least in Shanghai, China, this was the case. By extending one of the circle sectors to the very back of the motorcycle it gives a decent protection to the passenger as well. There is certainly a comical aspect to this form as well, which might help attract new taxi customers. To me this way of redesigning an already existing object holds great promise. It might not be an optimum product, but at least it’s not a new product replacing an old one, in an endless chain of consumption and production. Beloved objects can be modified to prolong their relevance and lifespan.”

3. Field Study

This chapter will work as an extended research based on the contextual understanding gained in the previous chapter, in order to create my own view of the sector. The field study is about to observe, understand and document practice of informal manufacturing and fabrication under extreme conditions such as resource scarcity & uncertain infrastructure. The aim of this chapter is to map out the existing infrastructure; materials flows, product segments and involved actors, to be able to identify and define one or several "hot-spots" within the value chain where interventions have the greatest potential to improve the Jua Kali Industry.

Methods

Various documentary activities have been conducted throughout the field trip. The methods used during the Jua Kali site visits mainly consisted of various observations and interviews. Gained insights are divided into general research topics and later defined into three identified development areas, whereof two will outline the main project focus during the later development work presented in chapter 4.

Six Jua Kali Craftsmen, all coming from different operational areas within the Jua Kali sector; metal, wood, food and textile have been interviewed. This was made to create a fair picture of the shared setting they all operate in. One of the interviewees also operates as Chairman of The Kibuye Jua Kali Association, a group of individuals working with various development questions for the main site of this research, Kibuye Market in Kisumu. For the sake of curiosity three external individuals, all operating in formal businesses, who in one way or another have encountered the Jua Kali sector, have also been interviewed; An Architect (Naeem Biviji, Studio Propolis), a Designer (Tosh Juma, IDEO.org), and an Engineer (Larry Toups, NASA). All Interviewees have been recorded, transcribed and categorized by research topic, and will be fluently used as reference throughout the chapter when fitted.

Observations have continuously been conducted throughout the field trip. Either at a distance though sketch, photography or video, or in a participatory way, where I physically have engaged in the everyday practice of a Jua Kali craftsman. The latter one is particularly important when it comes to building trust, as well as creating an actual feel of the operational setting of production. Three different Jua Kali sites were visited; Gikumba and Kariobanji in Nairobi and Kibuye Market in Kisumu. All three sites are considered more or less informal due to its scarce infrastructure and poor and tight working conditions.

3.1 General insights

Trust

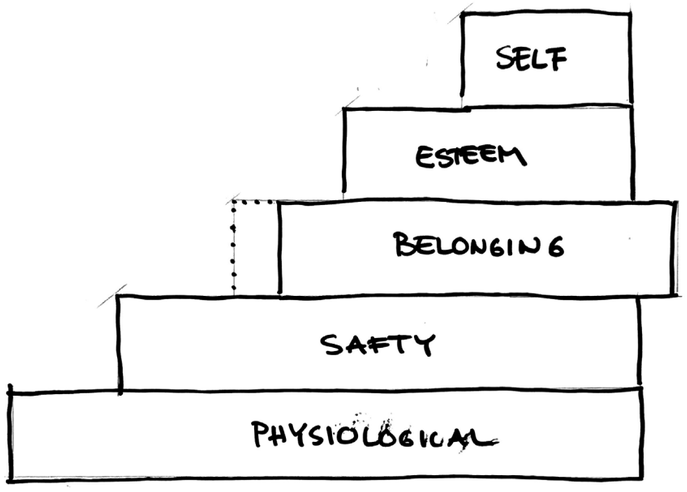
First of all, conducting a field study as a foreigner, or Mzungu as the local inhabitants call you, comes with some difficulties. A crucial part is to build up a trust with the people you are researching. By actually spending time with the craftsmen, observing their everyday practice and working conditions has thus helped me build this trust, but also helped getting a contextual feel. A feel for materials, tools, actors, habits, gaps, issues and of course possibilities. Basically a whole network of interconnected aspects, highly important to consider as a whole but easily forgotten or less prioritized when designing from a distance, which this project had to do due to the outbreak of COVID-19.

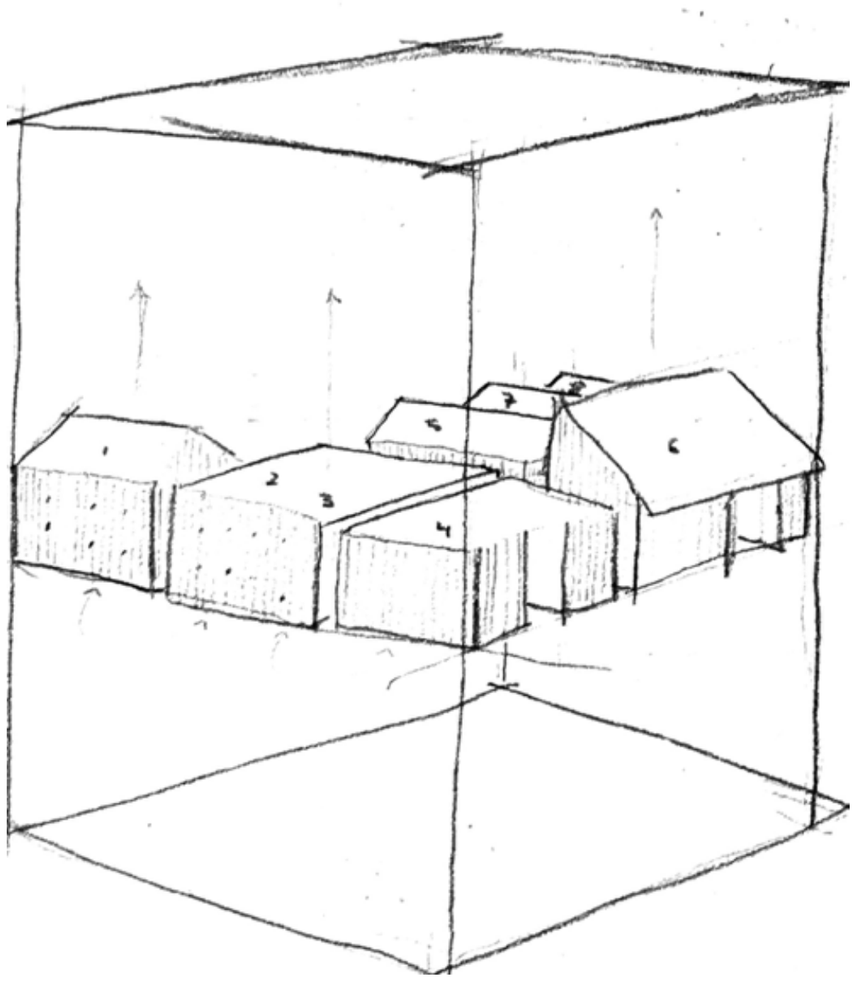
According to Tosh Juma, Managing Director of IDEO.org in Nairobi, The Human Centered Design approach is about working with end users, to remain close to the identified problem intended to solve. However, he still thinks designers need to spend more time deeply with the users to really understand their context. The notion of designing for users has shifted over time and for Tosh it is more about designing with users. He calls for another level of co-creation that actually allows the users to help you throughout the design process and guide you to the core of the problem; calling it customer intimacy! How much can you develop that intimacy professionally with them so that you allow them to actually have an end-to-end influence of what you are trying to design? You introduce the process, you enable the environment, but they really spend more time with you when you are designing with them. However, Tosh does not think IDEO.org, or other design firms have hacked that yet, but they are on a good path.

Needs

Need - A term used to explain people's goal oriented behavior. Psychologist Maslow divided needs into five levels. Maslow believed that once basic needs were met, needs at the next level became important. One of the triggers in this research came to compare Maslow's hierarchy with the various needs identified within the Jua Kali sector. According to Maslow, physical needs such as food, water and shelter is a requirement to feel safe and have some sort of belonging. When this exists, humans can start to feel esteem and self actualization. In large, there is a great truth in this message, but upon closer observation of the Jua Kali case, some questions occur.

According to all interviewees, most people operating in the Jua Kali industry are working for their daily bread, paying children's schools fees and housing costs. First step has passed, but barely so. Their operational areas, or the Jua Kali sites, are placed in rural areas with limited access to electricity and are constantly threatened by arbitrary seizures and other forms of harassment by civic authorities; In other words they are not safe. But surprisingly, the feel of belonging within the Jua Kali sector is indescribable! Even if you are just a simple scrap collector, you are a part of a large, strong community. According to Fred, The Chairman of The Kibuye Jua Kali Association, this is the reason why Jua Kali still exists today. The sector does not reject anyone so the influx is larger than the people exit. It is an absorber, an employer, a trainer! Most of the people trained in Jua Kali become business people within the sector. There is a horizontal growth, but rarely any businesses grow up in the sky. People are trapped in the middle, with no ground and no roof but their strong cohesion and large number holds a huge potential.





