KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

KUMASI

COLLEGE OF ARCHITECTURE AND PLANNING, FACULTY OF ARCHITECTURE AND PLANNING, DEPARTMENT OF ARCHITECTURE

Topic: **CLOTHING FACTORY DESIGN**

A DESIGN THESIS REPORT SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF

MASTER OF ARCHITECTURE

BY:

SIDNEY K. QUAYE

August, 2009

DECLARATION

I hereby declare that this submission is my own work towards the Master of Architecture degree and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

Sidney K. Quaye - 20064678 ..... 18/09/09.....

(Student Name & ID) Signature Date

Certified by:

Mr. B.G.O Odame .....

(Project Supervisor) Signature Date

Certified by:

Professor G.W.K Intsiful .....

(Head of Department) Signature Date

ABSTRACT

In the 1970s the textile sub-sector dominated the manufacturing sector; accounting for a quarter of Ghana's total manufacturing employment. Ghana is known to produce, one of the best quality textiles in Africa to date, however production and employment in the textile and apparel industry has reduced by about 70% for several reasons.

To revive the textile and clothing industry, the Government of Ghana in 2002 implemented some economic policies to take full advantage of the African Growth Opportunity Act (AGOA) and increase employment opportunities, expand and diversify the economy, promote both domestic and foreign investment as well as stimulate exports. The textile industry continues to decline despite the implementation of these policies. The problem with the textile industry in Ghana is the over concentration in the production of textile while paying little attention to the processing of rich fabrics into clothing. Research by the Multilateral Investment Guarantee Agency (MIGA), under the World Bank showed that Ghana's labour market availability in the textile and apparel industry is higher than the Africa average, hence a great development potential.

In this paper, light is thrown on the potential of Ghana's fashion industry and the problems it faces. Various clothing factories are studied and evaluated and relevant ancillary facilities are proposed based on case studies, interviews, focus group discussions, observation, reading and internet research. Based on the study a clothing factory is designed to address current problems in the clothing industry.

CONTENTS **PAGE NUMBER**

CHAPTER ONE

CHAPTER TWO; LITERITURE REVIEW

CHAPTER THREE; METHODOLOGY

CHAPTER FOUR; CASE STUDIES

CHAPTER FIVE; THE SITE AND DESIGN PROCESS

CHAPTER SIX; DESIGN PROPOSAL, RECOMMENDATIONS AND CONCLUSION

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AGOA	African Growth Opportunity Act
ATL	Akosombo Textiles Limited
ECOWAS	Economic Community of West African States
EPZ	Export Processing Zone
GTMC	Ghana Textile Manufacturing Company
GTP	Ghana Textile Products
ISI	Import Substitution Industrialization
LED	Light Emitting Diode
MDF	Medium Density Fibre board
MIGA	Multilateral Investment Guarantee Agency
MNC	Multi-National Corporation
NGO	Non-Governmental Organization
PSI	Presidential Special Initiative
PVC	Poly Vinyl Chloride
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations' industrial development organization
USD	United States Dollars

DEDICATION

This design thesis is dedicated to my parents Dr. & Mrs. Quaye and to the late Mr. Ebenezer Abaitey; my former supervisor on the project.

ACKNOWLEDGEMENT

I firstly thank God for seeing me through this project, my supervisor; Mr. B.G.O. Odame for his support and objective criticisms throughout the project, and other lectures; Mr. Edward Botchway and the late Mr. Ebenezer Abaitey for their guidance.

My sincere gratitude also goes to the following resource persons,

Mr. Kofi Asihene; Fashion designer

Ms. Akosua Paaku; Fashion designer and Textiles lecturer, College of Art, KNUST

'RAYMOL Klothing'; a group of fashion designers at the College of Art, KNUST

Mr. Thomas Oppong Danquah, Human Resource Manager, PSI Global Garments and Textile Limited, Ghana and his staff

Mrs. Baaba Owusu Ansah and the staff of Woodin Ghana Limited

I finally thank my friends; Caleb Sackey, Vida Agra, Jude, Collins Tekpertey, Hannah Ahenkan, Vida Tetteh, Ivan Kofi, Ruth-Anne Ankrah, Winston Larbi, Klortso Okai and Amina Quainoo for their support and encouragement.

CHAPTER ONE

1.1 Introduction

Industrial development is a means of ensuring a high and sustained growth rate of any country. In the 1960s and 1970s, Ghana and other African countries pursued import substitution industrialization (ISI) to move African economies from an agrarian state to modern industrialized economies. Policies to promote this were pursued, hence the establishment of light industries to produce goods locally and operate behind tariff barriers. Consequently, industries making textiles, soap, woodwork, etc were established. The textile sub-sector dominated the manufacturing sector; accounting for 27% of the total manufacturing employment and operated at 60% of plant capacity. Ghana was known to produce arguably, the best quality textiles in Africa. [7]

1.2 Problem Statement

Employment is a key issue in Ghana today. From the 1970s to date, there has been a drastic decline in textile production in Ghana for several reasons and hence a subsequent decline in employment in the textile industry. Then, there were 16 major textile companies but now, only 4 of these are still in operation. The Ghanaian textile companies combined have been operating at just about 5% of installed capacity since 1995. Hence a drop in employment from 25000 workers in 1975 to 7000 worker in 1995 to 5000 workers in 2000 and to 3000 workers in 2005.[3]

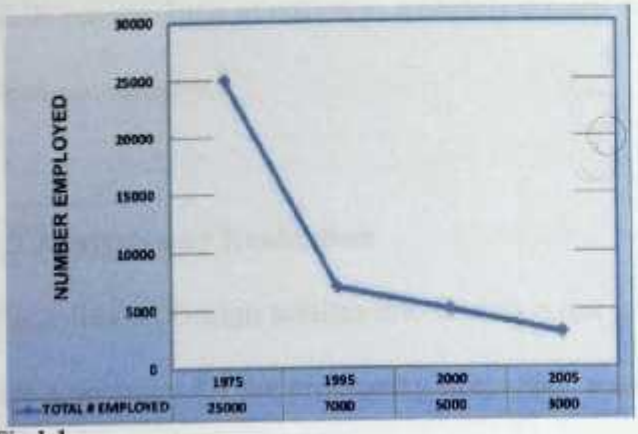


Fig 1.1

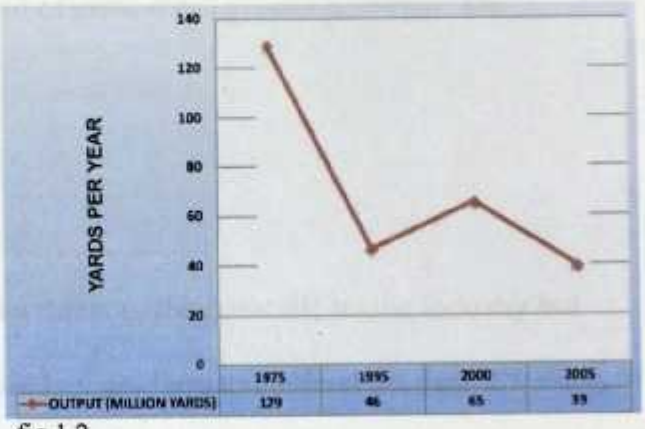


fig 1.2

Figures 1 and 2 (above) show the employment and production trends in the Ghana textile industry.

To revive the textile and clothing industry, the Government of Ghana in 2002 implemented some economic policies to take full advantage of the African Growth Opportunity Act (AGOA) and increase employment opportunities, expand and diversify the economy, promote both domestic and foreign investment as well as stimulate exports. AGOA offers duty and quota-free entry into the United States of America for certain textile and apparel products from selected African countries until 2015.[9] The policies implemented; *Textile/Garment Cluster Network, Textile/Garment Training Centre, PSI-Export Action Programme on Textiles and Garments, Cutting down tariffs etc,* in summary, are to provide training and financial assistance to workers in the textile and clothing industry and enable them produce and export more.

Unfortunately, the textile industry continues to decline despite the implementation of these policies as a result of a high trade balance between imports and exports in the industry, smuggling and lack of adequate advanced technology in the field.

The problem with the textile industry in Ghana is the over concentration on revitalizing an industry that barely produced above 65% of its total production capacity even when in its prime

while paying little attention to a closely related field of great if not greater potential; *The Fashion Industry.*[7]

1.3 Analysis and Evaluation

The influx of foreign textiles into Ghana is not just a threat to the domestic textile industry but also a potential for the processing of textiles; a secondary product, to the final product; *Clothing*. Diversity in the industry would create employment, improve the economy and market dynamics and improve the Ghanaian fashion industry. Research conducted by the Multilateral Investment Guarantee Agency (MIGA), under the World Bank showed that Ghana's labour market availability in the textile and apparel industry is higher than the Africa average. This could be attributed to the economic policies implemented above; however this is not enough to improve the industry. [13]

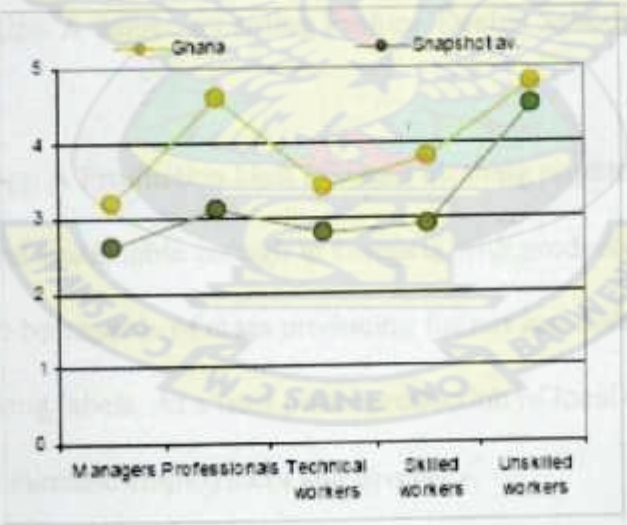


Fig 1.3 Labour market availability in the apparel industry

Ghana needs to change its image from a mere investor destination with cheap labour and raw materials (like most third world countries), to developing and showcasing *signature Ghanaian products* of the finest quality, produced and financed locally but advertised internationally through AGOA etc. That is, concentrate on quality and show the ability to mass produce at this

level and the spotlight will fall on us. With this approach when AGOA expires, Ghanaian textiles, clothing and fashion would be a trademark and foreign investors will look for us because of a unique set of Ghanaian design skills and not just our "cheap" labour. This way, we will no longer beg for investors and struggle with exports because our finished products will be peculiar to us.[1]

1.4 Proposals

Over the past decade, the Ghanaian entertainment industry has grown rapidly, implying a direct growth in the fashion industry since both industries feed off each other. With the high local demand for fashion and the AGOA advantage, I propose that the following projects be implemented.

1. Educational facilities: A degree-awarding Fashion Design School since Ghana does not have one.
2. Production facilities: A Production Unit for mass clothing production. This must be energy efficient and sustainable enough to compete with production in other parts of the world. It must also be capable of mass producing for not just domestic but also international clothing labels. At a later phase production of local clothing accessories could be added to increase employment and diversity.
3. Marketing and Commercial Facilities: A Runway-Auditorium for fashion shows and ancillary facilities.

The scope of my project is to design the second and third proposals only, under the topic, *Clothing Factory Design*.

1.5 Definition of Clothing Factory

A Clothing Factory *is a building or group of buildings purposely designed for the manufacturing of clothes on a large scale using machines or automation for the public*. Though clothing is defined as "any covering or garment meant to be worn on the human body", my clothing factory is for the production of *shirts, skirts, "kaba and slit" and dresses*. The factory will have all basic facilities required for the design, production and marketing of clothing.

1.6 Objectives

- To design an energy efficient clothing factory.
- To design with sustainable technology and simple construction methods.
- To provide facilities that will advertise the factory products and Ghanaian fashion as a whole.

CHAPTER TWO

LITERATURE REVIEW

2.1 The Modern Clothing Factory

Industries around the world agree that sustainable production plants that address environmental, social and economic issues are key to the success of any industry in the 21st century. Clothing factories are no exception and leaders in the clothing industry such as *Marks and Spencer, Next etc* concur.

Sustainable development is a difficult concept to grasp especially in the clothing industry. However Marks and Spencer; the largest clothing retailer in the United Kingdom (with a pre-tax profit of £1 billion in 1998 alone) set the trend by constructing the first purpose-built green clothing factory; Mas Intimates Thurulie, Sri Lanka in 2007/2008 in conjunction with the Holcim Foundation for Sustainable Construction (an NGO) and the Government of Sri Lanka. [4]

To make sustainable construction easier to understand, evaluate, and apply, the Holcim Foundation for Sustainable Construction developed a five-point definition. These five so-called "target issues" served as yardsticks to measure the degree to which the clothing factory contributes to sustainable development.

1. *Quantum change and transferability:* Significant advancements in construction practice, if applied on a broad scale, can contribute much toward global sustainability. Important advances must be recognized as such and repeatedly applied to achieve significant change. Practices and ideas that transfer best are those that are affordable, simple, and broadly applicable.

2. *Ecological quality and energy conservation:* Sustainable buildings conserve finite resources and minimize greenhouse gas emissions. Good built environments are healthful for humans, animals, and plants. Green buildings help keep the natural environment and ecosystems healthy by reducing waste, controlling pollution, and treating land, air, and water as precious resources.
3. *Ethical standards and social equity:* In many communities, sustainable construction principally involves supplying urgent basic needs such as shelter, water, schools, and access to goods, services, and medical care. Towns and buildings must respond to emotional and psychological needs of people by providing stimulating environments, raising awareness of important values, inspiring the human spirit, and bonding society. Sustainable construction also includes fair and respectful treatment of everyone involved during the design, construction, use, and recycling of buildings and cities.
4. *Economic performance and compatibility:* Every building must be financially feasible to build, operate, maintain, and ultimately remove. Sustainable buildings can help balance the distribution of wealth by supporting the disadvantaged. This can be achieved by establishing long-term new bases for livelihoods, stimulating local economic activity, and paving the way to broader economic integration.
5. *Contextual and aesthetic impact:* Sustainable architecture is durable and adaptable. It provides an attractive, comfortable, and functional indoor environment. It enhances its surroundings, fitting functionally and aesthetically into the community setting. It provides culturally relevant indoor and outdoor spaces.

The above principles set the standards for modern clothing factory design. Mas Intimates Thurulie is discussed in more detail in the next chapter. [12]

"Sustainable factory design is important because industrial manufacturing not only consumes substantial energy and material resources, but directly or indirectly accounts for significant emissions of pollutants and greenhouse gases. The factory as a building type has emerged over the last two centuries as a machine for mass production, with little concern for environmental or social effects. Factory owners and designers who wish to advance beyond this model must dismiss all preconceptions of what a factory is." Peter Spirig, CEO of Holcim Foundation, Sri Lanka. [4]

2.2 Designing a Sewing Centre

A well designed, convenient sewing area; large or small, saves time and energy. Careful planning is important for the area to be functional. Whether it is a corner or an entire room or building, the basic requirements are the same.

A cutting area

A sewing area

An ironing area

The space must be relatively quiet with an *area for business records*, as well as an *area to store equipment, notions, fabrics, finished garments* and other *related supplies*. The area must be open, well lit and spacious. [8]

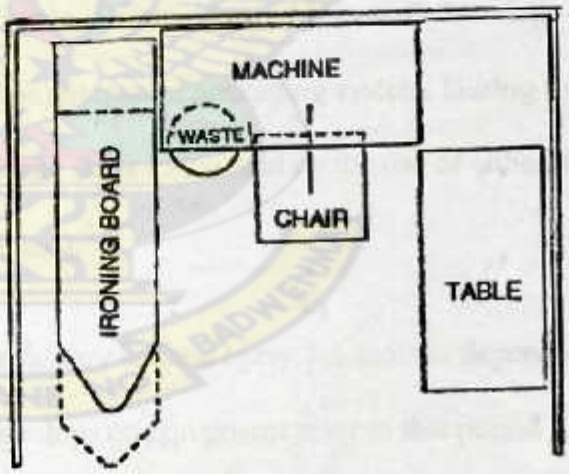


Fig 2.1 Basic domestic sewing set-up

2.3 Clothing Factory Staff

Clothing factory staff include, the factory manager, production manager, human resource department, design department, merchandising department, forecasting department, accounts department, store manager(s), machine operators, ironers, packagers and supervisors, quality control personnel, import and export department, maintenance staff, security personnel and janitors. Where a large number of workers are involved, they are grouped into production lines. The workers are grouped into machine operators, cutters and ironers. Material is transferred from one processing stage to the next by manual or automated in-line feeders. Each production line has a team leader and supervisor(s) for easy coordination. [6]

2.4 Equipment and Maintenance

The basic equipment required for efficient functioning of a clothing factory are; fabric inspection machines, automarkers, fabric cutters, fusion machines, different types of specialist sewing machines, industrial ironing set-ups and a manual or automated packaging system. During the production process, materials are transferred from one stage to the next by the use of either, hand trolleys, conveyor belt systems, goods lifts or by hand). [2]

Routine maintenance of all equipment used at the factory is done every 2-6 months depending on the factory management. However, if a fault develops on equipment prior to this period it is immediately serviced and work resumes.