Products and Material

As mentioned in the research part, the sector is offering a wide range of household products. These products are either completely manufactured with simple hand tools or with the support of frugal constructed machines. The various site visits made clear that some products are more common than others. One such product is the metal box. According to the interviewees this product has been in production since the early 90's, when the Jua Kali industry really started to grow. Today it is considered as the most popular Jua Kali made products among the local customers, thanks to its rigid construction and affordable price. It is sold all year around, to various people from all economic levels, who need a safe place to store their stuff. However, sales increase significantly during the weeks when primary school starts. Pupils and teachers use their boxes to store various school equipment, such as books, pencils and toys. Its design has more or less been unchanged through its years of existence, making it a true classic at the local market. Is this a sign for good design or just a matter of low infrastructural development? The answer for this is left unclear - but it seems to be there to stay.

The metal box is constructed out of old oil drums, mostly collected from the harbors along the coastline. Collectors from all over Kenya travel to get hold of this leftover material from the formal sector, who no longer seems to see a value in the product anymore. According to Ben, who has worked as a wholesaler of oil drums in Kisumu since 1995, the purchase price has more than doubled since he started his career. Today, a barrel costs around 1000 KES, equivalent to 90 Swedish kronor. The used drums are later burned to get rid of the leftover oil in the bottom, splitted and flattened out to big sheets of metal, ready to use as new valuable raw material. Due to the low infrastructure in the Jua Kali industry, this process may not be the healthiest for the workers, but it creates the largest source of material for the metal sector. Apart from the metal box various garden tools and cooking equipment are also made from this material. The oil drum is definitely not the only product turned into new useful objects; Old car parts, broken bicycle tires and used plastic containers, just to mention a few, are also converted into various Jua Kali made products.

Metal box
Oil drums

Hacksaw
Bent rebar

Sufuria
Aluminum

Bread forms
Sheet metal + steel wire

Cloth hangers
Steel wire

Sandals
Car tires + bicycle tubes

Oil drums in Kibuye Market, Kisumu

Scrap

During the site visits at Kibuye Market several scrap yards were visited. The larger ones tend to be focused around one particular material category, such as metal or plastic. These are located at a very close proximity to the construction site, making it easy for Jua Kali craftsmen to source their material. The smaller scrap yards are usually more wide spread and collect all sorts of materials, which mostly later are sold to the more specialized ones. According to the owner of Rachel Scrapyard, who operates in various metal types, the largest income is generated through the light weight metal, such as old sheet metal roofing. Most of this category is sold to factories within Kisumu or nearby cities to make all sorts of steel rods, later sold in local hardware stores. The up-cycling is made possible through melting which facilitates recovery of a major portion of materials going into a product. Ideally, this means that metals and their alloys could be used endlessly within the same or a different family of products (Balkrishna, 2017)
In the west *scrap* is most commonly associated with something that has lost all its value. But in the Jua Kali sector, people seem to easily find the value left, and naturally transform it into something new - In other words, up-cycling is a part of their everyday life. For instance, scrap collectors transform old speakers (containing large magnets) into simple tools for collecting nails, screws and other small metal pieces. Unfortunately the formal sector, or the government, does not seem to notice the value of their practice, as it all happens in rural areas.

Hardware store in Kisumu City

Sites

Based on the three different site visits, Kariobanji in Nairobi, demonstrated a higher level of quality, greater product range as well as a more clear production line. The other two sites, Gikumba and Kibuye Market, belong to the more common ones, with minor specialization among craftsmen, resulting in a less quality focused production. The reasons why Kariobanji has a more successful development than the other sites are many. But according to Samuel, Architecture student at University of Nairobi and former carpenter in Kariobanji, the main difference is the strong relation between client and maker. Today it is considered as the “go to” place in Nairobi if you as a customer require proper interaction with craftsmen, delivery on time, and less bargaining of prices.

The increased amount of cheap mass produced goods imported to Kenya, has led to a big change for all Jua Kali sites around the country. Samuel explains that, In the early 90’s people began comparing the surface finish of imported goods with Jua Kali made objects. Customers started picking on errors, pushing craftsmen to come up with even better, durable and cheaper products. At least this was the case for Kariobanji, but most likely experienced on other sites as well. Workshops in this region are today constructing the most spectacular jigs and molds to achieve a higher quality, but also speed up the manufacturing process. Although most of the work is still done by hand, there are clear production lines and distribution of work tasks. In short, another degree of specialization among the craftsmen.

However, in the less developed Jua Kali sites a clear cohesion was identified. Artisans who lack electric power, specific tools or materials always have a neighbor to ask. It is a system built upon services and favors all happens by default due to the close proximity of workshops and non-selfish tendencies among craftspeople. However, due to the large influx of people, an underlying competition has instinctively been built up among the young and old generation Jua Kali, creating a gray zone hard to handle. According to Charles, a carpenter in Kibuye Market belonging to the older generation, there is currently a big crisis regarding quality and price development.

Generally speaking, the younger generation Jua Kali deliver fast and cheap, but with less quality. The older generation takes more time and higher prices, but with long lasting quality. The challenge lies in finding a middle ground, where good quality products could be delivered faster and cheaper. Also, If people worked more as cooperative, as seen in Kariobanji, they would not have to rush all over to get hold of material for their individual workshop. A transparent production line with clear responsibilities, spread over several workshops, would not only increase production efficiency but also eliminate the gray zone between various actors.

Production line of balance scales in Kariobanji, Nairobi (mold/assembly/paint)

Human Resource Sustainability

According to Naeem Biviji, founder of the Nairobi based architecture firm, Studio Propolis, there is an embedded sustainability within the Jua Kali sector. The Global North can achieve material sustainability by simply replacing new plastic with recycled for instance. But what is easily forgotten is the human resource sustainability. We see how humans are getting completely outsourced by machines, and valuable skills from the older generation are not properly transferred. It is a waste of a knowledge resource that could be managed better. In the Jua Kali sector most of the practical know-how and skills in economic management is transferred through generations, from master to apprenticeship. In Kenya the economy still allows people to make objects by hand, and that holds a great richness, creating livelihood.

Digital vs Manual

At the moment there is a big trend in the west towards digital fabrication and robotics, which is amazing on one level, but the obsession that all the bananas should look the same is something that annoys Naeem. It creates tons of waste, and distorts people's perception of beauty. On the other hand, Jua Kali demonstrates a more local approach of making, that necessarily doesn't require that much technology. It is rather about making do, and creating livelihood for the community. Their frugal technology does not inhibit ingenuity or human craftsmanship.

During the site visits in Nairobi I also got to meet one of the founders behind Gearbox, a technology park and maker space situated in the industrial area. Quoted from their web-page, their aim is to “improve the ecosystem for hardware entrepreneurship by providing flexible working space, shared prototyping facilities, training in manufacturing, fabrication and design as well as mentorship, investment opportunities and community development.” They further state that “Gearbox is a trailblazer on Africa's path into the 4th industrial revolution!”. It sounds like a solution for my research topic already exists, but according to Neeem this approach of leapfrogging and jumping a whole lot of processes will not work for Jua Kali. If you have not followed the full development of a practice you are not able to do a proper job. If you are jumping to a technology, that is often given to them for whatever reason, you are missing a few critical steps.

They do not need the latest technology in digital fabrication - they need appropriate technology, basic tools that radically could change their product quality, such as a proper spray booth, measuring tape with numbers or a simple sheet metal break.

Naeem adds that there is also such a massive divide between designer and maker in the west. Computers and 3D-models constrains the designers, and separates them from the actual production. In a developed Jua Kali sector, such as Kariobanji, we see a rather collaborative approach of design, all happening by default, where clients and makers together generate designs through making and social interacting with each other to come up with a solution that fits both.

Linkages / independence

According to Larry Toups, a former researcher at the NASA international space station, who also participated in the field trip, The Jua Kali sector seems to be reinvesting into the community. For Toups it is not about buying and selling objects or materials, it's about the linkages in between which makes the system more dynamic. There is a stronger sense of give and take, hugely thanks to the strong social interaction between different actors. On the other side, Western societies tend to behave more and more self centered. Additionally he noticed a linkage to future space travels; The whole notion of going from the earth to mars is that your living space, your habitat, have to be totally sustainable. The connected dots between this and Jua Kali is that we will have to change our perspectives for space travel to where there is no longer any waste, but a resource for something else. While at the space station close to earth, you are earth dependent. And once you get to Mars for instance you are earth independent. Those are huge factors because independence requires you to get more creative in terms of resources and circular thinking. It reduces what you have to bring with you, which in turns helps you do the mission. In a sense, this is the situation of Jua Kali; They have found their own way of running business, without any further external support. The question is: What makes them so resilient? And if support was given - in what way should it be given?