2.5 Production Process

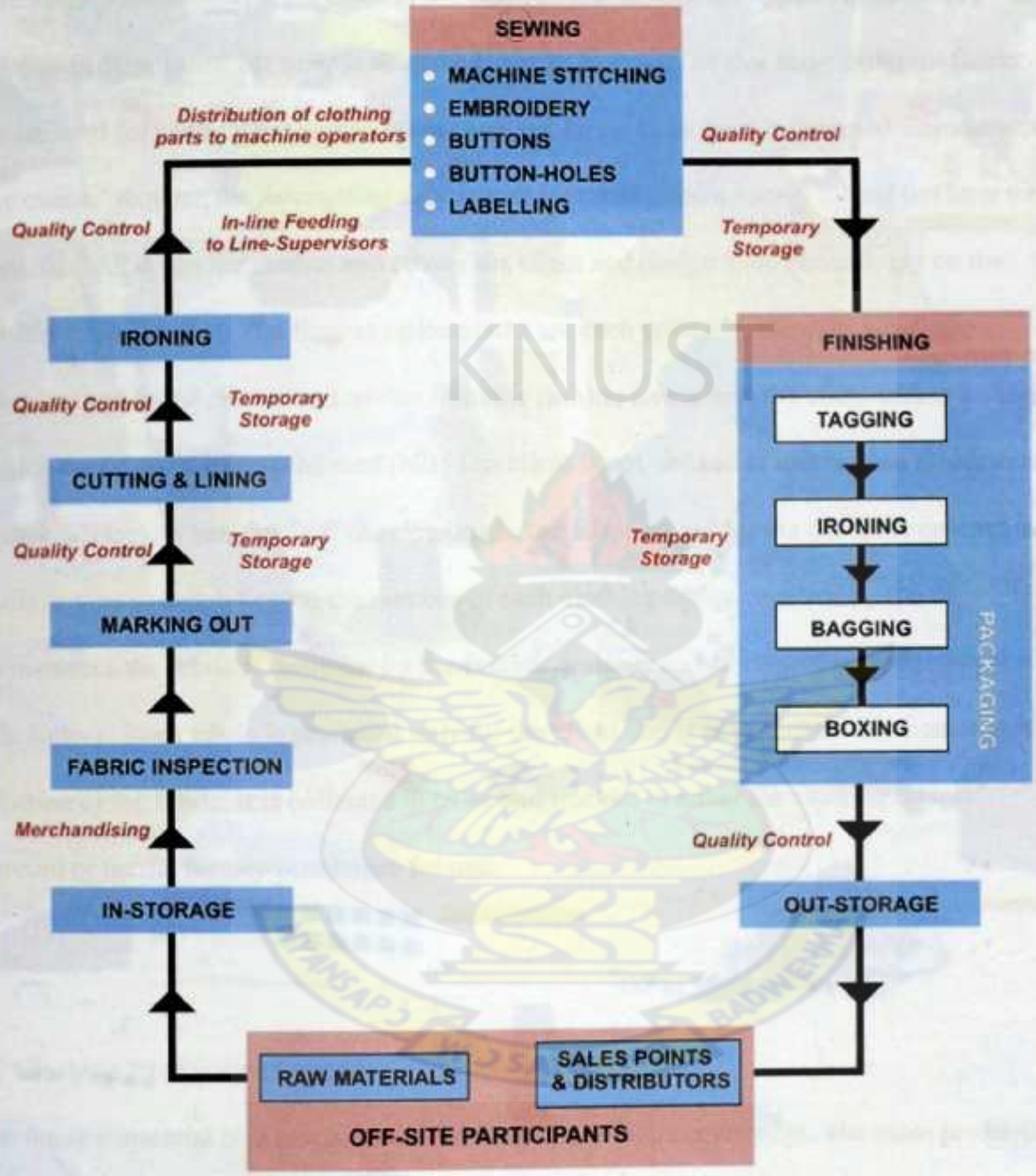


Fig. 2.2 Production Process Summary

The entire clothing production process is elaborated below. It gives a clear understanding of the different spaces required for administrative, production and post-production.

2.5.1 Pre - Production Process

Before mass production of any clothing, the client first describes the apparel to be mass produced to the design department for *sample design options* to be made. At this stage different fabric types are used for each option and in some cases the fabric to be used is designed from scratch. At the clients' request, the *forecasting department* is tasked to do a survey to find out how well the product will do on the market and advice the client and design team accordingly on the feasibility of the project. The final sample options are each costed by the *merchandising department* and based on this and advice from the fashion forecasters the client makes a choice on which one(s) to be mass produced (NB: The client is not obliged to use fashion forecasters or take their advice). When the final choice is made the fabric meant for the design is ordered from a textile company depending on the number of each clothing design required by the client. In most instances the fabric is designed by the fashion designer and or client for production at a textile factory. Such fabric is produced only for the client and is never put on the market. After production of the fabric, it is collected in bales and stocked in either the clothing factory storeroom or textile factory warehouse for use.

2.5.2 Clothing Production Process

When the raw material is in stock, actual clothing production commences. The mass production of clothing is a flexible process hence the layout could be either *linear, U-shaped or L-shaped*. A *production plan* is made by the production manager to enable the sewing team meet the client deadline(s). The machine operators are grouped into *production lines*. One line could range from between 10-50 workers or more depending on the production rate required to meet the

production deadline. At least one supervisor is assigned to every 20 workers (usually in the same line). The arrangement of equipment per line varies depending on the clothing type being produced and the number of clothing pieces required.

Fabric from the *in-store or raw material store* is inspected for flaws with a *fabric inspection machine*. If any flaws are found, the fabric is rejected and returned to the textile company. Otherwise, the cloth is coded and passed-on for *marking-out*; where the number of clothing pieces for every 6 or 12 yards of cloth is determined. Marking-out is either done manually or with an auto-marker. Each clothing part is marked and prepared for cutting. At the *cutting area* the marked parts are cut out using hand operated table top industrial fabric cutters or automated cutters. There are specialist cutters for each part. Where clothing parts require stiff lining, marking out and cutting is done for both the fabric and stiffener. After cutting the fabric is lined with stiffeners with a *fusion machine*. Each clothing part is *coded* according to fabric type, colour and type of stitching, long or short sleeve etc and then *bundled for temporary storage* on shelves and subsequently collected for stitching. Quality control personnel check for accurate marking out, cutting and bonding at the above stages to ensure easy stitching and low waste of fabric.

From the bundle shelf, the clothing parts are *ironed and sorted* according to the coding and transferred by *in-line feeders* to each production line. The line supervisors distribute the parts to the *specialist machine operators*. E.g. for shirt production, *the collar, labelling, front, pocket, yoke, back, sleeves, cuffs, side and sleeve joining, hemming, cutting button-holes and fixing buttons and embroidery* are all prepared by different workers for the same shirt. After each part is finished, it is again coded to show the level of processing. The parts are again checked by

quality control personnel and sent for mass ironing before the final assembly of all the parts is done by another group of machine operators in the same line. After this, another quality control check takes place. When everything is in order, the clothes are temporarily stored on shelves for *packaging*.

At the packaging department, the clothes are tagged with their specifications, ironed, bagged, and quality control-checked and assured, coded (batch numbers) and packed into boxes. The boxes of finished goods are coded, their number is documented and then packed into the *out or finished goods store*.

2.5.3 Post-Clothing Production Processes

Storage: The boxes are stacked on racks in the finished-goods store. The store must be kept dry and at a temperature less than 32 degrees Celsius.

Transportation and Distribution: The finished product is either collected by or transported to the client who in turn distributes the clothes to shops, institutions etc. in cases where the clothes have to be exported, the *imports and exports department* ensures that the product reaches the client by whatever means of transportation necessary (trucks, trains, ships, planes).

Marketing: Though not a requirement, it is possible to have a clothing factory that is involved in the marketing of the products especially if the factory belongs to a clothing label or some kind of fashion conglomerate. In the later case, *marketing and commercial facilities* could be added to the production facilities to aid in the advertisement of the products and showcase the handiwork of the factory workers. Examples of such facilities include *exhibition rooms, boutiques, beauty salons, runway auditoriums,* and any *ancillary facilities* that will draw attention to the clothing

factory and clothing labels that sew there.

Waste treatment: No toxic waste is produced during the manufacturing process. The dominant waste is *scrap cloth*. In cases where the cloth is custom designed for the project, the scrap is returned to the client unless otherwise specified by the client. Where the fabric used is "common" (on the market), remnant unused fabric is returned to the client but scrap fabric may be sold to market women for reuse. This must however be done with the permission of the client.[6]

2.6 The International Clothing Industry

During the last two decades, trade in clothing has grown significantly and developing countries have made a considerable contribution to this growth. In this period, apparel exports from developing countries increased sevenfold. According to UNCTAD, ***developing countries accounted for 76 percent of total world clothing exports in 2003***, compared with a 1985 figure of only 8 percent. Total global apparel trade was USD 462 billion in 2003 and has grown at a compounded annual rate of 6.6 percent since 1990. Market leaders in apparel exports include China, EU, Turkey, Mexico, India, the US and Indonesia.

The clothing industry is labor-intensive and offers entry-level jobs for unskilled labor in developed as well as developing countries. The majority of clothing is produced from textiles and fabrics across a very wide range of products, materials, styles and usage. Variations in this industry are unlimited and as fashions change and materials develop, new garments are being developed all the time as well as being re-invented. Moreover, ***it is a sector where relatively modern technology can be adopted even in poor countries at low investment costs***. This feature

of the industry has made it attractive as the first step towards industrialization for many poor countries such as Bangladesh, Sri Lanka, Viet Nam and Mauritius.

Elimination of quotas has benefited China, though increased fear of dumping of cheap Chinese apparel products has raised caution in markets such as the EU and the US. From this perspective, Africa could still benefit from a number of preferential trade agreements such as AGOA and the EU's Lomé Accord. As pointed out by a Value Chain Study conducted by UNIDO, sub-Saharan ***Africa currently lags behind other developing regions mainly due to poor transportation and communications infrastructure.*** These factors are very important to the functioning of apparel firms. Apparel exporters require ready access to inputs and global markets, streamlined customs procedures and reliable transport infrastructure. A number of countries are making an effort to both improve their communications infrastructure and to develop EPZs, and firms have benefited by establishing in many developing countries.

2.7 The Ghanaian Clothing Industry

The following observations were made by the Multilateral Investment Agency; under the World Bank in their January 2007 report.

• Investment in Ghana's apparel sector has increased since the announced eligibility for AGOA incentives in 2002, but total exports to the US and Europe are still rather low.

• Export-oriented apparel companies in Ghana produce a wide range of products including men's suits, women's clothing, casual wear, t-shirts, athletic wear and children's clothing. Apparel produced in Ghana is sold to markets in Kenya, Uganda, South Africa, Sierra Leone, the US, the EU, and Caribbean countries.

• Most imported fabric inputs come from Asia or other western African countries, but some apparel companies in Ghana have begun to import from the US and to export the finished goods back to the point of origin.

• According to interviewed firms, site selection in the capital city of Accra is a priority.

• Small apparel firms use Ghanaian employees. Large factories tend to hire expatriate workers from China, India and Europe for professional positions, while using Ghanaians as managers and skilled and unskilled workers.

• Ghana's rich cultural background features traditional apparel and provides export opportunities to Europe and the US. Large multi-national corporations (MNCs) have already purchased such apparel from Ghana.

• The Government of Ghana currently has a special initiative called the "Export Action Program on Textiles and Apparel" which is designed to develop a critical mass of high growth, internationally competitive export firms targeting US and European consumer markets. [13]

Table 2.1 Comparative SWOT Analysis for Clothing Industry (Ghana vs. *Snapshot Africa)*

Strengths	**Weakness**
1. Ease of sourcing local raw material inputs	1. Decrease in trade competitiveness
2. Weak current export performance	2. Good country credit rating
3. Ease of sourcing local component inputs	3. High water costs
4. Low country risk rating	
5. Business start-up procedures are minimal	**Opportunities**
6. Good rating on corruption perception	1. Ghana's rich cultural background features
7. Favorable labor relations	traditional afro-centric clothing, making the

8. Good availability of managers 9. Good availability of professionals 10. Good availability of technical workers 11. Good availability of skilled workers 12. Good availability of unskilled workers 13. Low wage rates for managers 14. Low wage rates for professionals 15. Low electricity usage charge 16. Low wage rates for skilled workers 17. Low wage rates for unskilled workers 18. Low site lease costs for industrial land lease	export of these products to Europe and USA an attractive target investment. Large multi-national corporations (MNCs) have already purchased a number of these products. Such products include: cotton apparels, pullovers, knitted and crocheted cardigans, suits and shirts. Apparel product exports would be facilitated through Ghana's eligibility for AGOA duty-free access to the USA market. It is important to note that there is significant local demand for ready-to wear apparel. **Threats** 1. The importation of used apparel and/or cheaper products from Asian countries threatens local market investments. 2. Other threats include Ghana's low purchasing power and the continued deterioration of textile and apparel production facilities. 3. Production of similar products by other ECOWAS states; hence competition with Ghana.

CHAPTER THREE

METHODOLOGY

3.1 Study Definition

At the end of the study a clothing factory is designed to address some of the problems of the clothing industry. An architectural design research approach is therefore used to identify the critical design issues to be solved. This includes case studies of clothing factories, interviews of fashion designers, fashion design students, tailors and seamstresses, and other relevant personalities in the field under study.

3.2 Sampling Methods

Choice of areas for study was such that data was collected on both local / Ghanaian and foreign works so that a global and unbiased picture on the topic is painted on the topic. However, since Ghana has a tropical climate, the foreign case chosen for study is also in a tropical region. This way, design approaches there can be creatively applied to the design proposal.

Purposive sampling was done to obtain the following information,

1. The basic staffing and spatial requirements of a purpose built clothing factory
2. The basic administrative and production processes of a clothing factory
3. To understand the demand and supply dynamics of my target products and hence guide me on the scale of the proposed factory and required workforce
4. To understand the international standards required for clothing production

5. To know design concepts related to mass clothing production
6. To know the technological advances made in the clothing production industry

Personalities interviewed were also specifically selected since a lot of the design issues to be addressed are quite subjective and it was necessary to get relevant information within the short time-frame for the project. Availability of some of these personalities was also a factor.

3.3 Data Collection

Information was gathered from a wide range sources; resource persons, students, lay-men (customers of clothing). Semi-structured interviews were used to draw valid information from the various classes of respondents. One-on-one interviews were done with fashion designers, lecturers, tailors and seamstresses, Production and Human Resource Managers of PSI Garments Village, Tema, Country Manager of Woodin Ghana Limited. For students and working staff in the field, focus group discussions were held. All participants in the discussions volunteered. From these interactions, opinions were sorted and analyzed in collaboration with personal thoughts, ideas and judgments. No written questionnaires were administered.

Apart from data collected from the above sources, clothing factories were also studied using non-participant observation to obtain architectural information evident to the trained eye. Also, to comprehend the post-production processes of clothing; especially marketing, I participated in the organization of a fashion show by final year textile students of the College of Art, KNUST.

The tools used during the study include, a digital camera, pen and pencil, a notebook, a tape measure, and laptop.

3.4 Search Engines

Literature for the study was retrieved from the internet, books and journals, Wikipedia Encyclopedia, Encarta World Encyclopedia and resource persons. Google Earth was used to obtain aerial photographs of sites under study in addition to site plans from the Town Planning office.

3.5 Ethics

The research is purely academic and the findings will be used solely for the purpose for which this research was carried out; *to design an energy efficient clothing factory by using sustainable technology and simple construction methods and design ancillary facilities that will advertise the factory products and Ghanaian fashion as a whole.* The participants were made fully aware of this basic understanding.

3.6 Limitations

Some relevant persons in the area being studied were not interviewed due to their unavailability for data collection within the given timeframe of six months.

CHAPTER FOUR

CASE STUDIES

4.0 Introduction

The purpose of these case studies is to identify both positive and negative aspects of existing clothing factory design.

The structure of these case studies will be premise on,

- Adequacy and quality of functional spaces prevailing in these areas
- Lighting and ventilation of functional spaces
- Worker spaces and manufacturing processes in compliance with standards and safety of users.

The positive results from the studies will be incorporated into the design programming and the design of the proposed clothing factory design facility.

Three cases were studied to understand the functioning of clothing factories. These are,

- *The Presidential Special Initiative (PSI) Garments Village, Tema Freezone, Ghana;* to study the basic administrative, staffing, spatial requirements and production processes of a purpose built clothing factory
- *Woodin Ghana Limited, Tema Industrial Area, Ghana;* to understand the demand and supply dynamics of my target products and hence guide me on the scale of the proposed factory and required workforce
- *Mas Intimates Thurulie, Thulhiraya, Sri Lanka;* To know design concepts related to mass clothing production and the technological advances made in the clothing production industry.

4.1 PSI Garments Village, Tema Freezone

4.1.1 Overview

The garments village was established in 2002 under the Presidential Special Initiative programme to maximize the AGOA advantage in the government of Ghana's attempt to revive the textile and clothing industry. This was done to increase employment opportunities, expand and diversify the economy, promote both domestic and foreign investment as well as stimulate exports. It occupies 178 acres of the Tema Export Processing Zone. Proximity to the port provides easy access for the import of raw material and export of finished products to the USA and EU. Currently, one clothing factory has been built as part of the project and has been operational since 2003. The factory now has 240 machine operators though it has a capacity of 1200.

Fig. 4.1 The PSI Garments Village

4.1.2 Composition

The factory is made up of three identical blocks fenced with hedges and gated with a security checkpoint. A concrete frame and floor with sandcrete block walls is the construction system employed.

Fig. 4.2 Schematic Block Plan

Each one is a complete production unit with the following facilities,

- A security check point
- A reception
- Office spaces for administrative staff
- A sample room
- Service yard and loading bay

- In and Out Stores
- Inspection, marking out, cutting and fusion area
- A sewing area and ironing bays
- Packaging and quality control area
- Maintenance unit
- A first aid booth, lockers and washrooms

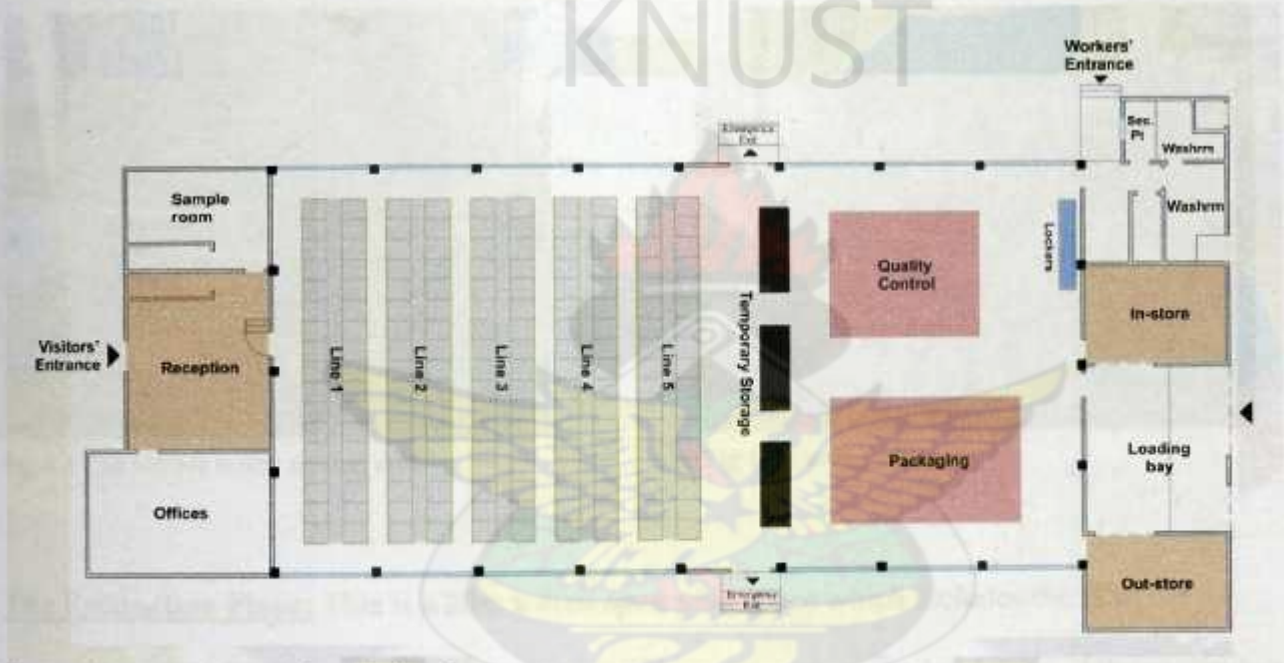


Fig. 4.3 Schematic layout of production floor

Each block has a 10 production line capacity (38-44 workers per line). However, the blocks are currently used as follows,

Block 1 – Production Floor

Block 2 – Cutting and Sampling

Block 3 – Mass storage of raw and waste materials

The Sample Room: Samples of various clothes to be mass produced are made here. It is a (3 x 4)m sewing room equipped with a dummy (for fitting clothes), cutting, ironing and sewing areas, a storage cabinet and hangers and a washroom. Unfortunately, there are no notion boards. The sample room is lighted and ventilated naturally but these are supplemented by two 36 watt fluorescent tubes and a fan when necessary. The floor and walls are ceramic tiled and plastered with a paint finish respectively. A plywood ceiling is used.

Fig 4.4 The sample room; sewing area

Fig 4.5 Cutting table

The Production Floor: This is a 20m x 40m ***open plan*** space which includes the fabric inspection, marking out, cutting and fusion areas the sewing area, ironing bays and the packaging and quality control areas. 0.4m x 0.4m columns are positioned at 5m centres. The open plan is necessary due to the flexibility of the production process. Separation between the various areas is done by the use of ***epoxy paint floor markings***.

Spatial Use: Of the 800m^2 production floor, fabric inspection, marking out, cutting and fusion areas occupy approximately 15%. About 70% is used for sewing and ironing and the rest is used for packaging and final quality control checks.

The space has a 7m ceiling height from which fluorescent tubes and sockets are suspended 1.5m - 3.0m down to light the working areas and power factory equipment respectively. Suspension of the sockets from above leaves the floor free for re-arrangement of production lines and avoids the use of extension cables and trunking from walls to the middle of the space. The ceiling height is however unnecessarily high.

Fig. 4.6 Open plan production floor

Fig 4.7 Suspended artificial lighting & sockets

Lighting and Ventilation: Natural lighting is provided by 6-bay high 0.8m x 0.8m glass louvre windows spread along either 40m side. This is supplemented *by artificial lighting* of approximately ***17 watts per square metre.*** No machine mounted lamps are used for sewing. Though temperatures sometimes exceed 29 degrees Celsius, no artificial ventilation is used.

Fig 4.8 Fluorescent lighting of aisle

The Sewing area: As shown in Fig. 4.3, the machine operators are arranged in production lines. Two columns; 0.7m apart, make one line. A 1.2m wide aisle separated one line from the next. Each line is lighted by an array of fluorescent lights as shown in Fig. 4.8

Fig. 4.9 The ironing bay

The Ironing bay / area: Ironing is done manually by use of an industrial steam iron that occupies an area of 1.2m x 1.2m x 2.5m each.

Transportation: Materials are transported from one stage to the next by hand and or hand trolley to temporary storage shelves. They are then collected by in-line feeders and distributed to the required destinations.

Finishes: the walls, floor and ceiling are finished with plaster and paint, PVC tiles and painted plywood respectively.

Fig.4.10 Loading bay

Fig. 4.11 Packaging area

Fig. 4.12 Sewing area

Fig. 4.13 Maintenance unit

Fig. 4.14 Quality control

Fig. 4.15 Lockers

Fig. 4.16 Drinking water jar

Fig. 4.17 Fire extinguisher

Fig. 4.18 Paint floor markings

Fig. 4.19 Storage shelves

Fig. 4.20 Raw material store room

Fig. 4.21 Machine study summary

4.1.3 Merits and Demerits

Merits

- Easy access to raw materials due to proximity to textile companies; Ghana Textile Products Limited, Ghana Textile Manufacturing Company, Akosombo Textiles Limited and Printex.
- Proximity to the Tema Harbour eases transportation of products for export.
- The design of identical production units with office facilities is advantageous because each unit can be rented to different managements for the production of different types of clothing and easier management.

Demerits

- Security at the factory is loose; workers use a route in front of the security booth instead of through it.
- Relatively high production cost hence few clients.
- It operates at about 16% of production capacity.
- No energy saving equipment and lighting.
- Currently, there is no mains water supply.
- The factory is secluded with no marketing facilities.
- Currently, there is no workers canteen.
- Storage space is wasted due to the absence of racks for organised stacking of raw materials and products.
- No fashion forecasting and survey department
- No notion boards on walls.

4.2 Woodin Ghana Limited, Tema Industrial Area

4.2.1 Overview

Woodin is a leading Ghanaian fashion label popular for the production of African cloth and clothing. The company is under the management of Textile Products Limited, along with GTP. The administrative structure of Woodin is as follows; *managing director, country manager, fashion design and sewing team, boutique managers, boutiques supervisors, sales personnel.* Woodin currently makes only men's shirts for sale.

Fig. 4.22 Woodin clothing factory (sewing room)

The sewing department currently has 15 workers and ***produces 800 shirts per month***. Woodin boutiques in Accra each sell up to 80 shirts per day. Of the 15 workers, 12 are trained tailors / seamstresses and the rest are ironers. Sometimes, national service persons join the staff. Of the 12 tailors/seamstresses, 7 are female. Female clothing is currently not in production at Woodin, however the company supplies fabric to various fashion houses for clothing to be made and tagged with the Woodin label. Woodin plans to triple production and add an in-house female clothing line by the end of 2009.

4.2.2 Composition

Woodin does not yet have a purpose built clothing factory. Their current work area is a rented space on Ghana Textile Product Limited's factory premises. It is made up of two rooms occupying a total area of 104m^2. 30% of this area is used for cutting and sampling and the rest is used for sewing and packaging. Woodin uses GTP's the finished goods store as their raw material store and finished goods are packaged and sent to destination boutiques daily.

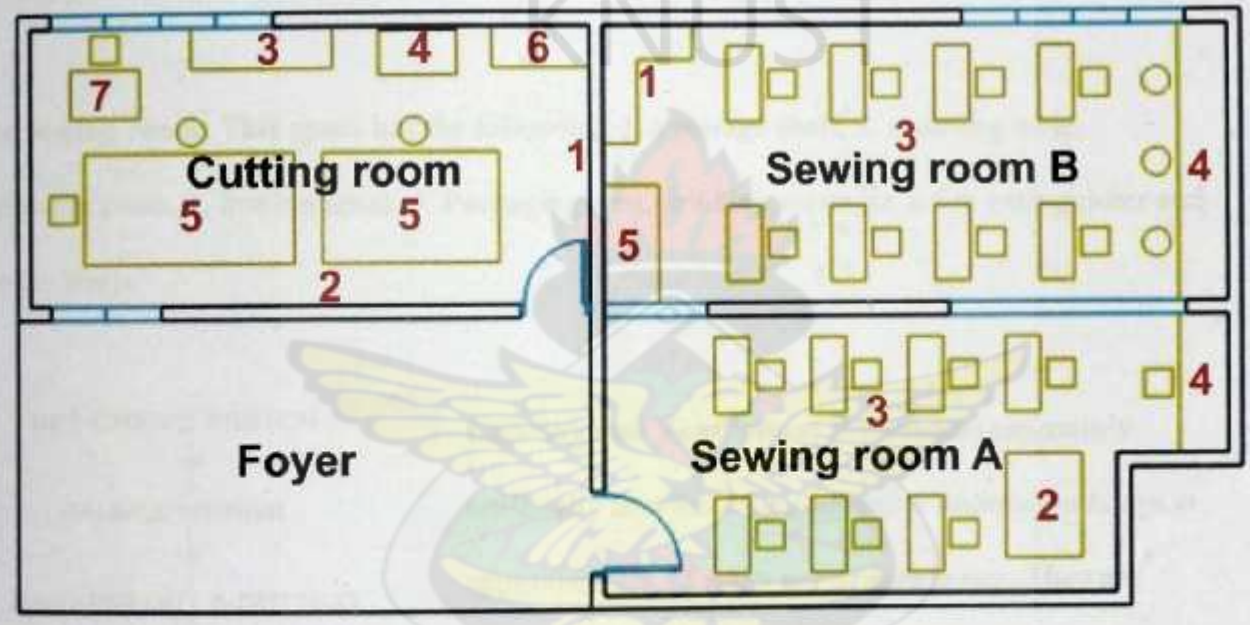


Fig 4.23 Schematic layout of Woodin clothing factory

The Cutting Room: This doubles as the sample room and has the following; 1. a discussion board, 2. display or notion wall, 3. storage cabinet, 4. sewing machine, 5. cutting tables, 6. fabric and thread storage and 7. a supervisor's desk.

Fig. 4.24 Cutting tables

Fig. 4.25 Storage shelves

The sewing room: This space has the following; 1. a storage shelf, 2. a sorting table, 3. Sewing areas, 4. Ironing areas, 5. Packaging area, drinking water jar, a fire extinguisher and display walls.

Fig 4.26 Production process (above)

Lighting and Ventilation: Both rooms are mainly artificially lit with ceiling-mounted fluorescent lamps at approximately ***25 watts per square meter***. They are ventilated purely by split air-conditioners.

Finishes: the walls are finished with plaster and paint, the floors with linoleum mats, and the ceiling, with painted plywood. The cutting and sorting tables are finished with formica.

Fig. 4.27 Sewing room

Fig. 4.28 Packaging area and storage shelves

Fig. 4.29 Air-conditioner

Fig. 4.30 Wall-mounted fire extinguisher

Fabric scraps are currently sold to local craftspeople and market women.

3.2.3 Merits and Demerits

Merits

- Proximity to source of raw materials.
- Proximity to the Tema Harbour eases transportation of products for export.
- An intimate workspace due to its relatively small size. This is advantageous since clothing design and production is people-based and highly interactive.

Demerits

- Inadequate natural lighting
- No direct or internal link between the cutting and sewing rooms
- Sewing area is noisy since the workers use separate radios
- Inadequate storage and unsightly exposed storage
- No security checkpoint
- No washroom facilities
- Inadequate power points hence unsightly use of extension cables and trunking
- No filing area for the supervisor
- Floor finish (linoleum) is not resilient. Hence it is torn and unsightly

Fig. 4.31 Torn linoleum floor finish

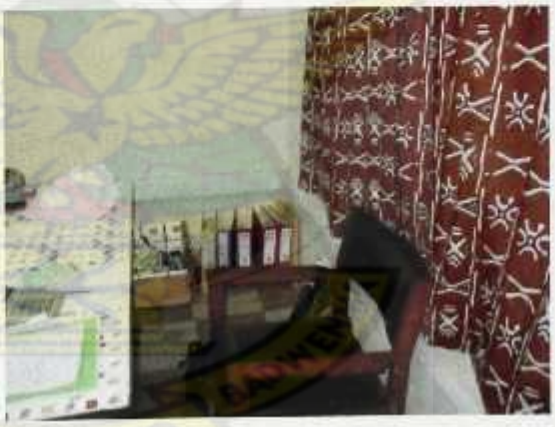


Fig. 4.32 No filing shelves for records
(Files on the floor)

4.3 Mas Intimates Thurulie, Thulhiraya, Sri Lanka

4.3.1 Overview

Fig. 4.33 Mas Intimates Thurulie

Clothing production and export accounts for two thirds of Sri Lanka's industrial product. The three-billion-dollar industry is the country's largest export earner. Marks and Spencer joined forces with Mas Holdings; the largest clothing manufacturer in Sri Lanka, to design a green clothing factory as part of their social sustainability program.

As a result this world class clothing factory was designed, built and commissioned in 13 months. The factory was opened in 2008. The designers of MAS Intimates Thurulie concentrated on environmental and social criteria. The approach led to an extraordinary factory that is not a sweatshop, but a workplace in unison with nature.

4.3.2 Technical Data

Climate: tropical, humid

Site Area: 52,434 m^2

Parking: 10 spaces for vehicles and 25 for bicycles

Building volume: 48,486 m^3

Maximum number of occupants: 1,300

Gross usable floor area: 7,854 m^2

Construction: concrete and steel framing; compressed stabilized earth block exterior walls; zinc-aluminum roofing and green roofs

Construction cost: USD 2.66 million (338.50 USD/m^2)

Construction cost of typical factories in Sri Lanka: 308 USD/m^2

Annual operating cost: 0.3 USD/m^2

Annual operating cost of comparable factories in Sri Lanka: 1.61 USD/m^2

4.3.4 Composition

It is a two storey factory made up of three production units; each orientated North-South with a central storage unit and linked by East-West walkways and a welfare unit. In contrast to the industry norm, in which the typical factory is a single large hall, the lean-production standard requires smaller production areas, each containing a complete value stream, from cutting fabric to packaging finished garments.

Fig 4.34 Block plan of factory

The production floors are free from columns and other hindrances, so that each production cell can arrange its machinery to best suit the garments being made. The arrangement of electrical receptacles and lighting fixtures provides the same flexibility. The production areas and offices are visually connected to enhance direct collaboration.