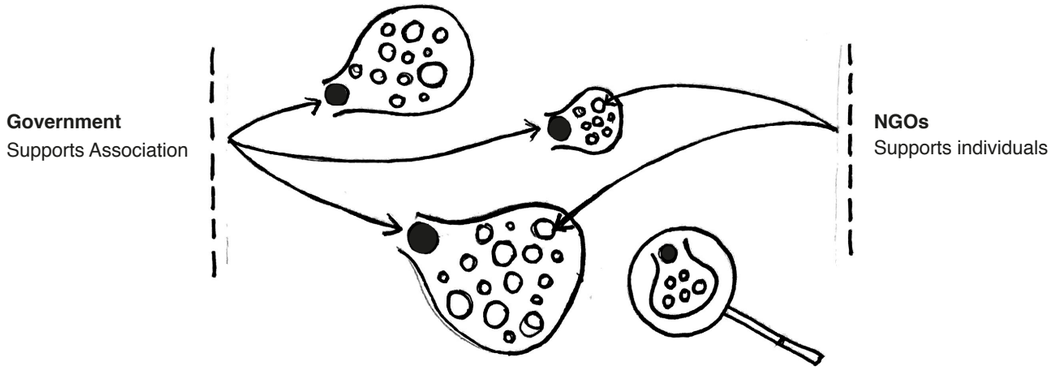
3.2 Concluding map

Jua Kali does not have one particular definition, it is rather a network of many aspects interconnected to each other. In order to get a brief overview of the sector and its various actors a map has been created. The semi-closed circles symbolize a Jua Kali site. Each site consists of a number of workshops (white dot) and a Association (black dot) acting as the face out for external government support and future development. Observed is that this type of support, generally benefits the Association more than the sector as a whole, quite similar to what happened during the post colonial times. Financial support is either given for the wrong purpose due to the lack of contextual understanding, or miss managed by official leaders. NGOs takes another approach: identifying individual workshops and supporting them with external design suggestions. This type of support is good, as it enables individual workshops to grow vertically - but misses the importance of seeing the sector as a cooperative that could benefit from each other.

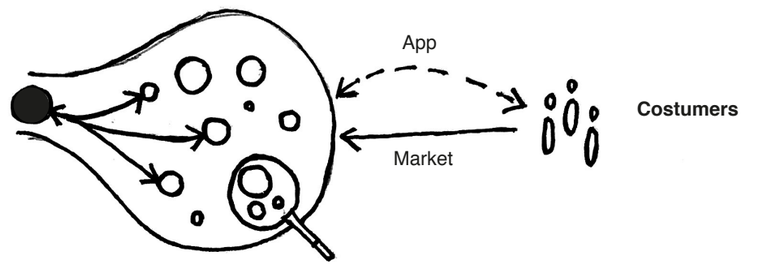
Jua Kali attracts all types of customers, but many people are not feeling comfortable walking into these areas. They are not ready for the hustle, they just want to go to a place with a set price tag without any need for negotiating. This has partly been solved in Nairobi through a mobile application, where Jua Kali craftsmen can post and sell their objects with fixed prices. However, this type of service has a risk of separating the craftsmen from the physical customer contact, which proved very important for Kariobanji's positive development. In Kisumu, another approach of finding new markets is starting to happen, as Kibuye Jua Kali Association is constructing a physical showroom for high quality objects made within the site.

Comparing the three sites I have divided the fabrication sector into 3 levels; low, medium and high productivity jobs (see illustration). The highest level is what has been spotted in Kariobanji. According to Samuel these businesses run fully independently with no need for external support, generating large profits. The other two sites provide low or medium productivity jobs, and face plenty of limitations. These sites also tended to use more recycled material. For these sites the Government should invest in some really basic infrastructure. Just setting up a flat paving would radically change everyday life among the Jua Kali craftsmen. Or give proper access to simple services and utilities that could help increase the quality of objects.

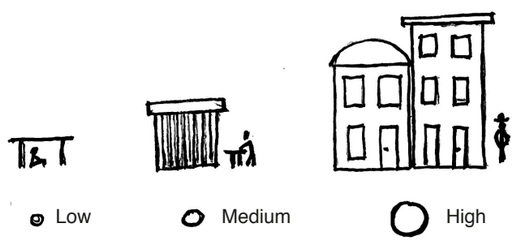
This thesis will approach the current setting of low and medium production setting by not seeing the limitations, but the full spectrum of possibilities that could happen in-between. The Development phase will explain how minor changes can make a big difference.



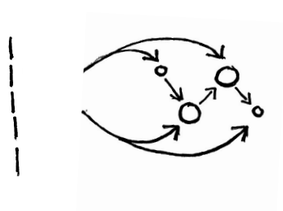
Association
Poor support to the sector as a whole



Level of productivity
Basic infrastructure and appropriate technology is needed for low and medium. All levels needs to be recognized more by formal institutions.



Thesis
Approach Low and Medium Enterprises as group, finding development opportunities for Jua Kali as a collective.



3.2 Identified Development Areas

Based on the general insights, three possible development areas (IDAs) within the Jua Kali sector have been identified as “hot-spots”. Each area will separately be summarized below:

Refine Production Quality

The goal is to challenge the existing production setting in less developed Jua Kali sites by introducing appropriate technology such as Jigs and templates, in hope to inspire for more quality based production.

Increase/visualize Collaboration

The goal is to enable a collaborative focused production, where various craftsmen come together and use their individual skill set in a jointly produced product - and analyze the quality and economics of it.

Enable New Markets

If the above mentioned areas could be fulfilled, the next goal would be to change the preconceptions of Jua Kali. The Kibuye Jua Kali Association is currently constructing a physical space which will serve as a showroom for external visitors, where selected objects will be displayed, depending on its quality. Its purpose is to serve as a social hub where formal actors could get a better understanding of the Jua Kali industry, as well as a trigger for more quality objects within the informal sector.

4. Development

Refined Production Quality was identified as the main research topic or “hot-spot” within the Jua Kali sector. In order to explore and develop a concept around this topic, I have also identified a local need In Kisumu City, which will exemplify how small changes can make big differences - with the power of “glocal collaboration”.

4.1 Local Need

Site

The identified need, or problem, is connected to the public sports ground in central Kisumu. The park has multiple uses such as; Sports activities, stage for public events, and areas for various business activities. These activities vary widely, some businessmen sell ice cream and sweets, others devote themselves to ID photography, but the group that this Master Thesis chose to focus on conducts the rental service of plastic furniture for meetings of various kinds. According to one of the main rental operators, the largest revenue is obtained through private rental within the park. The furniture is also leased for various public events such as, outdoor church services, concerts and funerals, but this type of service happens less often. The rental in the park is usually paid per piece and hour, or by individual arrangement. People from all walks of life and professions rent the furniture for their specific meeting, place them in circles under the shade of a tree. According to the same source, this meeting place is more popular than arranging meetings at each other's office or workplace - It acts as a free zone where neither parties feel away nor at home.

Contested object

The plastic furniture used in the park is the renowned monobloc chair - Light, cheap and super stackable. These chairs have been mass produced since the early 80's after the French engineer, Henry Massonnet presented the Fauteuil 300 in 1972, which today is considered as the archetype of this single mold plastic chair. More and more companies all over the world adopted the same molding technology and soon it was spread all over the world, representing the ambivalence of today's consumer society. Beyond its functional qualities it serves as the symbol of an affordable and thus democratic furniture. At the same time, it does not meet sustainability criteria and exemplifies the global mass consumption of uniform products (Vitra Design Museum, 2017).

The varying climate of hot sun and heavy rain in Kisumu has shown negative material effects on the chair. According to the interviewed rental operator, this is made visible on the backrest and legs that easily break, which entails large expenses on repair. However, this does not seem to be a problem for privately owned plastic chairs, as the mentality of quick and dirty repairs takes place everywhere.

Despite its poor quality, users are constantly repairing them in the most spectacular ways, but the simplest fix is made by just placing another one on top.

These chairs are either mass produced in Nairobi or imported from huge factories in China. The production of one chair takes less than two minutes and is completely operated by machines. As a human centered design engineer with a big interest in how objects are made, this incredible production pace fascinates me on one level, but disgusts me on another. Why would a country as Kenya import a bad quality plastic chair, when there is a huge local working force dedicated to hand-made production of various kinds? Would it be a crazy idea to challenge this multifaceted chair, by introducing a locally made alternative constructed out of up-cycled materials found within the Jua Kali sector? The answer is probably yes, but my curiosity of constructing a chair as a catalyst for change, made me dare to try.

Fauteuil 300 (Modernmag, 2018)

Kisumu Sportsground

Repaired plastic chairs

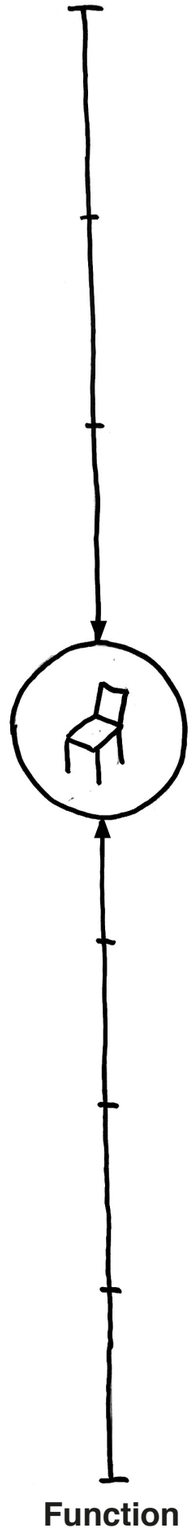
4.2 Frugal Design

Frugal Design, -Innovation or -Engineering is a quite new term within the design community. The approach has many definitions, but as previously mentioned Mr. Radjou (2014) summarizes the concept as; The art of overcoming harsh constraints by improvising an effective, good enough solution using limited resources. Applying this frugal mindset at an early stage of the project, has enabled me to transform the various insights into essential requirements for the upcoming design phase.