Fig. 4.35 Ground floor plan

Each hall has its own service spaces including a mechanics room, meeting rooms and toilets. The collaborative style of working at the plant requires places for impromptu meetings without the confinement of isolated meeting rooms, hence the introduction of ***'relaxstations'***. The upper floor is linked to the lower one by staircases and goods lifts.

4.3.5 Construction Materials

To reduce the gray energy in the building, the main exterior walls are made of compressed stabilized-earth blocks manufactured forty kilometers from the site. The blocks, made of local soil, sand, and locally manufactured cement, are machine molded with a wire-cut finish and chamfered corners. The walls require no plaster finish and are simply sealed with varnish on the interior and exterior.

Fig. 4.36 Use of stabilized earth blocks with a steel and concrete skeletal frame (above)

The building is framed in concrete and steel with a high recycling content. Roofing is zinc-aluminum. Windows are metal framed. Floor finishes include polished concrete tile, rendered and cut concrete, tile, and wood. Bamboo is used for window blinds and various forms of sunscreen. Non-hazardous finishes and materials are used throughout the building, ensuring good indoor air quality, which is aided by a high rate of air exchange. Partitions are made with gypsum board and tabletops, with MDF. No viable greener alternatives are available in Sri Lanka.

Aesthetics of MAS Intimates Thurulie is fashioned by the interplay of linear structures softened by the organic forms of trees. The structure is finished with exposed steel and ducting, with soft brown brick walls. Art and antiques add character to the spaces, and the bare walls are adorned by colorful posters of lingerie models and the key environmental messages of the factory.

4.3.6 Indoor Thermal Comfort

The air in production spaces and offices is cooled and exchanged by a system of ***evaporative cooling units.*** These units intake outdoor air, filter it, and treat it with atomized water. The air is then distributed through ducts to the spaces, which remain under positive static pressure. Exhaust fans help replace the air at a rate of about 40 air changes per hour. Indoor air movement is perceptible.

4.3.7 Energy Efficiency

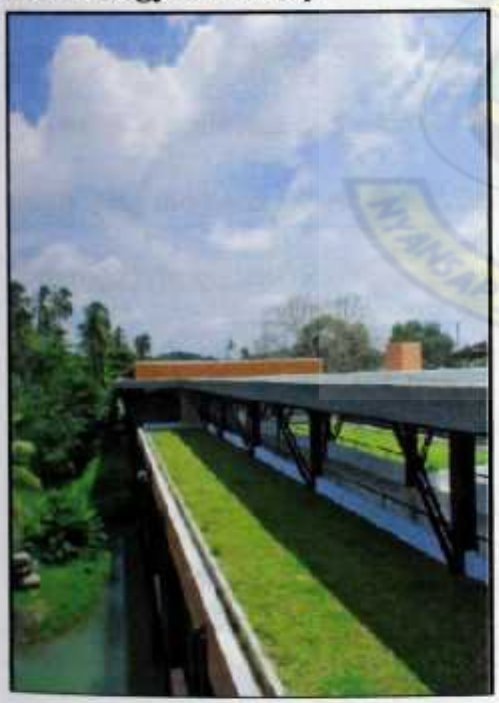


Fig. 4.37 Green and cool roofs are used to reduce the thermal load

MAS Intimates Thurulie was designed for low energy consumption by reducing power demand and by using efficient equipment. Energy consumption for lighting was reduced by maximizing daylighting and by using well-designed systems with efficient lamps. Offices, cafeteria, lounge, reception area, meeting rooms, and board rooms are normally illuminated by daylight only.

In conventional factories the whole production floor is floodlit at a uniform high intensity.

At Thurulie, aisles are illuminated with natural and ambient light, and work areas are illuminated with task lighting – ***high efficiency T5 tubes and LED lamps*** mounted on the sewing machines – focusing the correct amount of light at needlepoint. The system requires about half the number of light fixtures. Every light fixture can be easily repositioned and switched on and off individually as required. Sewing machines with ***direct-drive servo motors*** were chosen for energy efficiency, as were laptop computers.

Fig. 4.38 A direct-drive servo motor operated, LED mounted sewing machine

4.3.8 Water Management

Consumption of potable water is about half that of comparable plants. Rainwater that falls on the cool roofs is collected and used for flushing toilets. The storage tanks and toilets are gravity fed, eliminating the need for pumps. When the tanks run dry during a drought, water is sourced from the main system. Rainwater covers ninety percent of the flushing needs.

Wastewater from all plumbing fixtures is treated on site in an ***anaerobic plant***. The system uses very little power – relying primarily on gravity in moving wastewater and sewage to the plant using pumps only for the last phase. The plant by itself does not consume power and generates bio gas, which is captured and used in the kitchen.

The factory uses potable water only for cooking, washing, drinking (after filtration), for the evaporative cooling system, and as a backup for flushing toilets. ***Dual-flush toilets and low-flow plumbing fixtures minimize water consumption.***

4.3.9 Clean Energy

The plant uses clean energy only, and in several forms. The rooftop photovoltaic system with a capacity of 25.6 kilowatts generates ten percent of the power required. A small hydroelectric power plant connected to the public grid provides the other ninety percent of the factory's power. Thus the plant's two primary energy sources, photovoltaic and hydroelectric power are renewable and carbon neutral. The plant is equipped with a vacuum-tube system for solar water heating. Water is preheated in the tubes and then heated in conventional boilers. Methane gas from the sewage-treatment plant is collected for firing stoves and ovens in the kitchen.

Fig 4.39 Photovoltaic roofing is employed to generate 10% of the factory's electricity

4.3.10 Green Manufacturing

Empty thread cones are ***recycled*** as are paper, plastics, glass, and metal. The plant is collaborating with Marks & Spencer to develop a ***fabric-defibering system*** for fabric waste. Fabric scraps currently go to local craftspeople. The company seeks to reduce transport-related CO^2 emissions by promoting carpooling and offering financial incentives for employees who commute by bicycle or bus. Finished products are shipped to Europe by sea, the most environmentally efficient mode of transport. [4]

4.3.11 Merits and Demerits

Merits

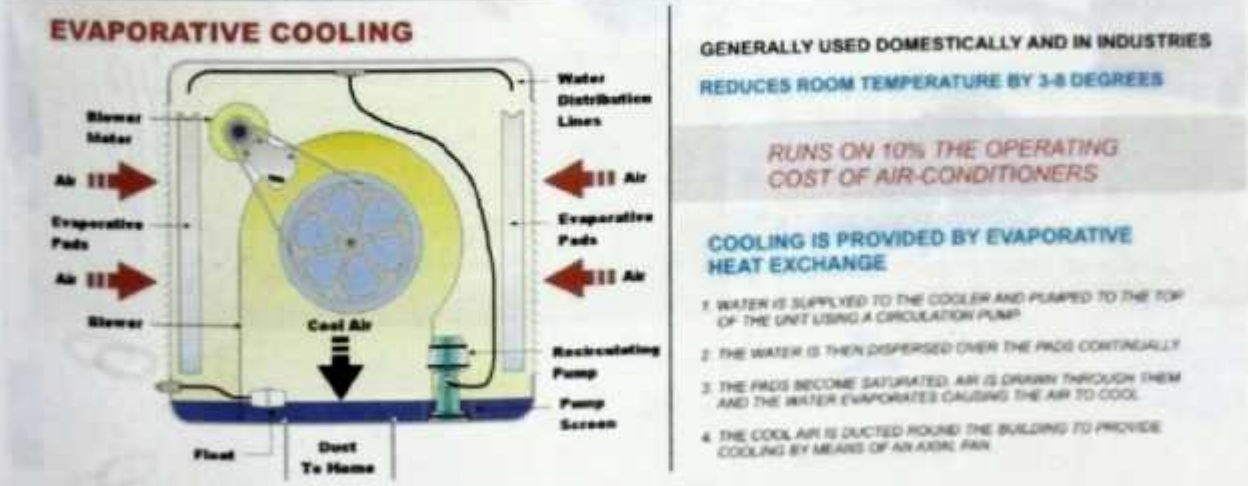
- A comfortable working environment
- It is energy efficient and uses locally acquired construction materials and building methods
- The decentralized industrial process makes climate control more efficient
- Visual connection between supervisor offices and production floors
- The just-in-time production process reduces required storage space for raw materials and finished goods
- Its running cost is approximately 20% that of comparable clothing factories

Demerits

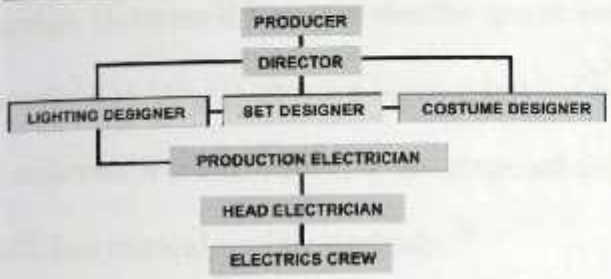
- The building cost 25% more to build than comparable factories.

4.4 Technical and Special Studies

The biggest problems with management of industries are high production cost and high running cost. Others are thermal control, worker comfort and marketing of products. Studies on *Rainwater harvesting, Photovoltaic roofing, Evaporative cooling and. Runway auditorium design were done to address these issues.*[11]



AUDITORIUM LIGHTING DESIGN



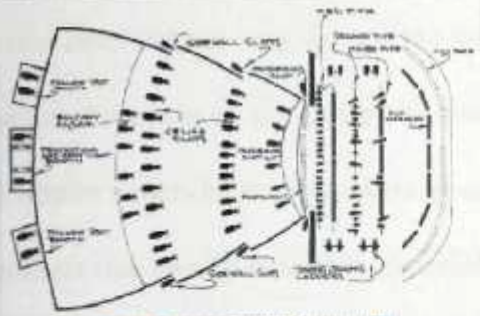
LIGHTING DESIGN CHAIN OF COMMAND

GOOD LIGHTING FOR ALL STAGES IS VERY IMPORTANT. FOR RUNWAY AUDITORIUMS THIS IS EVEN MORE CRITICAL

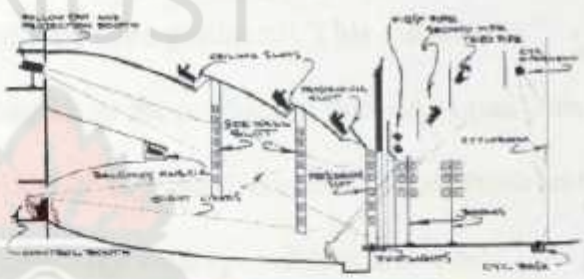
*THE DRAWINGS BELOW SHOW **STANDARD LIGHTING POSITIONS** FOUND IN MOST THEATRES.*

THE LIGHTING POSITIONS INCLUDE

- CEILING COVES
- BALCONY RAILS
- WALL SLOTS
- BOX ROOM
- OVERHEAD STAGE PIPES
- FLOOR LIGHTING
- FOOTLIGHTS



PLAN OF PROSCENIUM AUDITORIUM



SCHEMATIC CROSS-SECTION THROUGH PROSCENIUM AUDITORIUM

TYPES OF LIGHT FIXTURES

SPOTLIGHTS
(5-70 degree spread)
DISTANCE: 15-150ft

FLOODLIGHTS
(70-150 degree spread)
DISTANCE: 3-25ft

PROJECTORS

STRIP LIGHTS (SERIES OF FLOOD LIGHTS)

RUNWAY WITH LIGHTING INSTALLATIONS

THE FASHION RUNWAY

THE RUNWAY MUST BE AT LEAST 20ft LONG AND 4ft WIDE

- **WHEN THE RUNWAY IS RAISED ABOVE THE FLOOR IS CALLED A CATWALK**
- **FOR FASHION SHOWS AERIAL LIGHTING IS MOST CRITICAL. SIDE LIGHTING IS USED AS A SUPPLEMENT**
- **STAGE LIGHTING FIXTURES RANGE IN WATTAGE FROM ABOUT 300 WATTS TO OVER 10000 WATTS IN SIZE AND CAPACITY**

4.5 Conclusion

From the cases studied, it is clear that there are different design approaches to clothing factory design. However it is crucial that the spaces are well lit, preferably *naturally, with supplementary artificial lighting* to obtain a lighting level of at least 50 footcandles for efficient work. *Energy conservation* is also critical hence proposed use of LED lamps, photovoltaic roofing and energy efficient tropical cooling methods. [10]

An *open plan design* is necessary because of the versatility this gives in the arrangement of production lines (which vary depending on clothing type to be produced). This dictates the installation of sockets on the ceiling to avoid impedance on the production floor. An open-plan also facilitates supervision of workers in each line. Relatively *simple construction methods* and the dominant use locally available materials and technology where possible is also vital.

All the above with the incorporation of ancillary facilities that *improve worker comfort* and marketing of factory products will evolve into a unique clothing factory that addresses the problems discussed in Chapter One. [4]

CHAPTER FIVE

THE SITE AND DESIGN PROCESS

5.1 Site Selection

The Greater Accra Region was considered for the following reasons;

- Relative proximity to all 4 major textile companies; ATL, GTP, GTMC and PRINTEX, hence ***access to raw materials***
- Proximity to the Tema Harbour and Kotoka International Airport for easier ***transportation of products for export***
- The Greater Accra Region is the highest migration destination in Ghana, hence a comparatively high unemployment thus ***labour availability***
- The Greater Accra Region has the highest ***demand for fashion*** due to higher and rapid growth of the entertainment industry.

Areas considered for location of the factory are, Tema Freezone, areas along the Spintex Road, and Prampram. The strengths and weaknesses of each area are compared below.

Strengths	**Weaknesses**
Tema Freezone • *Vast land for expansion* • *Proximity to the Tema Harbour* • *Existing power and water supply and advantage of economy of scale*	• *The environment does not suite the marketing criteria required due to seclusion of the site* • *There is an existing clothing factory on the site*

Spintex Road • *Already an urban industry destination* • *Power and water supply* • *Vast land for expansion* • *Proximity to PRINTEX (raw material source)* • *Proximity to Tema Harbour and Airport* • *Proximity to the Accra Mall* • *Easily accessible by workers from Tema,* Accra *and Spintex areas* • *Good views from both the Spintex road and Accra-Tema motorway*	• *Traffic congestion on the Spintex road* • *Building height restrictions due to proximity to the Kotoka International Airport Runway*
Prampram • *Vast land for expansion* • *Vehicular access* • *Power and water supply*	• *Difficult worker access for Accra commuters* • *Poor advertisement* • *No advantage of economy of scale*

Table 5.1 Strength and weakness comparison of various sites

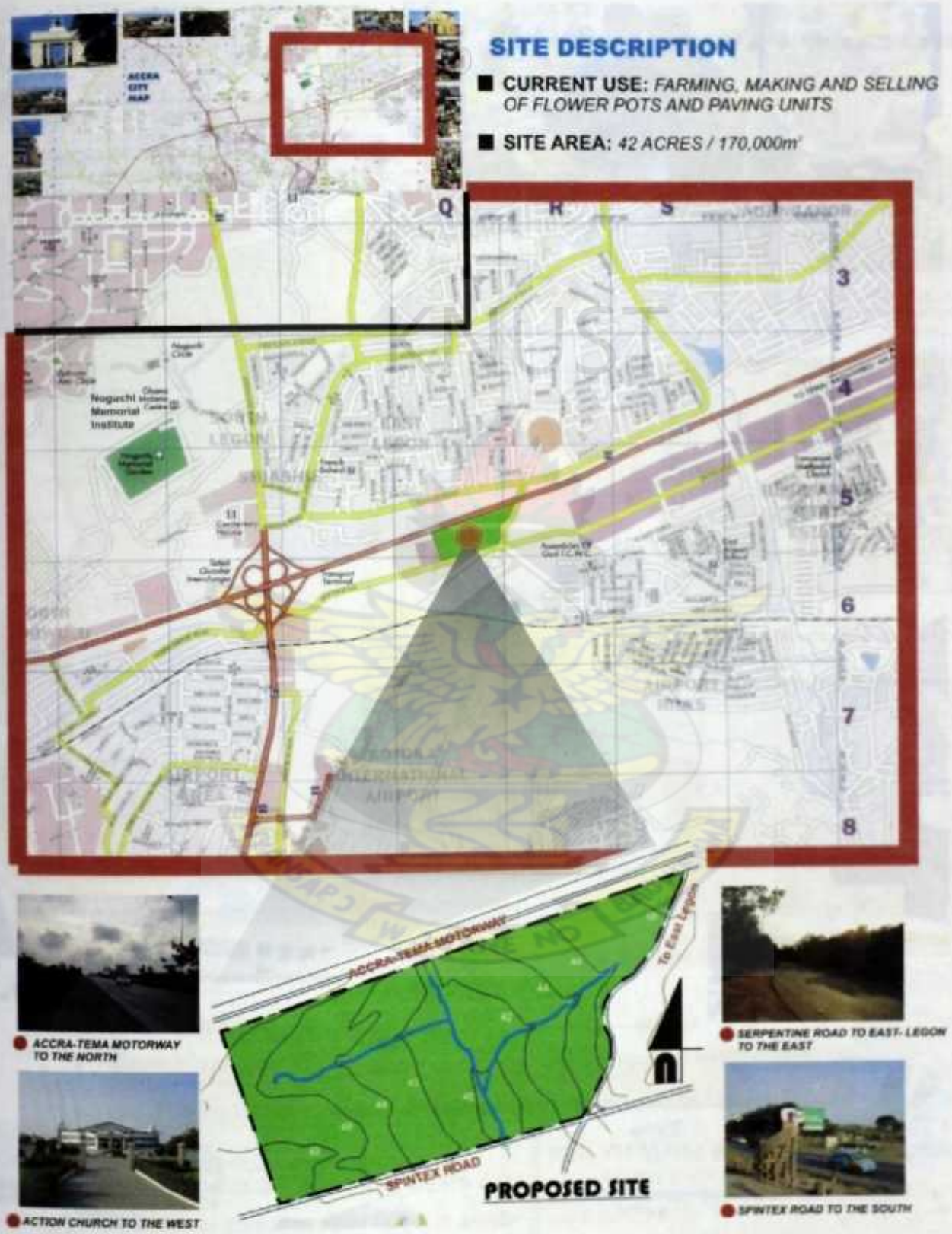
Based on the above analysis, the Spintex area was chosen for the siting of the clothing factory.

Fig. 5.1 Proposed site

Some other industries on the Spintex road are

- *Printex*
- *Dark and Lovely Ltd*
- *Consar Ltd*
- *The Flower Pot Industry*

5.2 Site Location



5.3 Site Conditions

5.4 Design Philosophy and Concepts

The philosophy of this project is; **"THE MIND TO THE RUNWAY"**, that is, it includes educational facilities required to train fashion designers (*the mind of fashion*) and a fashion design studio, production facilities, to bring the ideas of the designers to life and finally, marketing facilities that will advertise the products to the public *(...the runway)*.

The design is driven by the use of ***sustainable technology***; photovoltaic roofing, rainwater harvesting, evaporative cooling, the use of direct-driver server motor equipment, low-flow plumbing fixtures, T5 tubes and LED lamps and the use of stabilized earth blocks for the production units.

Another driving force for the design is ***worker comfort.*** This is translated into design by the north-south orientation and cross ventilation employed for the production units. A *decentralized production system* was used to allow the design of smaller production units and make thermal control of the buildings easier. Since the clothing production process is an intimate and people-based one, seating of machine operators is grouped into *small clusters* of 8-10 (as opposed to long chains of workers) to reduce the industrial feel of the space. An outdoor "*relaxstation*" is provided for use during breaks and for receiving of visitors. Finally, each production unit has in-built sanitary facilities and first aid units for the workers.

In the fashion industry ***marketing*** is critical to the sale of all products hence the provision of a *runway auditorium, exhibition areas, a boutique and beauty salon, photo studio and lettable office spaces*. These facilities are meant to increase interaction between the public and clothing factory, hence advertising the products and Ghanaian fashion as a whole. Finally, since the clothing / fashion industry is driven by the entertainment industry, an outdoor landscaped area is incorporated into the design to be used for entertainment shows etc. These marketing facilities

are sited to be clearly viewed by the public and also generate revenue for the running of the production units.

5.5 Developed Brief

From the analysis of the merits and demerits of the case studies and literature review, the following facilities are to be provided for this clothing factory.

- *EDUCATIONAL FACILITIES; **FASHION DESIGN SCHOOL** (A 4 year 1st degree course)*

ADMINISTRATION; Reception, Faculty Lounge, Admissions Office, Head's Office, Accounts Office, 8 Staff Offices, Documentation Room

1 ASSEMBLY HALL (400 seating capacity)
4 CLASSROOMS (50 capacity each)
2 LECTURE THEATRES (50 capacity each)
2 DESIGN STUDIOS (50 capacity each)
2 COMPUTER LABORATORIES (25 capacity each)
2 CLOTHING CONSTRUCTION STUDIOS (50 capacity each)
1 LIBRARY (200 seating capacity)
1 EXHIBITION ROOM
PARKING

- *PRODUCTION FACILITIES*

ADMINISTRATION; Reception, CEO, Factory Manager & Accounts Offices, Human Resource Department, Import & Export Department, Fashion Department, Boardroom, Meeting room, Parking.

PRODUCTION UNIT

-Security Point(s)
-Wash & Changing Rooms
-In & Out Stores
-Store Manager's Office
-Production Manager's Office
-Sampling Room
-Training Room
-Production Department *(Phase 1: 200 machine operators, Phase 2: total of 400 machine operators)*
-Supervisors' Offices
-Quality Control (Q.C.) Personnel Offices
-Maintenance Unit
-First Aid Booth(s)
-Supervisor and Q.C. Washrooms
-Service Yard(s)

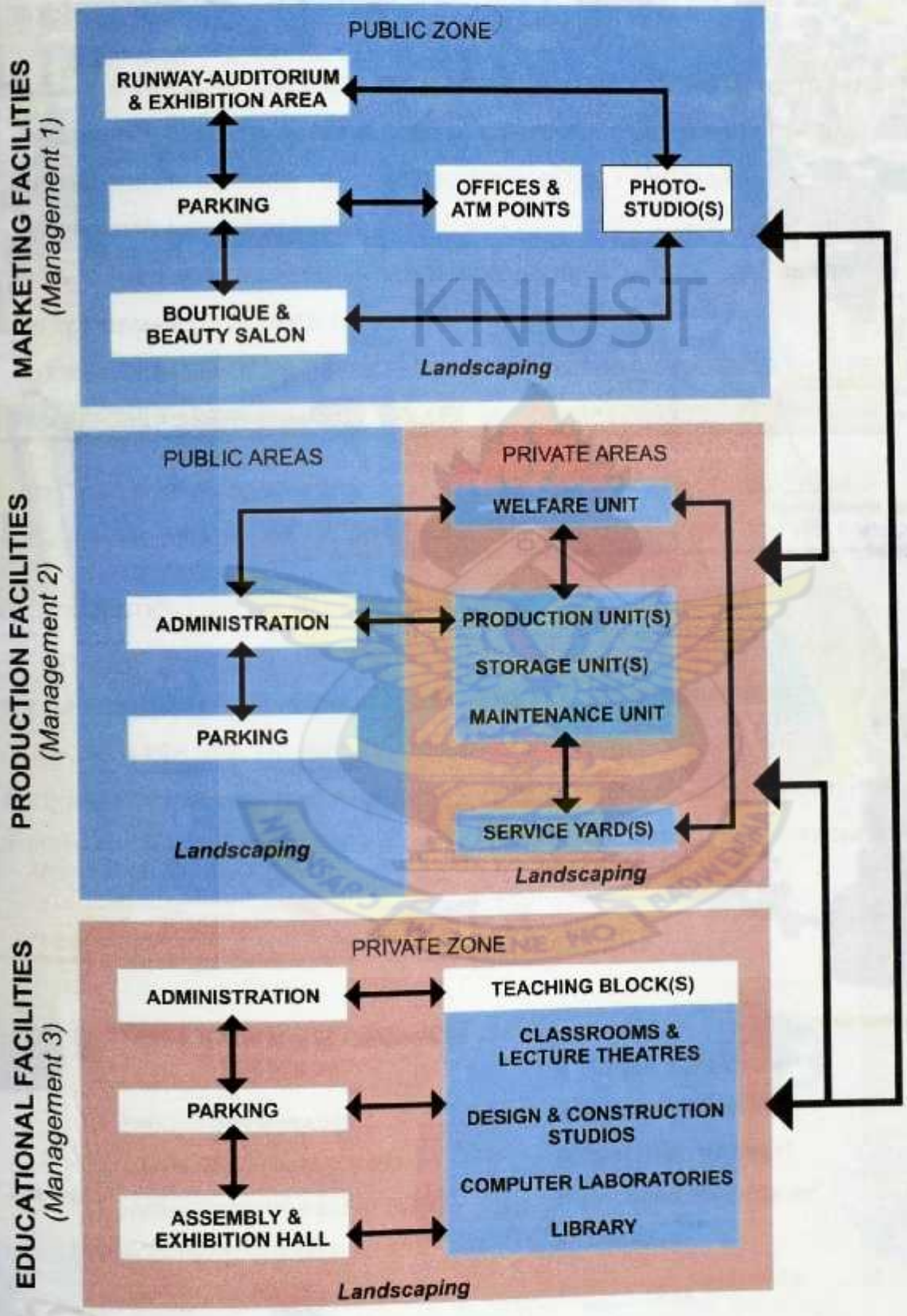
WELFARE UNIT
-Cafetaria (200 capacity)
-Clinic

- *MARKETING AND COMMERCIAL FACILITIES*

RUNWAY - AUDITORIUM & EXHIBITION AREA
BOUTIQUE
BEAUTY SALON (Hair, Nails & Make-up)
PHOTO STUDIO
OFFICES
ATM POINTS
PARKING

Note: *For this thesis project, the educational facilities will not be detailed out.*

5.6 Functional Diagram



5.7 Required Workforce

With the exception of janitors all employed workers must have at least JSS / JHS education.

FROM THE WOODIN CASE STUDY, CURRENT PRODUCTION RATE = **800 SHIRTS PER MONTH**

DEMAND FOR SHIRTS IN ACCRA ALONE = **80 SHIRTS PER WOODIN SHOP, PER DAY**

THEREFORE DEMAND FOR 1 SHOP PER MONTH = 80 X 30 = **2400 SHIRTS**

WOODIN HAS 4 SHOPS IN ACCRA,

THEREFORE TOTAL DEMAND PER MONTH FOR WOODIN = 2400 X 4 = **9600 SHIRTS**

HENCE DEMAND IS 12 TIMES SUPPLY

CURRENT NUMBER OF MACHINE OPERATORS AT WOODIN = 15 (WORKING 8HRS PER DAY)

THEREFORE TO MEET DEMAND = 15 X 12 = 180 WORKERS **(APPROX 200 WORKERS)**

TO CATER FOR GHANA AND INTERNATIONAL DEMAND, A FACTOR OF 2 IS ASSUMED

THEREFORE 200 X 2 = **400 MACHINE OPERATORS** WILL BE REQUIRED FOR THE FACTORY

- 1 PRODUCTION LINE = **40 MACHINE OPERATORS**
- THEREFORE NUMBER OF LINES = 400 / 40 = **10 LINES**
- 2 SUPERVISORS PER LINE, THEREFORE = 10 X 2 = **20 LINE SUPERVISORS**
- 2 IRONERS PER LINE, THEREFORE = 10 X 2 = **20 IRONERS**
- 2 PACKAGER PER LINE, THEREFORE = 10 X 2 = **20 WORKERS (PACKAGING DEPT)**
- FROM PRODUCTION PROCESS, **6 QUALITY CONTROL AND ASSURANCE PERSONNEL** ARE REQUIRED

THEREFORE **TOTAL PRODUCTION STAFF = 466 WORKERS**

OTHER STAFF / DEPARTMENTS INCLUDE,

- *FACTORY MANAGER*
- *PRODUCTION MANAGER*
- *MAINTENANCE DEPARTMENT*
- *HUMAN RESOURCE DEPARTMENT*
- *ACCOUNTS DEPARTMENT*
- *IMPORT AND EXPORT DEPARTMENT*
- *STORES DEPARTMENT*
- *FASHION DEPARTMENT*
- *HEALTH DEPARTMENT*
- *CATERING DEPARTMENT*
- *JANITORS*
- *SECURITY PERSONNEL*

5.8 Accommodation Schedule (Table 5.2)

■ MARKETING AND COMMERCIAL FACILITIES

	SPACE	#	DIMENSION	AREA/m²	TOTAL
	RUNWAY-AUDITORIUM & EXHIBITION AREA	1		450.00	
	BOUTIQUE & BEAUTY SALON	1		124.00	
	PHOTOSTUDIO	1	8.0 x 5.0	40.00	
	MANAGEMENT OFFICES	3	3.0 x 3.0	27.00	
	ATM SERVICE POINTS	4	3.0 x 3.0	36.00	
	PARKING	30	2.5 x 6.0	450.00	1127.00

■ PRODUCTION FACILITIES

			#	DIMENSION	AREA/m²	TOTAL
ADMINISTRATION	RECEPTION		1	4.0 x 6.0	24.00	
	CEO's OFFICE		1	4.0 x 6.0	24.00	
	FACTORY MANAGER'S OFFICE		1	4.0 x 3.0	12.00	
	HUMAN RESOURCE DIR., ACCOUNTS,IMPORT & EXPORT OFFICES		3	3.0 x 3.0	27.00	
	HUMAN RESOURCE DEPT.		1	3.0 x 6.0	18.00	
	SECRETARY		1	3.0 x 3.0	9.00	
	1 BOARDROOM, 1 MEETING ROOM		2	5.0 x 8.0	80.00	
	HEAD FASHION DESIGNER'S OFFICE	FASHION DEPT.	1	3.0 x 3.0	9.00	
	DESIGN ASSISTANTS' OFFICE		1	4.0 x 3.0	12.00	
	FASHION STUDIO		1	5.0 x 12.0	60.00	
	MERCHANDISING UNIT		1	6.0 x 4.0	24.00	
	FORECASTING UNIT		1	4.0 x 3.0	12.00	
	WASHROOMS		5	2.5 x 1.0	12.50	
PRODUCTION UNIT	SECURITY POINT		2	3.0 x 2.0	12.00	
	WASH & CHANGING ROOMS (1:30)		20	2.0 x 1.5	60.00	
	PRODUCTION MANAGER		1	4.0 x 3.0	12.00	
	IN & OUT-STORE + STORE MANAGER			6.0 x 13.5	81.00	
	SAMPLING ROOM		1	6.0 x 6.0	36.00	
	TRAINING ROOM		1	6.0 x 6.0	36.00	
	FABRIC INSPECTION & MARKING OUT		1	6.0 x 4.0	24.00	
	CUTTING & LINING		1	6.0 x 4.0	24.00	
	SEWING AREA		2	10.0 x 40.0	800.00	
	FINISHING			6.0 x 7.5	45.00	
	SUPERVISORS' OFFICES		2	2.0 x 10.0	40.00	
	QUALITY CONTROL PERSONNEL'S OFFICE		3	2.0 x 3.0	18.00	
	FIRST AID BOOTH		2	2.0 x 3.0	12.00	
	SUPERVISOR & Q.C. WASHROOMS		5	2.5 x 1.0	12.50	
	MAINTENANCE UNIT		1	6.0 x 6.0	36.00	
	SERVICE YARD. Three 60 seater buses, 2 delivery trucks, 2 delivery vans			18.0 x 25.0	450.00	
WELFARE UNIT	KITCHEN STORE	CAFE-TARIA	1	6.0 x 2.5	13.00	
	KITCHEN		1	6.0 x 7.5	45.00	
	SEATING (capacity: 200)		2x3 for 10	15.0 x 10.0	150.00	
	WAITING ROOM	CLINIC	1	3.0 x 2.0	6.00	
	CONSULTING ROOM		1	3.0 x 3.0	9.00	
	TESTING AREA		1	3.0 x 3.0	9.00	
	WASHING AREA		1	3.0 x 1.5	4.50	
	TREATMENT		1	3.0 x 3.0	9.00	
	GENERAL WARD + WASHROOM		1	6.0 x 10.0	60.00	
	NURSE'S CUBICLE		1	3.0 x 3.0	9.00	
	WASHROOM		1	2.5 x 1.0	2.5	
	WELFARE OFFICE		1	3.0 x 3.0	9.0	
	WASHROOMS		7	2.5 x 1.0	17.50	
PARKING	STAFF CAR PARK		20	2.5 x 6.0	300.00	
	BICYCLE PARK		25	0.5 x 1.5	18.75	2671.75

■ EDUCATIONAL FACILITIES

		#	DIMENSION	AREA/m²	TOTAL
	ADMINISTRATION	1		200.00	
	LIBRARY (capacity: 200)	1		240.00	
	ASSEMBLY HALL	1		400.00	
	EXHIBITION ROOM	1		48.00	
	CLASSROOMS	4		240.00	
	DESIGN STUDIOS	2		300.00	
	CLOTHING CONSTRUCTION STUDIOS	2		900.00	
	COMPUTER LABORATORIES	2		60.00	
	PARKING	20		360.00	2500.00