Object as a Catalyst

The chair, as a catalyst, could have been any other object, even an already existing one. The idea is to use it as a physical communication tool to highlight unanswered questions, existing challenges and future possibilities for less developed Jua Kali sites, such as Kibuye Market in Kisumu. Ideation have been made in two parallel paths; One dealing with the issues regarding production quality and how it could be refined. Generated ideas from this path, will then be applied to match the various requirements of a rental park furniture. The following sections in this chapter will describe how this dual-track approach has been conducted; balancing the technical improvement in production with the functionality and aesthetics of a park furniture.

As mentioned in the timeline in Chapter 2, the most essential question, which has been in the government's pipeline for decades without any further result, is how to industrialize the Jua Kali sector? This question has not been answered yet, as Kenya's history of high corruption and mismanagement by official leaders continues. The ideation regarding refined production quality will thus focus on how to modify existing infrastructure, rather than suggesting new complex ideas that would depend on governmental or other external support.



Appropriate Technology

Jigs and templates should be used for an increased production quality, as well enabling for a collaborative approach of production.

Local fabrication

The production should be based on local material and current production setting, making it sustainable and easy to implement.

Affordable

The price should not be more than the plastic chairs, otherwise it will be hard to enter the market.

Durable

The chair should be durable and maintenance-free, which are the main issues with the plastic chair.

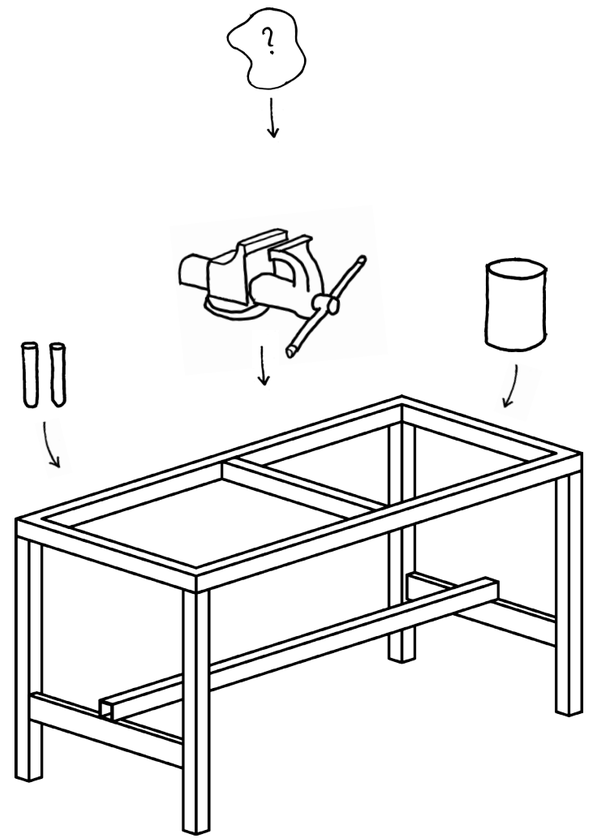
Familiar

The chair should have a familiar yet new look to attract costumers and blend in with the local ambiance.

Workbench

There are many ways to describe a typical metal Jua Kali workshop, but the workbench somehow embodies the whole spirit around fabrication. In absence of flat pavement and proper tools this square tube table frame serves as an extended arm for many manual operations. Different parts are attached around the table frame for multiple purposes. Many also have a vise mounted to it, often used when cutting steel rods.

The approach has been to use this workbench as reference throughout the whole exploration and design phase. Instead of seeing the limitations in this workbench, the idea has been to utilize and take advantage of the already existing features. Seek new user applications by going beyond its prescribed functions. In the same spirit as the craftsmen add functions according to perceived needs, the ambition was to develop a tool applicable to the table frame which allows for increased precision and quality production.



Typical Jua Kali Workbench

4.3 Exploration

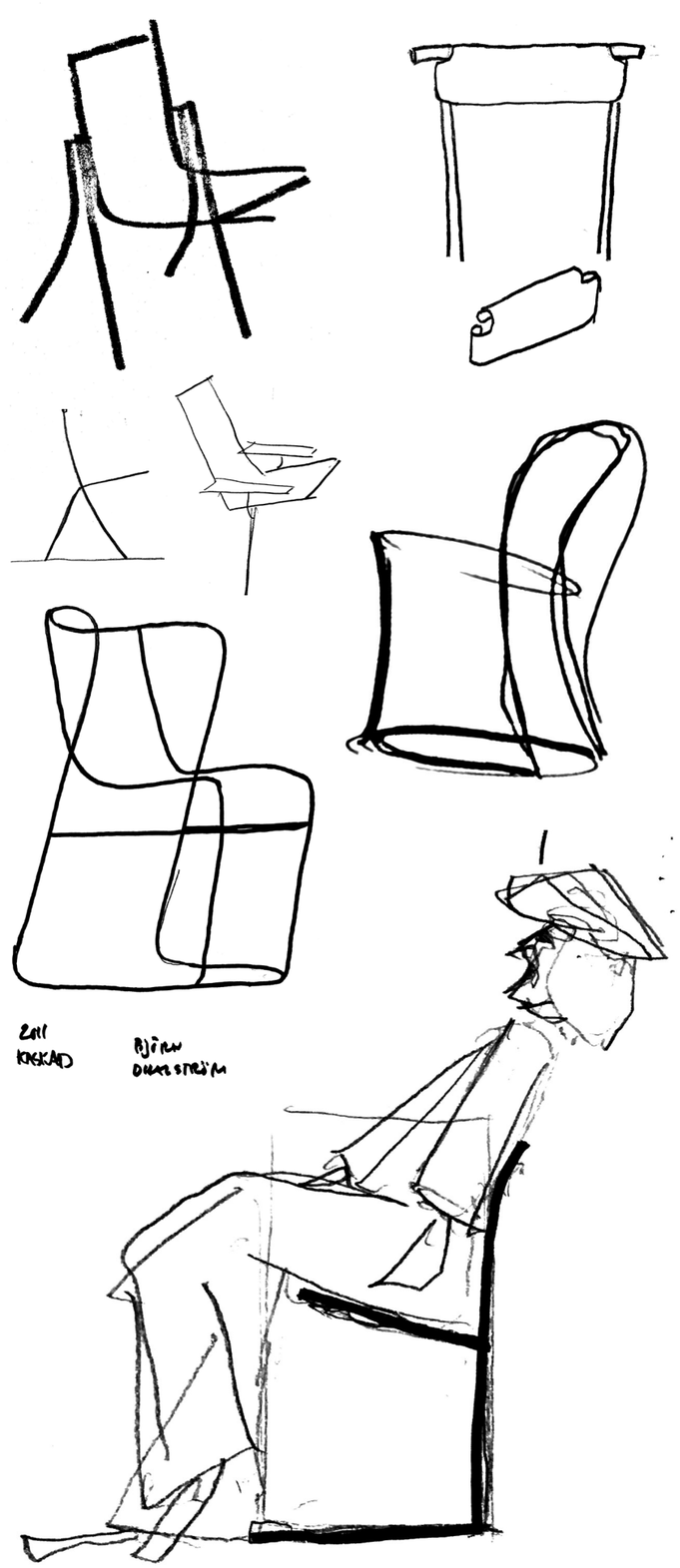
Analysis

Full-scale prototyping has been the main and most important focus of the development work of the chair. But in order to physically test ideas regarding production, a comprehensive design analysis process about form, function and materials has been carried out in advance.

It all started with analyzing the pros and cons of the existing plastic chair and its relation to the site, Kisumu Sports Ground. As already mentioned, the plastic monobloc chair is light, cheap and super stack-able. And surprisingly comfy, due to the soft and flexible properties of plastic. On the other side, it easily breaks resulting in large repair costs for the rental service operators. Cracks mainly occur due to varied climate, active use as well as poor transport management within the park, using semi-opened carts. In addition to this, the lawn in the park also tends to become muddy during the rainy season, resulting in legs easily sinking into the ground and cracks when used. The plastic chair is also an imported product. Either from large factories in Nairobi or Asia, meaning huge transportation costs and CO2 emissions. Plastic as material can also be discussed, but in this report I have chosen to simply classify it as a lightweight and malleable material built upon finite resources.