5.9 Conceptual Site Planning

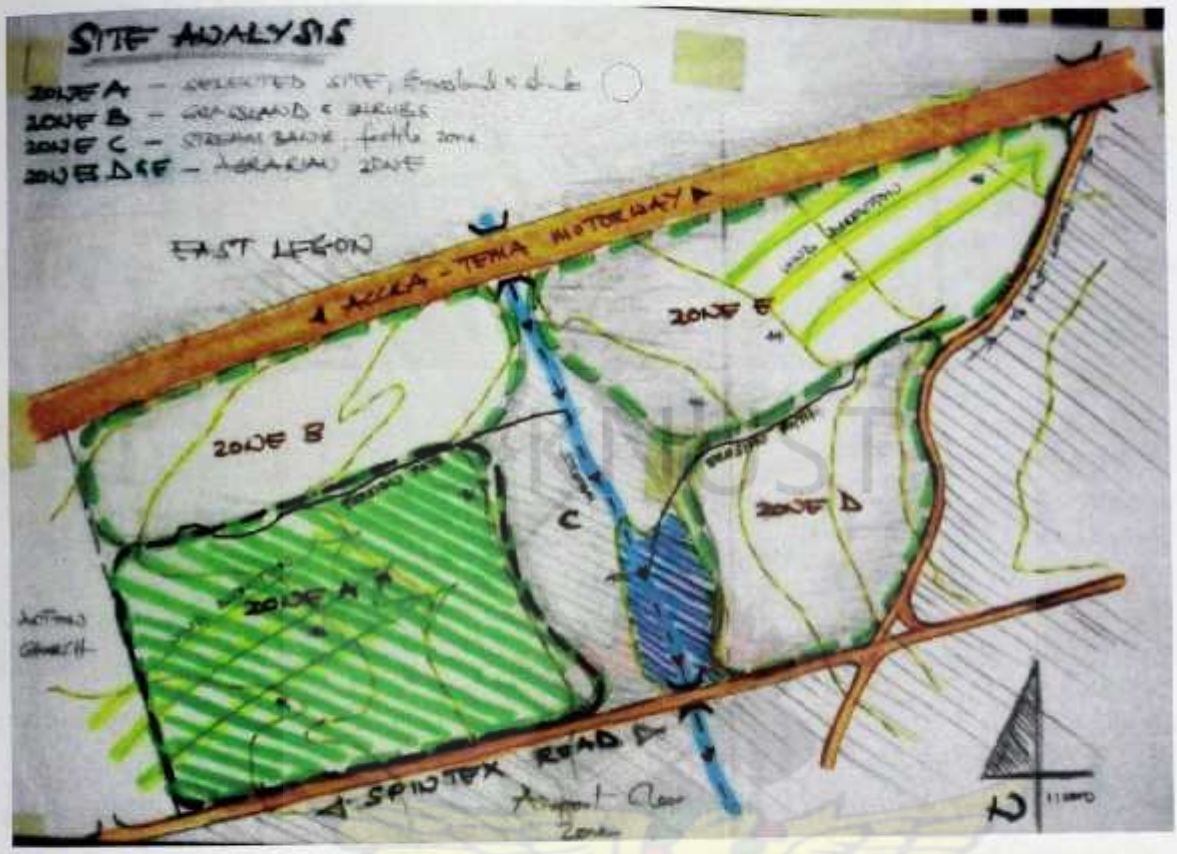


Fig 5.5 Site Analysis

Since the available site is larger than is required for the project, it was zoned into five according to terrain, soil type, vegetation and current use. Zone A (hatched green above) was selected due to its *appropriate land size, good lateritic soil type, relatively gentle slope, easy access from the Spintex road and high marketing potential for the factory*. The whole site was however planned to avoid a sprawl as is shown in Fig 5.3 below. Zone A was then planned in more detail and design options were reviewed for the best possible solution.

Fig 5.6 Site zoning

In option 1 below, the administration and runway auditorium are fused into one building and the boutique and beauty salon are in another. The welfare unit fronts the three production units.

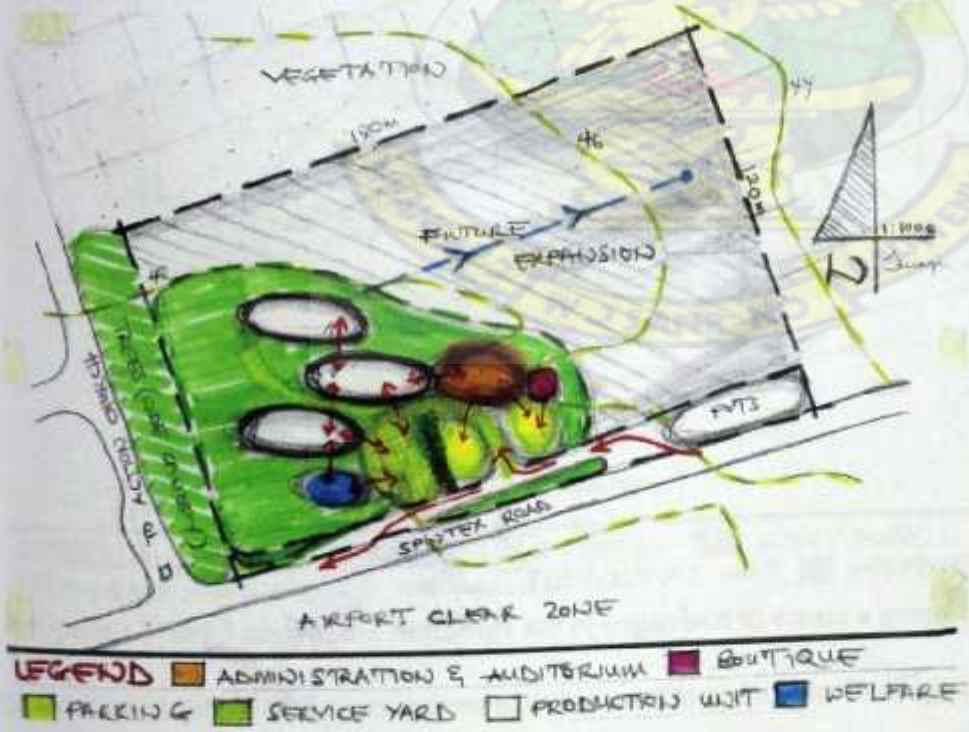


Fig 5.7 Option 1

Fig 5.8
Option 2

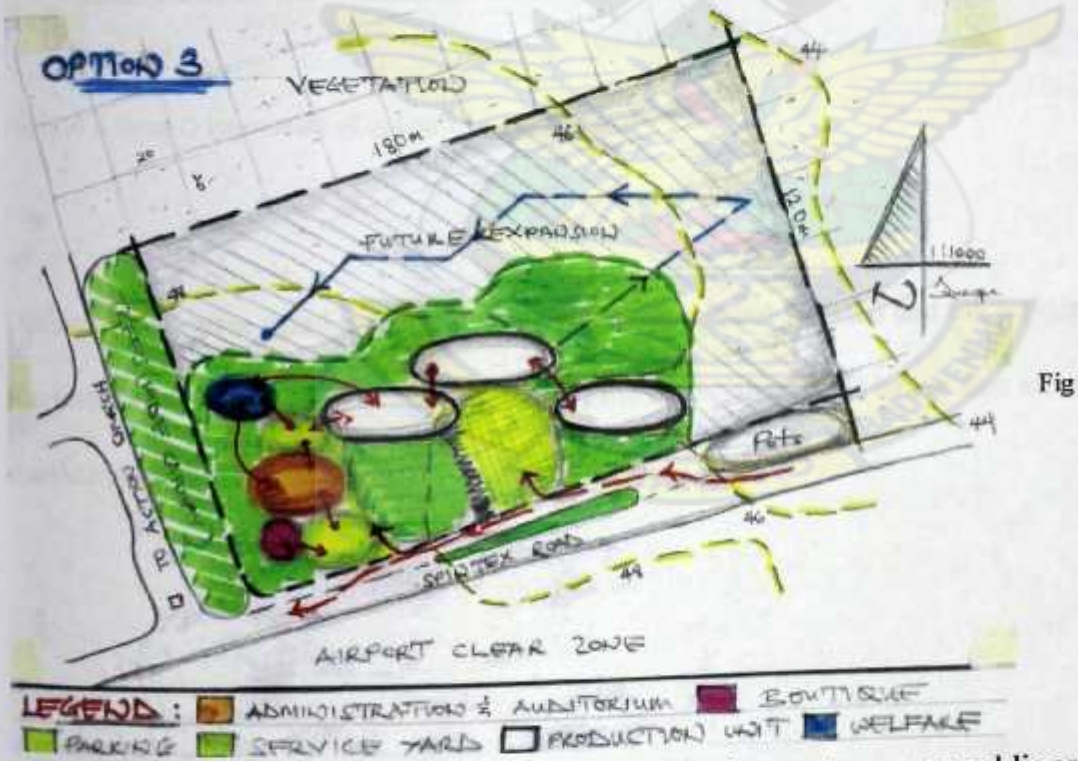


Fig 5.9 Option 3

In Options 2 and 3 above, the buildings are re-organised to create a green public area in front for outdoor exhibition and entertainment activities and to reduce the heat island created by the parking and service yard areas.

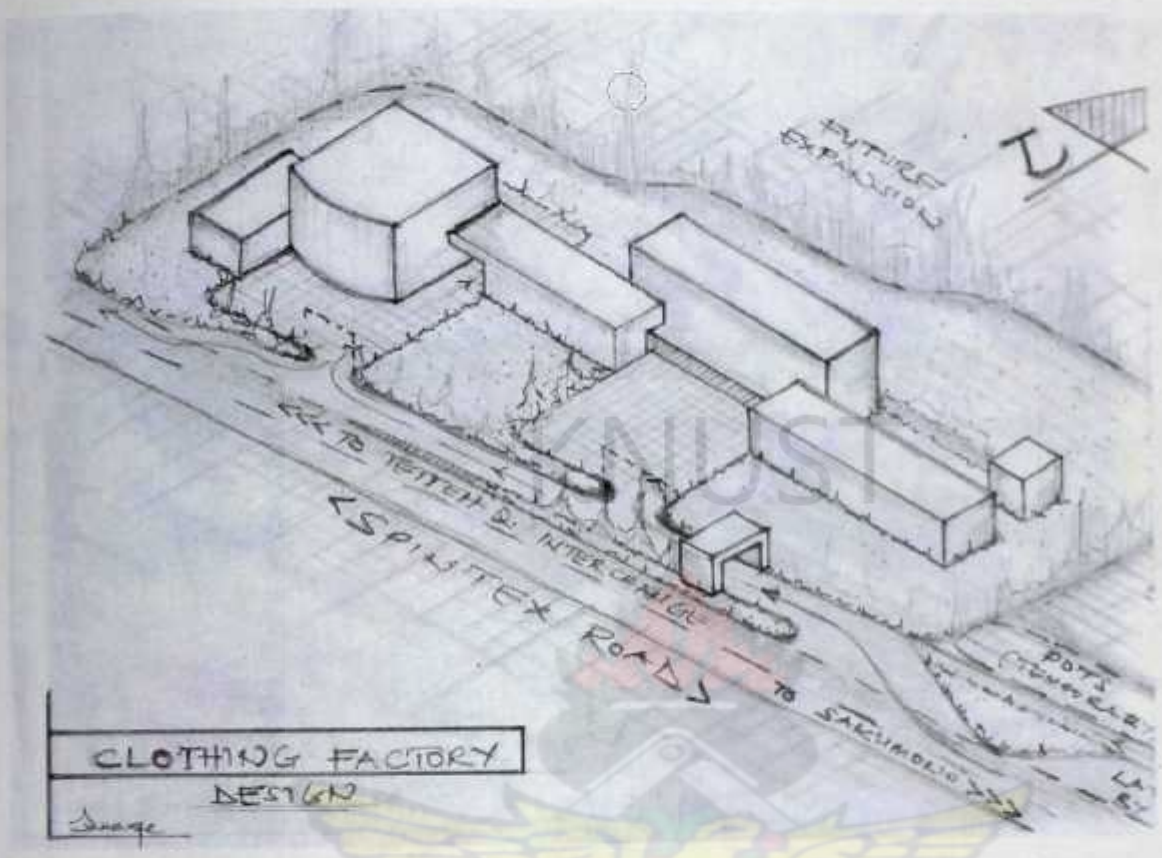


Fig 5.10 A three-D impression of option 3

Options 1 to 3 were ruled out because activities seemed too isolated and the service yards in front of the buildings destroyed the beauty of the landscaped areas hence also affecting the marketing image of the facility.

Fig 5.11 Option 4

In option 4, commercial and marketing facilities were integrated into the runway auditorium design, the service yards were hidden from the public, and the entire facility overlooked a landscaped area with a focal point. The proposed educational facilities are located to the right of the clothing factory. Option 4 was further refined to the final site layout.