With the above mentioned parameters in mind, multiple furniture ideas were generated through sketching. Photographs of various Jua Kali made objects have served as a great inspiration, as well helped not losing the actual production setting and available materials. Addition-ally a brief research has been made on various space saving furniture throughout the history, to get an understanding of how things could stack/fold, but also how to eliminate the risk of legs sinking into the ground. Most of the collected chairs displayed below were designed during the early/mid 20th century, to match the production methods found in Jua Kali.

Based on this exploration and the analysis on the existing plastic chairs - an interesting solution to eliminate the risk of legs sinking into the ground seemed to appear; the U-shaped base.








(Stockholms Auktionsverk, 2016)
(eMuseum, 2020)

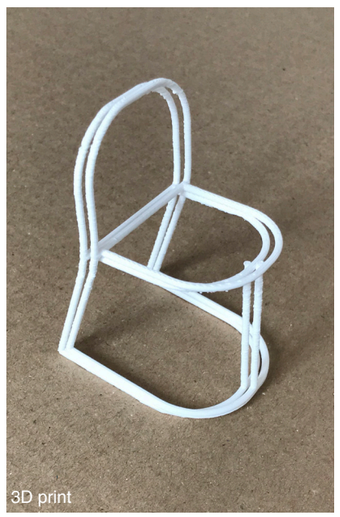
Design Decision

Considering the existing production setting, materials and the U-shape, it seemed appropriate to use some sort of coated steel rod, as a structural frame for the chair This material exists in various profiles and diameters and is easily found in any hardware store in Kenya. As previously mentioned, this material is also a result of an already existing recycling process, where collected old light weight metals are transformed into new steel rods in nearby factories. Its solid profile, yet thin appearance makes it both strong and fairly light, which are important factors when designing a stackable outdoor furniture. For seating and backrest various alternatives have been considered - as long as it is long lasting, resistant for varying climates and of course comfortable. The first concept was based upon the idea of joining various fields of production in one product. For instance, letting the tailoring sector be responsible for seating, and the metal sector producing the frame. But upon closer analysis, fabrics found in Jua Kali would not be the most long lasting solution for an outdoor furniture, especially when it is going to be used as a public furniture. Instead came the idea of using an already established production process: the transformation of oil drums! These thin metal sheets have found many application areas within Jua Kali as craftsmen are experts in manual cutting, folding and punching. By using a familiar material with a whole industry around it, would thus minimize the step of introducing a new idea to the market.

Initial Prototyping

After an intensive idea generation of form, function and material, it felt natural to zoom out and consider the ideas based on the actual goal of the project - to refine production quality. Different activities, such as Computer modeling, 3D printing and quick PVC mock-ups, were conducted to better understand how the chair actually could be fabricated. This process was also important to understand functional properties, such as stackability and comfort. So, with the inspiration of clear production lines and jigs found in Kariobanji, and the typology of a typical workbench found at any Jua Kali site, I have together with a Gothenburg based blacksmith (Boll Smedja) physically explored the possibilities of manufacturing. The goal was to develop frugal manufacturing jigs for bending and welding, adopted to the existing workbench.

4.4 Result


3D print


PVC Mock-up

Construction of Jigs

Through an iterative process of learning by making together with Boll Smedja in Gothenburg, two types of bending jigs and one welding jig have been constructed for the U-shaped chair. The jigs are designed, using minimal material and to fit the existing workbench found at any Jua Kali site.

Various bar diameters were verified according to strength, weight, bendability and visual appearance. After some manual testing 14 mm was chosen for the final prototypes as it perfectly balanced the above mentioned properties. The skeleton consist out of three main parts; base, seat and back, which all share the U-shape. In order to achieve a perfectly bent 180 degree curve with the right part width, it is necessary that the jigs allow for over-bending. To find out the right radius and additional bend degree for the jig, a test-jig with the exact same shape as the desired part was created. When releasing the bend material will flex back to a undesirable shape. The shape deviation was measured and used as input to a mathematical python script developed by Boll Smedja, calculating the desired radius and over-bend for the final jig. As the base and back share the same width, only one jig is required for those parts. The seat has its own jig, as requires a smaller width in order to make the chair stackable. The additional parts do not require any jig as they could be bend with already existing bending pins commonly found on the Jua Kali workbench.

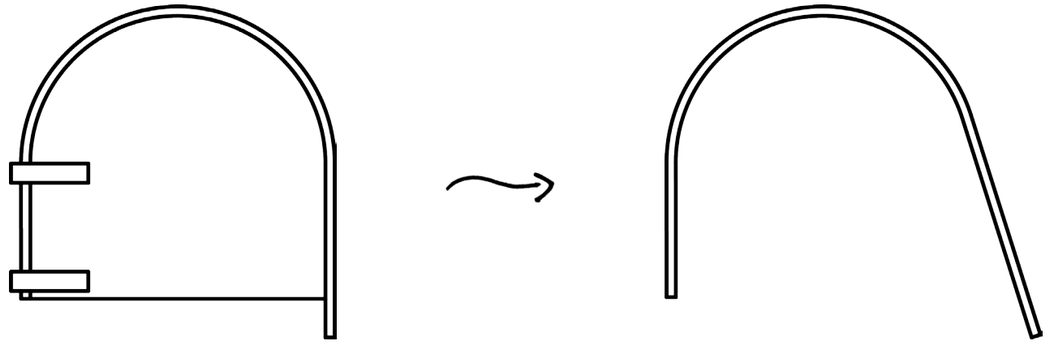
The jig for welding all parts together was constructed after the development of bending-jigs. Its construction could be made of various metal parts found on any scrapyard as long as it gives a great support and locks the bended parts to the right position. As the back legs and the front leg has angle towards the center of the chair, an additional template was created to simplify this welding operation. In order to keep the bended parts in place while welding the chair together, small metal pieces was welded on top of the construction.

The last step was to bend the backrest to a comfortable angle of 20 degree (Berglund, 2004). For this operation another jig was created. All jigs are designed to be mounted on the vice - commonly found on the Jua Kali Workbench.

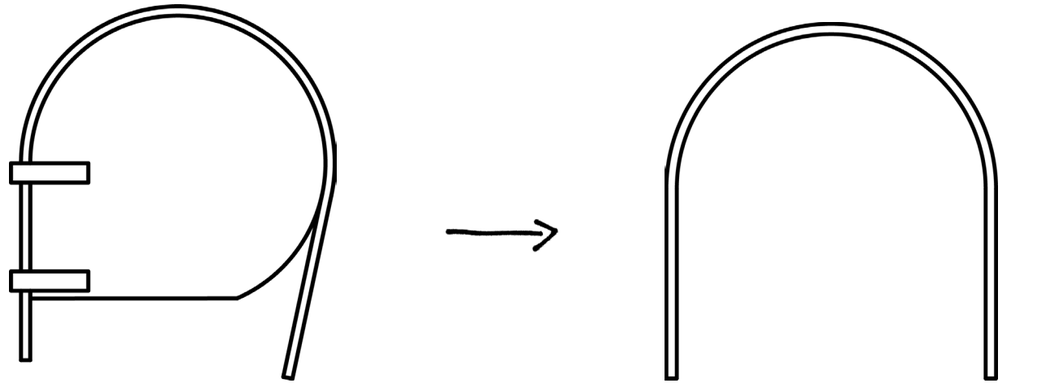
The creation of the seat and backrest does not involve any major changes in production. However, to increase production speed and save material a template for each part could be created and used when cutting out the parts from the drum sheets. The manual technique for punching out the holes in metal sheets is very familiar and will be applied in these components.

The most basic construction steps of the bending jigs is presented in the illustrations beside. Additional information such as, material costs, dimensions of bending jigs, technical part drawings and further explanation of the prototyping process will be presented in Appendix II. However, these prototypes should serve as a guideline rather than a precise manufacturing technique; The important thing is not the design itself - but the process! Some material could be changed according to the individual workshop depending on availability of material. For instance, the bending jigs were made of thick plywood - but could likewise be constructed with metal for an increased stability and durability.

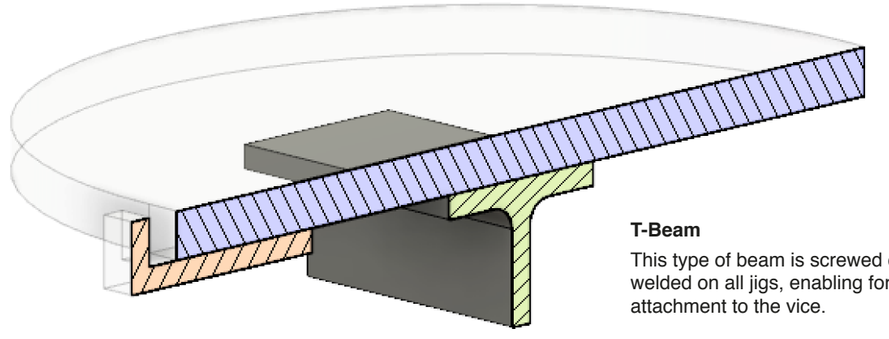
The idea of these frugal designed jigs is to enable a refined production quality, as well inspire for a more collaborative approach of production. Ideally this would mean four different metal workshops collaborating on a single product: 1. Cut/Punch, 2. Bend 3. Weld and 4. Surface treatment. Dividing the production process into four clear steps, will hopefully help decrease the perceived grayzone between actors: meaning craftsmen working with less developed tooling, such as cutting and punching, will feel a greater responsibility for the fabrication process as a whole. Another positive aspect is that product defects of the chair can easily be traced to the responsible workshop.