5.10 Conceptual planning of buildings

a. Production Units

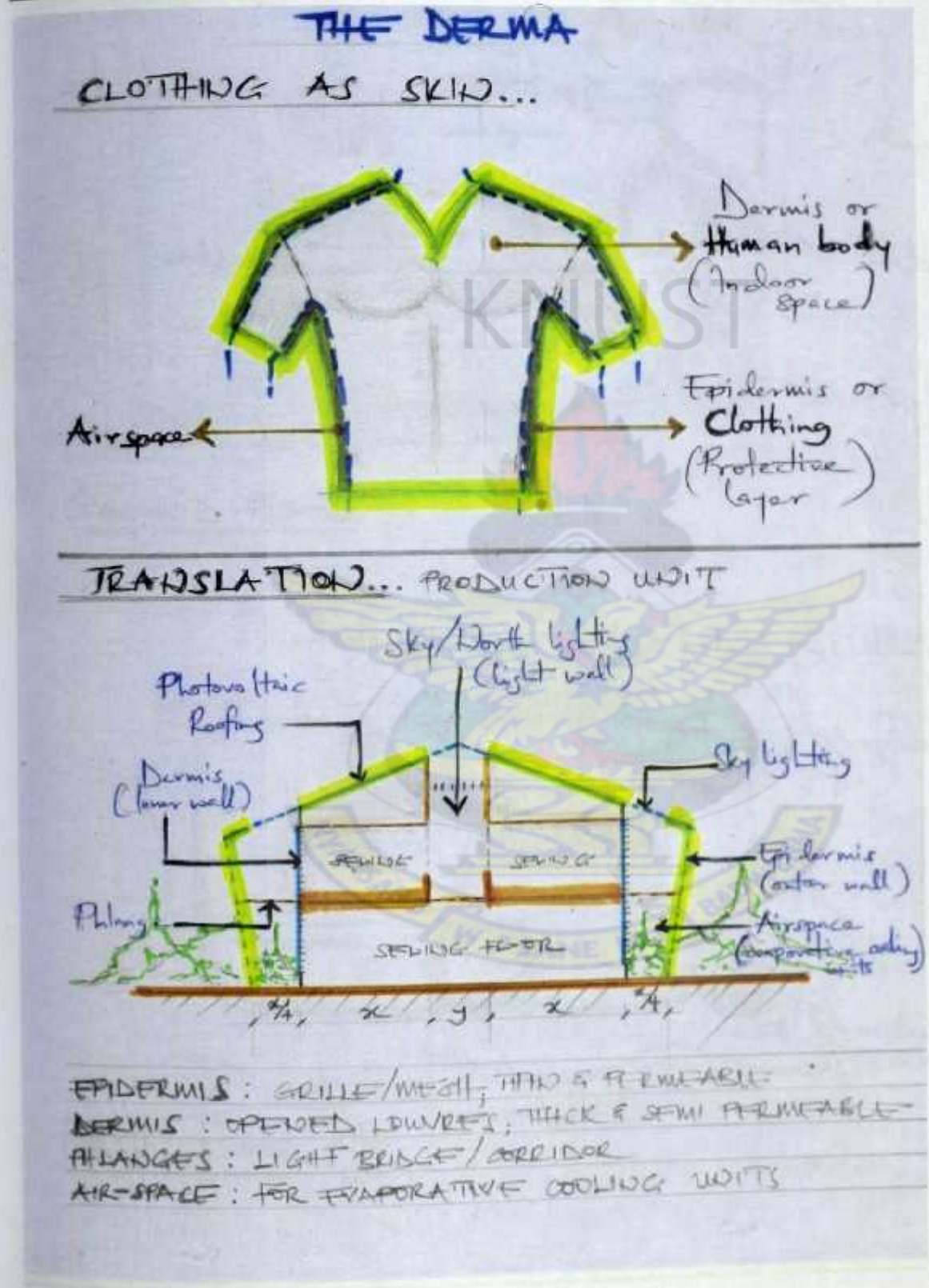


Fig 5.12 Conceptual clothing production unit

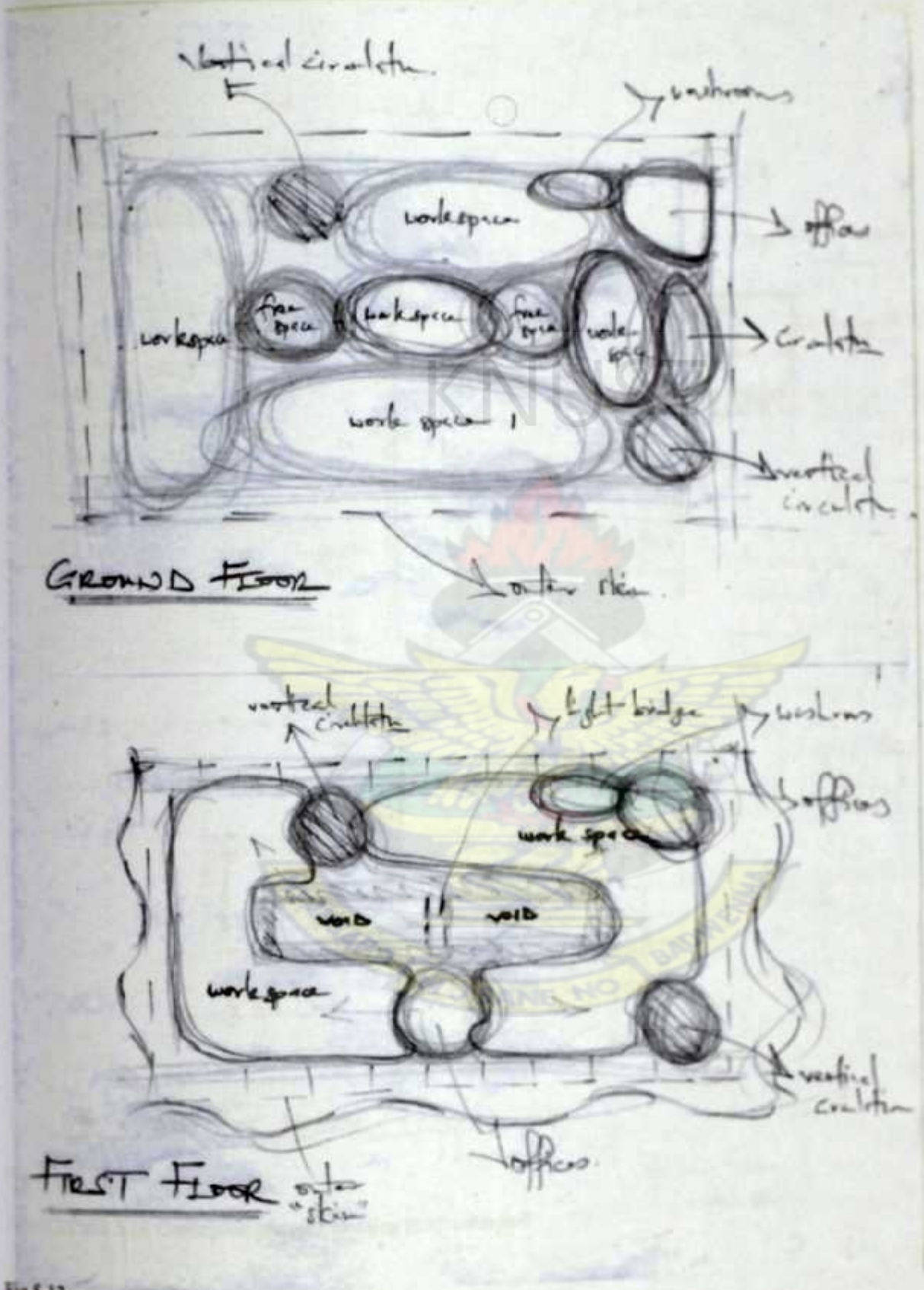

vertical circulation
washrooms
workspace
offices
workspace
free space
workspace
free space
circulation
work space 1
vertical circulation
GROUND FLOOR
vertical circulation
light bridge
washrooms
offices
work space
VOID
VOID
workspace
vertical circulation
offices
FIRST FLOOR

Fig 5.13

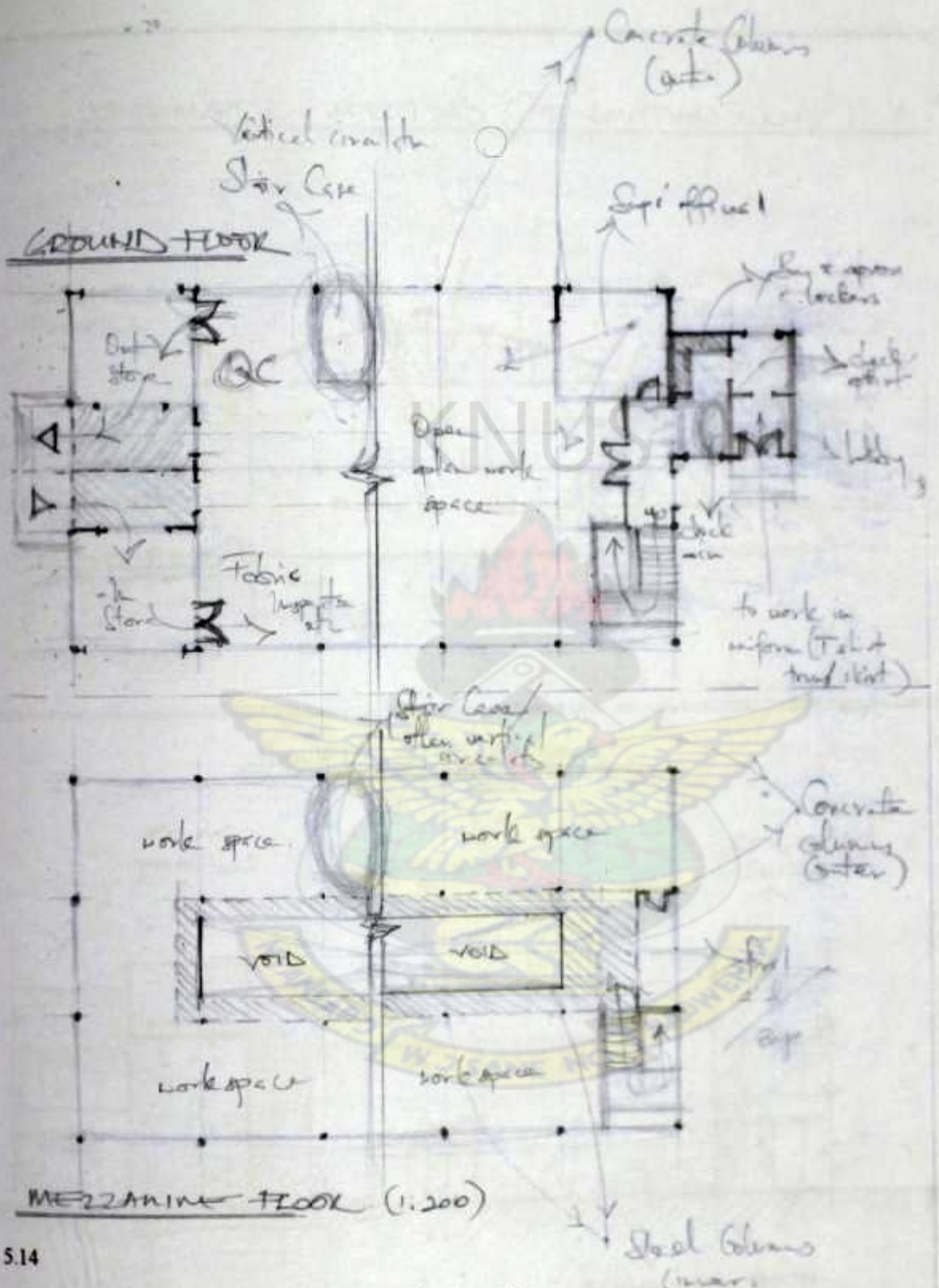


Fig. 5.14

Figs 5.13 and 5.14 Conceptual plans of clothing production unit

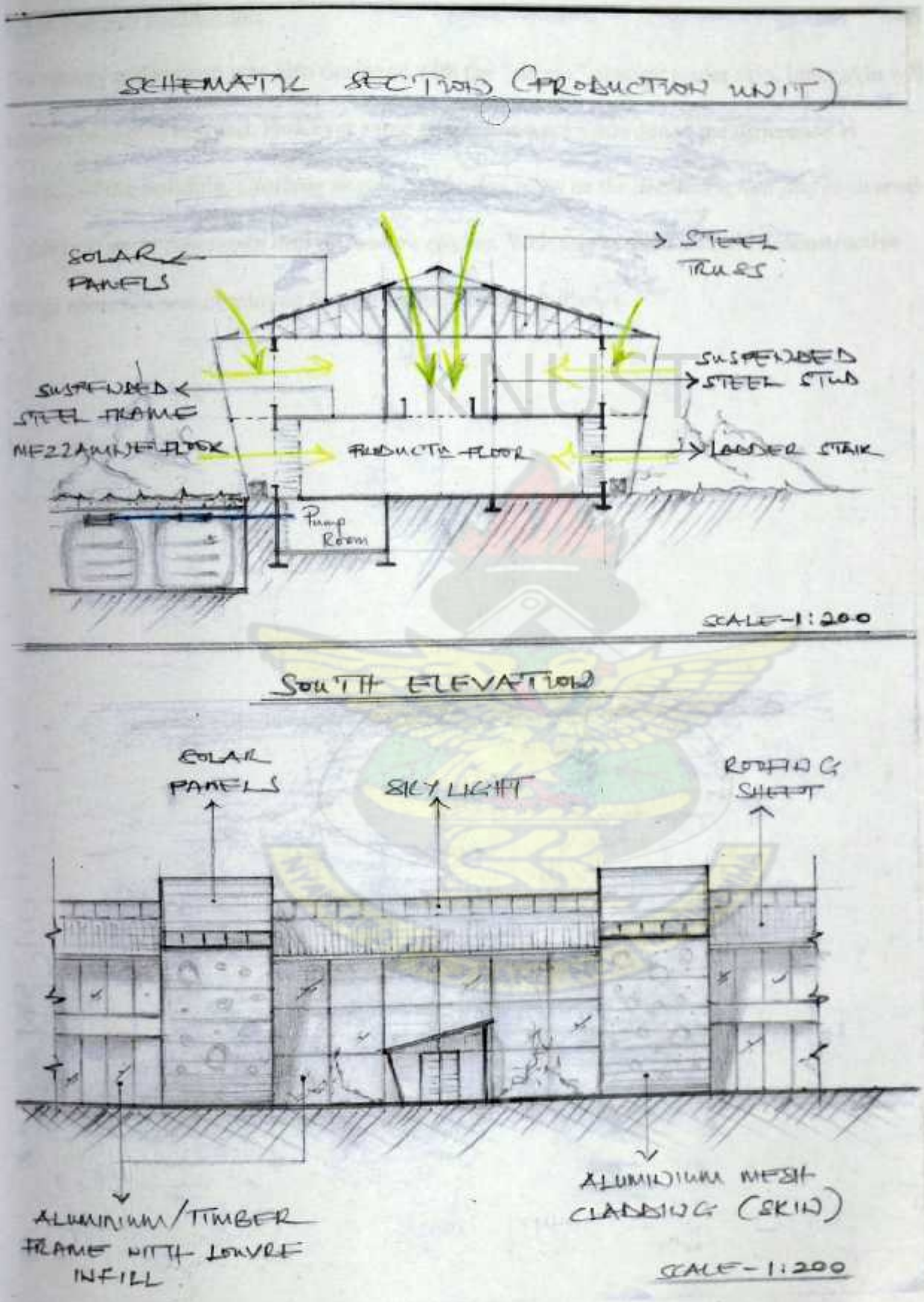
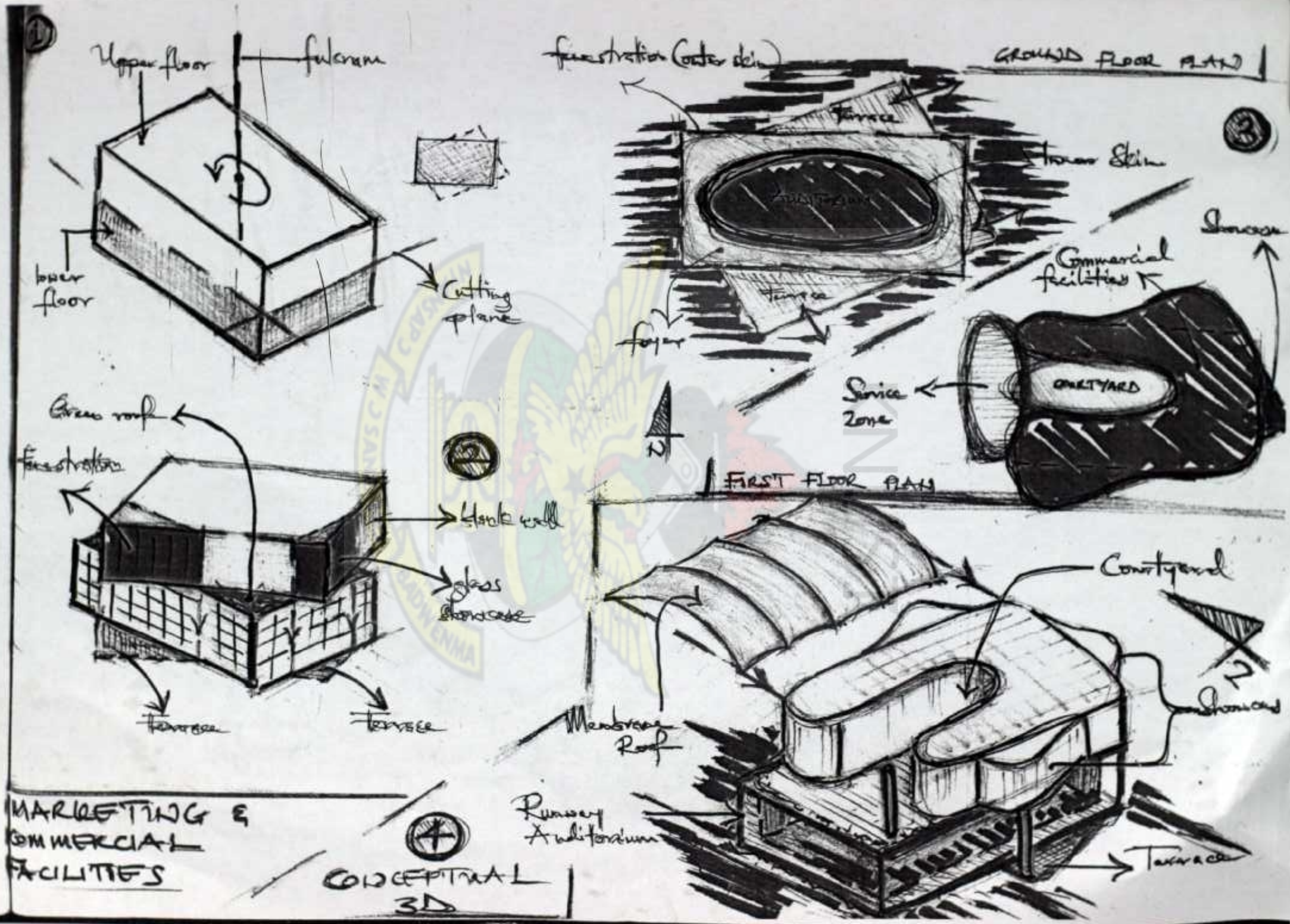


Fig 5.15 Schematic elevation and section

b. The Runway Auditorium

The runway auditorium was also designed with the *"derma" concept* (outer skin, inner skin with airspace between) in mind. However some alterations were made due to the difference in function of the building. *Clothing design can be described as the deconstruction and re-assembly of fabric to make functional and or couture clothes.* With this in mind a subtle deconstructive design approach was employed for the auditorium and axillaries.