Test jig
Was constructed to find out how the material properties



Final jig
Was constructed based on the shape deviation from the test jig.



T-Beam
This type of beam is screwed or welded on all jigs, enabling for a easy attachment to the vice.

Presentation of Chair

The product exemplifying how the IDAs could be approached, happened to be a stackable metal chair, after facing a local problem with the plastic chairs in Kisumu Sports Ground.

With the non-sinking base as a starting point, and a frugal attitude regarding construction and materials, the chair has created a balanced expression with round uniform curves. It is maintenance-free, stackable and surprisingly comfortable. The design is a symbiosis between craftsmanship and small scale industrial production, furthermore a celebration of the skilled local working force. For an extended longevity and enhanced character, the chair is painted in a monochrome color. Preferably in a wild palette inspired by the vibrant local culture.

Below is a simplified diagram describing the major differences between the plastic monobloc chair and the Jua Chair. Since the chairs are constructed with two completely different materials it is hard to make a fair comparison. The most significant difference in terms of usability is the weight; a problem difficult to overcome without changing the material. On the other hand, using a more rigid construction frame enabling for a more durable product that will last way longer than the plastic monobloc chair.

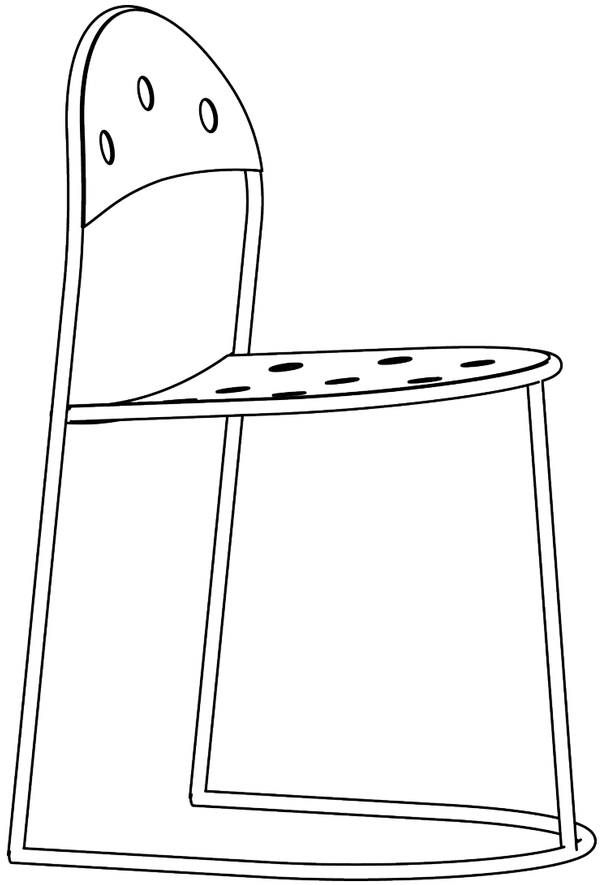
Properties	Monobloc	Jua Kali Chair
Weight	~ 3 kg	~ 6 kg
Price	~ 1000 KES	~ 750 KES (+ Labor)
Stackability	Endless	Endless (on wagon)
Comfort	Comfy	Comfy enough
Durability	Low	High
Material	Finite	Up-cycled

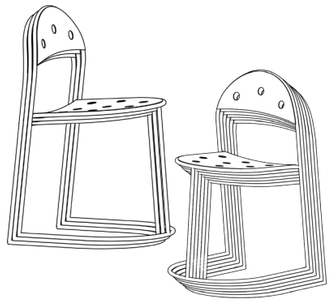
The construction of the chair follows a frugal design language where a great deal of emphasis has been put on reducing the number of components to save material. Its light, yet solid appearance creates a good enough support for the body that will survive an active usage in the park. The flat u-shaped base does not only eliminate the risk of sinking into the soft grass, it also visually marks how to insert the chairs into each other. 10 units could easily be stacked on flat ground, and theoretically endless with some modifications of the storage cart found in the park. Smaller carts, often used along side the road for handling heavy goods could also be hacked according for the chair, allowing easy transport for a relatively heavy chair compared to the monobloc chairs.

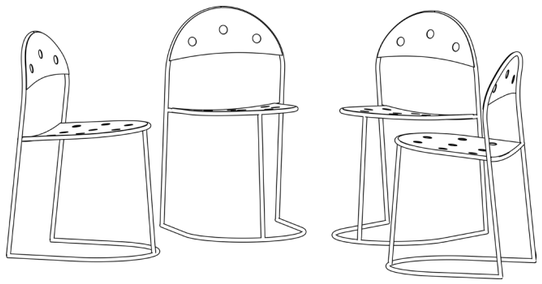
The chair fits for multiple scenarios; placed in circles for meetings, lined up for concerts and church services or just a simple rest for any street vendor. Thanks to its solid construction and coated surface it will withstand any environment no matter weather conditions. However, a great deal of concern has revolved around the use of metal as material for a the hot climate in Kisumu. But it seems like the coating is doing a good job, preventing the chair from extreme temperature changes.

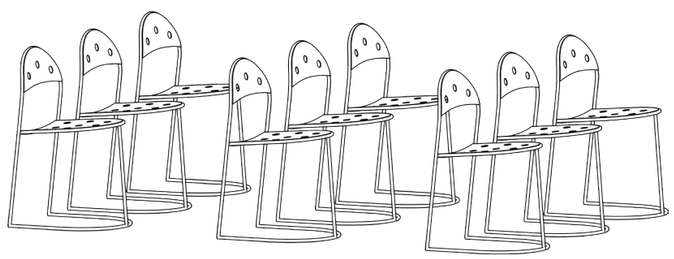
The listed requirements from the dual-approach figure found in chapter 4.2 are considered fulfilled, but what still remains unknown is whether this chair could act as a catalyst or not. This is something only time can judge, but at least it is a object that everyone can relate to, no matter what costumer you are or what level of production setting you are in. In terms of material and construction, it is well rooted in the local culture which according to Hansson (2016) is a prerequisite for an frugal innovation to work. Additionally, as it solves a local need it is perceived as valuable for the local community.

As this project aims to highlight the potential of Jua Kali as a whole as well as solving a local need, it could be viewed from multiple angles and received as valuable for all actors involved. I hope it inspires more people to search for small opportunity spaces where interventions can make big social and economical impact. How simple adjustments could allow for an increased collaboration and vertical growth. How designers in the west could observe, listen and learn form “less developed“ places like Kenya. How technical engineering knowledge could be coupled with the hands-on approach of makers in Jua Kali.









(Skalgubbar, 2020)
(Cleanpng, 2020)
(Afrikut, 2020)

5. Discussion and Conclusion

This chapter presents the discussions about the thesis results, regarding the purpose, aim and the two objectives from the introduction. Also, an evaluation of the thesis approach and methods will be presented. Finally, a conclusion of the thesis is presented including further development.

5.1 Discussion about result and objectives

The purpose of this project was to investigate the Jua Kali sector as a whole; Highlight already existing qualities, as well as identify key areas where interventions have the greatest potential to improve the ever growing sector. The aim was then to develop a proposal, how less developed Jua Kali sites can benefit from the support of frugal design through appropriate technology. This has been achieved by fulfilling the two objectives; Map Jua Kali in order to identify possible development areas, and develop a product based on these areas.

Identified Development Areas (IDAs)

The process of first creating a comprehensive map of Jua Kali as a whole, to then frame the project into specific development areas has been a major challenge in the project. As mentioned in the introduction, this project has been focusing on highlighting the ingenuity that could be found in Jua Kali, aiming to find smaller gaps, just large to fill for a master thesis within Industrial Design Engineering, rather than approaching the larger infrastructural issues. The IDAs has been suggested based on the general insights generated form the various activities during the field trip. The most triggering insight was the fact that the Jua Kali sector is continuing to grow, despite the poor infrastructural support from the government. Independent form external support, they demonstrate a certain inclusive business model where no one is rejected to enter. The horizontal growth is massive - but barely any business grows up in the sky. I am curious to know if these IDAs would enable for a more vertical growth, or if the general insights are missing any important aspects.

The IDAs, or identified gaps, were primarily directed towards an improvement of less developed Jua Kali sites. However, during the development of jigs I discovered another direction regarding how technical engineering knowledge could be coupled with the practical know-how of makers in Jua Kali. It would be interesting to explore this direction even further, by investigating how a possible platform of various knowledge exchanges between the Global North- and South could look like. How could two completely different design approaches benefit form one another? Based on the general insights, I believe the approach of glocal collaboration would enable Jua Kali to more easily test new ideas, which according to all interviewees was a major issue.

One insight that might be valuable to highlight is that all interviewed Jua Kali craftsmen have access to a smart phone, meaning a maintained communication can be kept from distance. Whats-app and other digital communication spaces were used to share and discuss pictures during the prototyping phase, as well to find out supplementary information regarding local material prices and dimensions. This does not only help refining the concept, but also allows to involve the investigated people, crating a “costumer intimacy“ as Tosh Juma at IDEO.org was mentioning during the filed trip. In short - Smart phones is a essential tool when it comes to “glocal” collaboration.

Developed product based on IDAs

The initial idea of traveling to Kenya was mainly based on my own previous experience of the context and a build up interest of the widely spread Jua Kali sector. The plan was not only to observe, interview and document the practice of their everyday life, but actually physically engage and co-create with them to really get to know their setting. But due to the outbreak of COVID-19 the field trip, which initially was planned to be at least 8 weeks, had to be canceled after just 4 weeks, meaning most practical engagement with the local actors were not accomplished. The project suddenly had to be redefined due to the new circumstances. Before the outbreak of the virus, the development phase was planned to be conducted within the Jua Kali sector together with a few selected craftsmen. Instead, all development work was accomplished from distance. However, the activities that actually were carried out during the field trip, proved to be very valuable at the later stages of the project; Not least in order to preserve the contextual conditions in mind during the design phase, but also to maintain the meaningfulness of the project as a whole from distance. Digital verification of the project idea was also carried out during the design phase. Via Zoom, meetings regarding construction possibilities and material decisions have been conducted with local friend and project partner, Evance. Although the end result might have looked significantly different, the hope was to convey the same message.

The decision of only working with metal as material was partly influenced by the limited time. If the field trip had not been interrupted, the search for more interesting material flows and manufacturing methods would have been investigated.

5.2 Approach and method

Since the development phase was conducted from a distance, and not in the real context, it has been a challenge to keep the frugal mindset. Once back in Sweden, I saw myself slowly falling into a stereotypical design process highly influenced by computer modeling and other digital tools. To keep the real context in mind, practical experimentation with physical material was applied as an essential tool. Even though Boll Smedja is equipped with more advanced tooling such as a CNC plasma cutter and magnetic welding clamps, which radically could have accelerated the prototyping sessions, the approach has always been to work as if it was in Kenya. I truly believe this has helped me develop a concept applicable for a Jua Kali production setting, where no advanced or digital tools are used. The process of manual fabrication stands in sharp contrast to the highly machined and precise wester production settings, where small defects are perceived as failure. Instead, manual fabrication is accommodating different imperfections, creating character and beauty. For me it is not about right or wrong, but a celebration of different techniques.

With the Frugal Design approach as a starting point I found myself using an object to communicate the various qualities and identified gaps within Jua Kali. The method of using the chair as a catalyst emerged very naturally, as it enabled me to highlight various topics within a single object. However, since the chair was designed from a distance, with no physical contact with the actual Jua Kali during the development, the level of inclusiveness is decreased. In order to minimize that risk it might have been more appropriate to approach and analyze an already existing object, the metal box for instance. In that case, there would be less risk of discrepancy between me as an external designer and Jua Kali. The approach would look similar, but instead of developing tools for a new object - tools for improving an already ongoing production would be developed.

A brief comparison of function and material between the chairs was made, but of course it would have been interesting to carry out a more in-depth analysis of environmental aspects through a LCA (Life Cycle Assessment).

5.3 Conclusion and further development

This Master thesis all started with a very open brief: to explore the qualities and gaps within the Jua Kali sector. After weeks of research and an intensive field trip a contextual understanding of the sector as a whole was achieved and three Identified Development Areas (IDAs) were defined. By contesting an imported plastic chair with a Jua Kali made metal chair, I was able to exemplify how the IDAs could be approached. Even though the development was conducted from a distance it was designed in a frugal manner applicable for the local context. The end result is a how-to manual ready to be tested in the local context. But the project result should also be viewed as a contribution to an ongoing exploration of how future collaboration between the Global- North and South could look like.

The next step would be to test the production method in the real environment. Depending on the situation of COVID19, this will either happen through a second visit or by sending over technical drawings and providing instructions via Zoom. Even if the prototypes developed in Sweden works fine, some changes might need to be considered depending on the workbench and local material properties. It would also be interesting to try hollow tubes for a decreased weight. At the end of the development phase Evance pointed that even those tubes are commonly made from recycled metal. However, that will include another prototyping session and finding new proportions for the bending jigs. Another next step would be to develop a practical transport solution for the chairs. Instead of creating a whole new cart perfectly designed for the chairs, I suggest to modify or hack the already existing ones by developing some sort of attachable structure that could support the chairs in a leaning position allowing for a vertical stacking.

Lastly; In an ideal world with no corruption and mismanage budgets - the most fundamental things to do would be to invest in some really basic infrastructure, training facilities and integrate the Jua Kali by giving proper access to essential services. But in order for this to happen, the qualities within the sector first needs to be recognized. As external top-down down attempts on how to industrialize the sector not seem to work, I hope this project have showcased how a more bottom-up approach with just small modifications could help recognizing the sector. Therefore, I suggest future project within this field to observe the sector form an inside perspective, treating Jua Kali as an opportunity for growth, rather than something that needs a total make-over!

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Appendix I

In the following collection of photographic observations, I have tried to describe products far adrift from the limited world of professional designers. You will see how objects can be modified by coincidence, context and cunning ingenuity. How they can serve multiple purposes or meet unexpected demands by going beyond their prescribed functions.

There is no doubt that everyone would call this a chair, since it in terms of topology consists of the elements a chair normally has; A seat,a back and four legs. But this chair, spotted outside of a metal workshop in Kisumu, Kenya, offers something extra. By observing its construction, one could guess it was quickly assembled with residual parts. Although, upon closer examination it seems more refined than that. The slightly too long seat, along with the tools, suddenly converts the chair to a workstation. A minor formal alteration has here facilitated a products area of usage immensely. A shape by context.

This water station is to be found at a school in one of the slums in Kisumu, Kenya. It is used daily by staff and pupils during lunch break for cooking and washing. These plastic water tanks are very common in Kenya and are usually placed high up in towers, or directly on the ground. This one in particular, has been mounted on a table base at comfortable height away from the muddy ground. The table has in addition been given an armature feature to help ease the users to hold the bucket while refilling. These two welded rings may seem frugal in their construction, but oh it does the job well. I am fascinated by how solutions can be arrived at instantaneously, as perceived problem arises.

These welded chairs are not an unusual sight among the metal craftsmen around Kisumu, Kenya. At first glance, it simply seems to be the place to rest between the commissions but after spending a few months in the context I discovered a greater value, beyond what we usually expect from a chair. Like the previous metal chair mentioned in the book, this one also offers something extra in the form of a modification or extension of some kind. After asking the creator "why" I received a quite broad answer "I use it for everything; as armrests, signs the customer's receipts, but also to earth the weld in". I forgot to ask whether the chair was meant so from the beginning or if the shape has changed over time according to the needs of the owner? I wonder how I would use it? Maybe as a piece of furniture for the hallway, but is it really a real need?

There are probably thousands of wagons on the market, but certainly none would have carried these 21 water tanks as well as this one. Somehow I think this photograph represents an ideal reality where each situation is given its unique appropriate solution, to eliminate any discrepancy between form and function. This stands in contrast to a market driven idea of design where new products are created to match trends and imagined situations, but often miss the mark. I certainly believe the western world has a lot to learn from places such as Mombasa, Kenya, where this photograph was taken.

Sometimes it is not the product itself that fascinates me, but the composition of several different products working together. Take this roof and flowerpot for example. The roof is primarily there to protect the indoor environment from sun and rain, but is also redirecting water down into the garden, nourishing plants and animals. Plants are therefore partly placed along the house facade to utilize the water from the roof, but what the owner of this house in Nairobi, Kenya have done is something even more interesting. By hanging the flower pot directly under the roof, it is not only receiving the water, but is also protected from chickens and cows in the garden. This is not the innovation of an object, but a smart contextual adaptation. Objects always holds a relationship to their surroundings, so why not make use of it?

The local residents of Kisumu, Kenya, are indeed experts in transforming junk into new valuable items. Old car tires become sandals and oil tanks become saucepans. In this photograph, a couple of beer crates have been repurposed as motorcycle saddle bags. The resourcefulness is inspiring, but I also find the versatility of the crates very beautiful. I wonder if objects with more general qualities (that surpasses a specific initial purpose) can allow for an open ended user application? These crates are perfectly square, and so can balance over the saddle easily. Was this the deciding factor when the motorcycle owner adopted them, or was is merely a contextual coincidence?

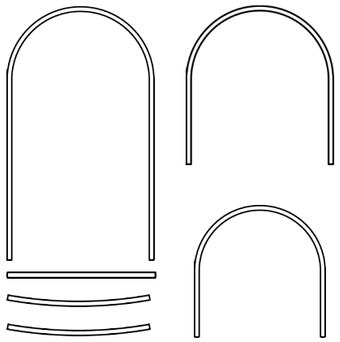
Usually bicycle baskets are constructed with a thin metal mesh, but in this case the creator in Mombasa, Kenya has developed an open tubular framework prepared for a variety of uses. Currently an old woven straw bag is attached with electrical cable, offering a deep and soft shipping volume, but it could just as well be used for transporting longer pieces of timber or suspend goods from the rail. Regardless of how refined an idea for a product might be, users will always find room for modification. Why not acknowledge this from the beginning of a design process?

Yet another sheet metal roof in Kenya, but this time at a primary school in the slums of Obunga, Kisumu. This photograph was taken during the rainy season, a period when schools in this area experienced great difficulties in conducting their lessons. Windows and ceilings are often poorly constructed, allowing the rain to enter the indoor climate, making books and other essential learning equipment completely wet. However, after having spent some months at the school I started to notice that the administration department were using the roofs for drying books, by utilizing its heat properties. To me, this type of routine holds message of the importance of context responsiveness. How useful features can be found almost anywhere in our built environment.

In Kenya, the motorcycle taxi drivers are addressed as Boda Boda. A big part of their daily life is spent searching for customers, either by actively driving around the city or by waiting at a fixed location. In this photograph we can see a driver overlooking a small wooden chair with slight disinterest. Why sit on a chair when you can turn around and comfortably use the passenger footrest? I can imagine the manufacturer of this motorcycle did not have this particular situation in mind during the design phase. And sometimes I wonder to what extent context should be a defining parameter within a design brief. A well designed product can function well in any number of contexts, given there is a strong bond formed to a user group. After hours, days and years of driving - the motorcycle has become an extension of the driver's body.

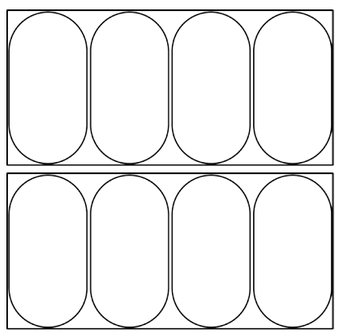
Appendix II

This Appendix presents material costs, dimensions of bending jigs, technical part drawings and further explanation of the prototyping process.



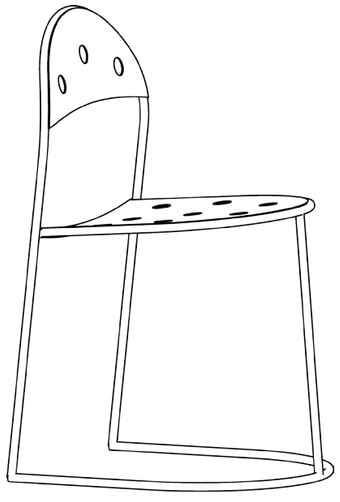
Steel rods

Total length: ~ 5.3 m
Price: ~ 110 KES / m
One chair: 600 KES



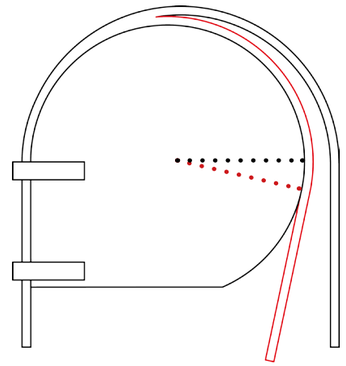
Drum Sheet

Pattern: 16 chairs / 3 drum sheets
Price: ~ 1000 KES / drum
One chair: 125 KES



Total cost

Bars: 600 KES
Drum sheet: 125 KES
One chair: 725 KES + labor cost

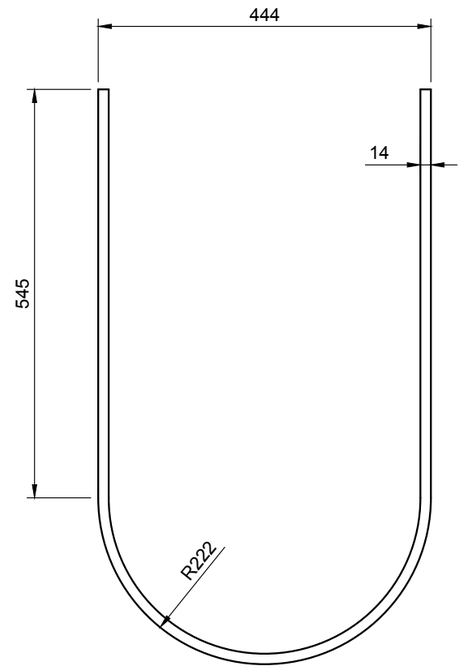


Seat jig

Material: 14 mm steel rod
Radius: 171 mm
Bend: 193°

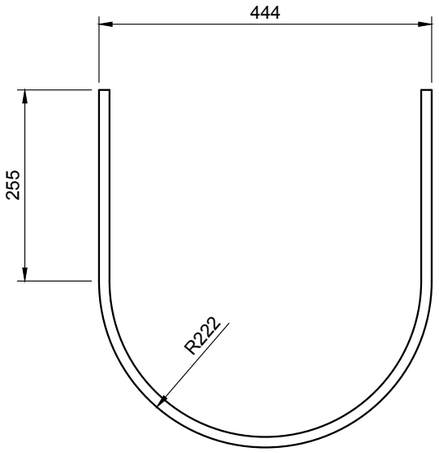
Base/back jig

Material: 14 mm steel rod
Radius: 191 mm
Bend: 193°



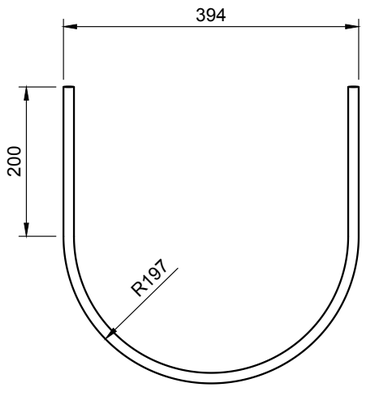
Back

Total length: 1 765 mm



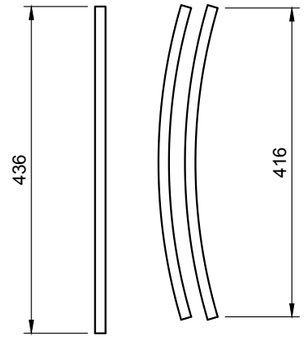
Base

Total length: 1 185 mm
(preferably little extra for a proper bend)



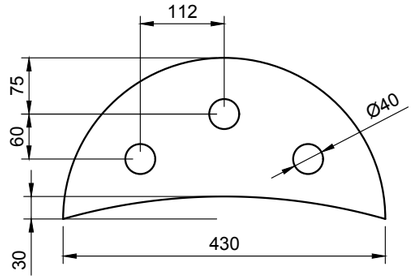
Seat

Total length: 997 mm
(preferably little extra for a proper bend)



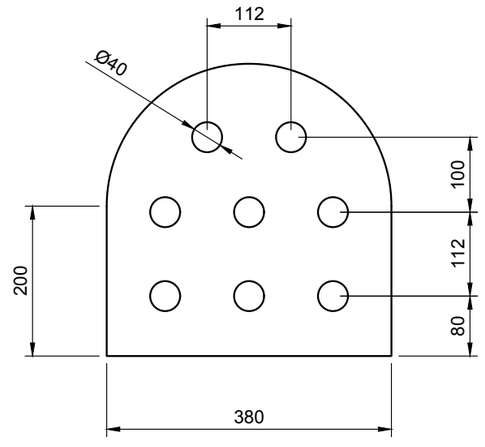
Front leg + crossbars

Crossbars are cut to fit in-between “back” and hand bend according to the shape of “backrest”.



Seat and back rest

Cut out from oil drum and holes are either punched or drilled.



Welding- and Backrest jig

The design of the Welding- and Backrest jigs are made from various metal parts assembled to fit the technical part drawings. In this report no further instructions will be given, as the shape likewise could be constructed in another way - as long as it fits the parts and creates a solid frame when finalizing the chair.

Both Jigs are preferably constructed with a T- or L-Beam. This will allow for a steady and comfortable working position. For the Backrest jig -Attach jig to vice, insert the top of the back and bend to desired angle using the full structure as lever.

Seat and Backrest

Templates were made in cardboard to test proportions according to visual appeal and comfort. The final shape were then manually cut out and holes were drilled. However, the hole making process could also be done by hand as it is used in several other products.

The initial idea was to make the parts slightly larger allowing them to fold around the steel structure, and then spot weld on the back. Unfortunately, this technique has not been tested during the prototyping session, as it requires time consuming cutting operation around the edges. The prototypes where instead spot welded in top and then ground to smooth intersection with the steel frame.

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