1
Upper floor
fulcrum
lower floor
Cutting plane
2
Green roof
Fenestration
Hardie wall
glass showcase
terrace
terrace
3
fenestration (curtain skin)
GROUND FLOOR PLAN
Terrace
Curtain Skin
Commercial facilities
Showroom
Terrace
foyer
COURTYARD
Service Zone
FIRST FLOOR PLAN
Courtyard
Showroom
Membrane Roof
Rumsey Auditorium
Terrace
4
CONCEPTUAL 3D
MARKETING & COMMERCIAL FACILITIES

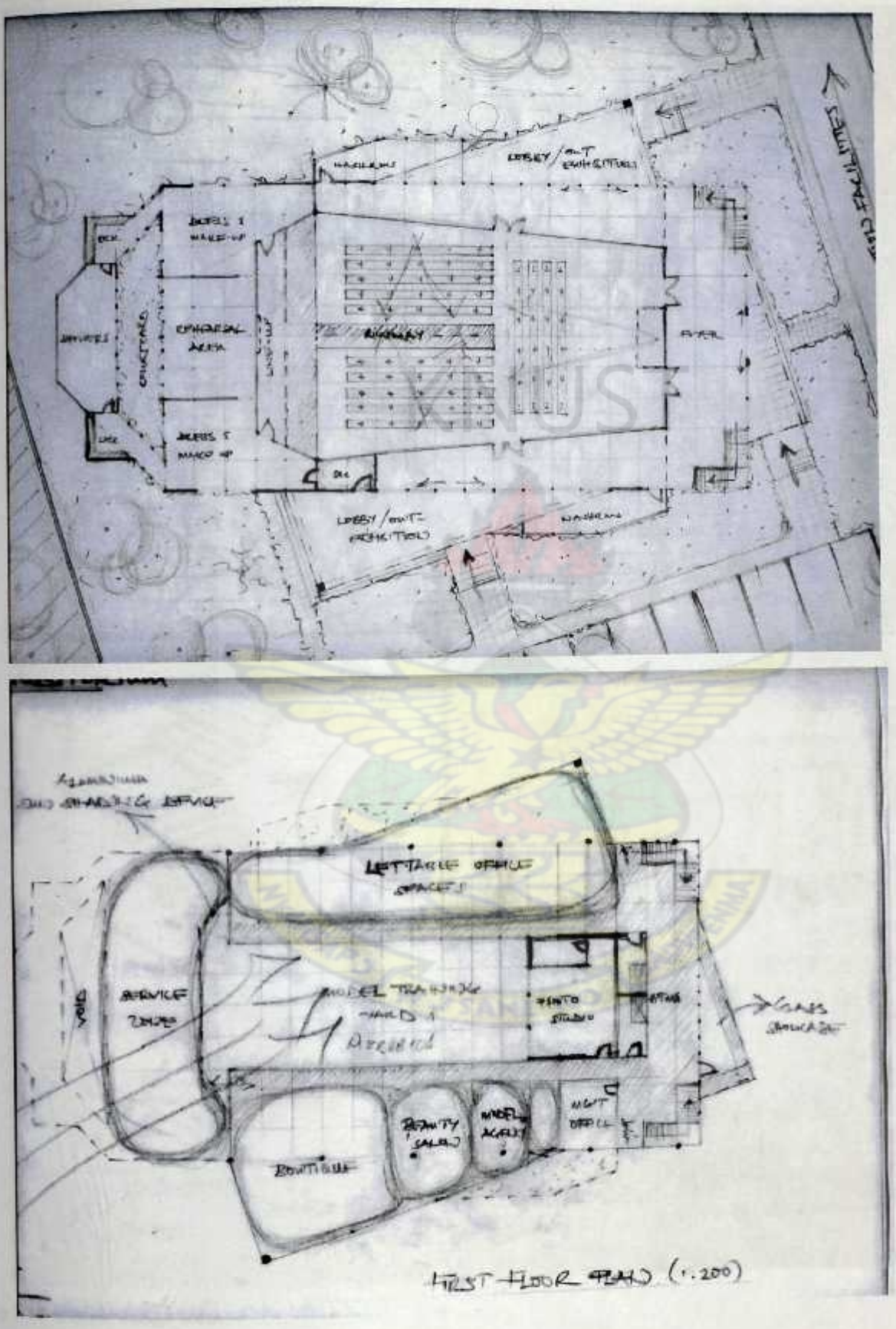


Fig 5.17 Schematic plans

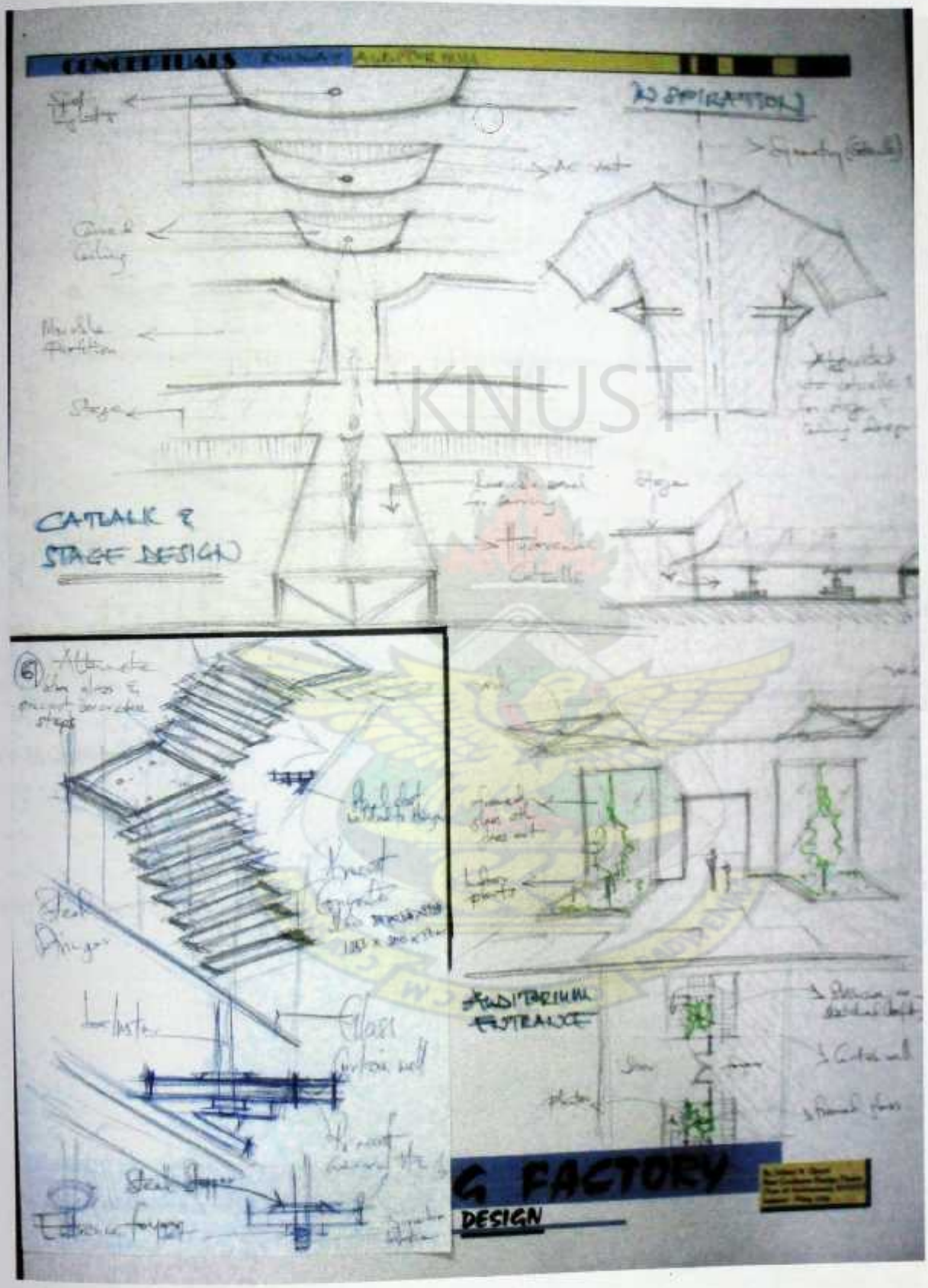


Fig 5.18 Interior design ideas

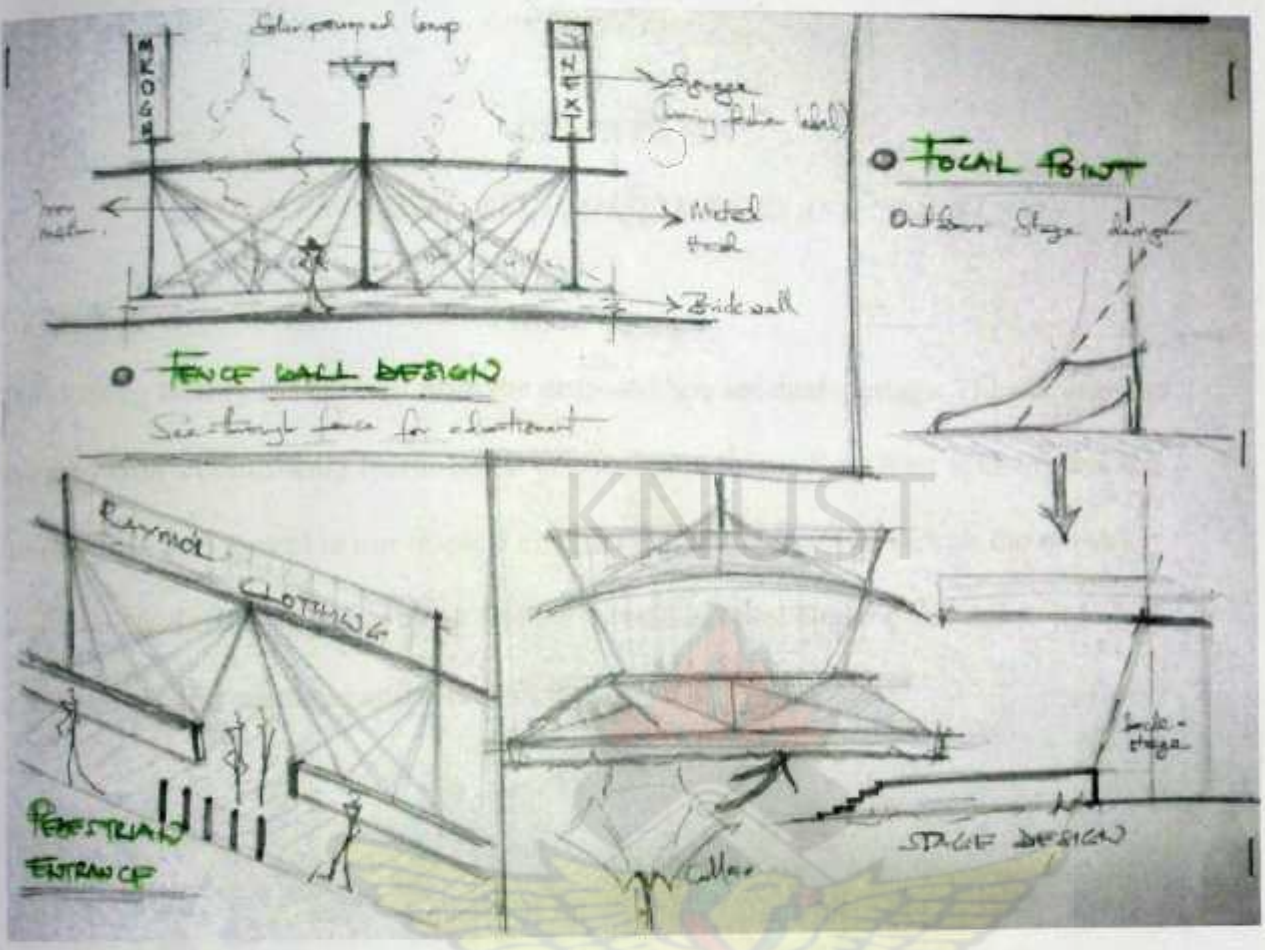


Fig 5.18 Outdoor design elements

Note: Drawings required for comprehension of the project are attached in the appendix.

CHAPTER SIX

DESIGN PROPOSAL, RECOMMENDATIONS AND CONCLUSION

6.1 Block Plan

The clothing factory is accessed from the proposed Spintex dual-carriage. The facilities are designed with a dominantly North-South orientation to reduce East-West solar ingress and facilitate thermal control in our tropical climate. Marketing facilities include the runway auditorium and administration block fronted by soft and hard landscape elements for entertainment and customer and senior staff parking.

Fig. 6.1 Block plan

Behind these facilities are the production and welfare units. The main service yard and power room is located to the East of the production units and to the West, there is junior staff car and bicycle parking. The welfare unit encloses the kitchen service yard. Finally, further North, a future production unit, warehouse and anaerobic digestion plant is proposed. East of the clothing factory is a proposed fashion design school. The blocks are arranged to create a large open space for various outdoor activities to generate extra revenue for the industry.

Fig. 6.2 Aerial view of proposed clothing factory

6.2 Circulation

A lay-by, separated from the main road by a *soft landscaped island* was created at the entrance to avoid a build-up of vehicular traffic when vehicles slow down to turn into the factory. A security point is built across the lay-by to check in-coming vehicles and avoid using it as a thoroughfare.

The main gate to the facility is controlled electronically from the security point. Vehicles then move on either straight ahead to the service yard or otherwise, to the customer parking area. Parking at the school supplements the auditorium parking during evening events at the auditorium and outdoor entertainment areas. No visitor vehicles are allowed past the staff security and service yard gate points. The circulation plan in the appendix shows the routes of goods, workers, visitors and customers.

6.3 Building form

Though a strict North-South orientation was opted for in design, parts of the runway auditorium and administration blocks are parallel to the main road in order to achieve harmony with both the main access road and the proposed on-site roads.

A linear form was employed for the two production units. All main work and or habitable spaces are orientated north-south while circulation and storage spaces are east-west, thus enclosing a courtyard. The courtyard houses two underground water storage tanks and photovoltaic cells. On the ground floor, the blocks are linked by a corridor with locker spaces (on the west) while on the first floor a covered walkway (on the east) is the link. Service yard and outdoor seating areas are shaded with flat roofs held in place by tension chords. The production units are fronted by the administration block. A short corridor links them on them on the ground floor.

The L-shape of the welfare unit encloses and screens off the kitchen service yard and junior staff parking while creating a private open space for worker relaxation during breaks.

6.4 Structure and Materials

A simple post and beam system of construction was used for all the facilities.

Administration Block: Reinforced concrete columns and beams are employed for the structure. The floors are reinforced concrete slabs with a porcelain tile finish. Sandcrete blocks with a smooth plaster and paint finish are used for the walls. A timber rafter and purlin system is used for the roof structure. Non-reflective coated aluminium sheets are used to roof the gable area and a concrete flat roof is employed for the rest of the building.

Runway Auditorium: A reinforced concrete skeletal frame is again employed here but for the first floor, a waffle slab is used to span 20 metres. For the main structure, a steel framed membrane roofing system is used in contrast to the other structures while green roofs are employed for other areas that require roofing. Glass curtain walls are used for all showcase and staircase areas while sandcrete walls are used everywhere else. Exposed steel columns are used to support projected concrete slabs above them and also a feature. However, the main showcase area on the East of the building is cantilevered forward for a dramatic effect and to mark the main entrance to the building.

Production Units: Reinforced concrete columns and beams are used for the external structure. A reinforced concrete floor slab is used on the ground floor while pre-fabricated hollow steel framed flooring is employed for the first floor mezzanine. The mezzanine floor is supported from above by I-section steel columns anchored to steel roof trusses that span 15 metres at 5 metre centres. Hence there are no internal columns on the ground floor. Stabilized earth blocks and timber are used for the walls and mezzanine floors respectively while the ground floor is given a terrazzo finish. The walls require no plaster finish and are simply sealed with varnish on the

interior and exterior. Glass louvers were used for windows to allow in the maximum possible daylight and facilitate cross ventilation. Internal wall partitions are made with gypsum board. Floor markings are made with epoxy paint to separate various areas on the factory floor where walls are not used. The main structure is roofed with non-reflective coated aluminium sheets while the circulation paths are covered with green roofs.

Welfare Unit: The same structural system and materials used for the production units are used here, however a one and a half volume space is employed in the cafeteria to allow for stack ventilation and cater for the extra heat load in the space.

6.5 Façade Design

An interactive fence wall design is used in the South to get a clear view of the facility from the Spintex road. The marketing facilities and extensive landscaping is seen by pedestrians passing by.

Fig 6.3 Interactive fence wall design

The monotony of the long linear production unit is masked by fronting it with the contemporary design of the administration block. The concrete skeletal frame of the production unit contrasts the stabilized earth masonry walls and verticality is introduced by the evaporative cooling duct which continues down directly from the roof.

Though a subtle deconstructive approach is used for the runway auditorium, harmony is created by the use of colour and by designing the administration block as a miniature of the auditorium. The administration is positioned between the auditorium and production unit (though not in the same plane) to merge the contrasting industrial and commercial designs.

South Elevation

Fig 6.4 View from Spintex Road

An abstraction of fabric weaves and patterns are used on the facades and in fenestration design. For example, on the west façade, some fins are projected forward while others are recessed in a different plane to represent the threads in a kente weave and circular openings are used represent the drawings on Ghanaian cloth. Together these patterns with the interplay of shade and shadow create rhythm and portray a tropical architectural aesthetic. Window frames are also designed with intricate kente patterns in mind. An abstraction of clothing accessories is also employed by the use of glass, tension chords and steel elements. All the above elements are subtly incorporated to represent the dynamism and variation of clothing and fashion design.

6.6 Services

Water supply: Water to the facility will be from the mains along the Spintex road. However rainwater will also be harvested into underground water tanks to supplement this. The rainwater will be used for evaporative cooling and flushing of water closets.

Electricity Supply: Power will be tapped from the mains along the Spintex road and stepped down by a 1000KW transformer and sent to a switch board from where it will be distributed to panel boards. Provision is made for a stand-by generator set with automatic switches to serve the whole facility. Photovoltaic cells connected to roof-mounted solar panels will be used to power all artificial lighting in the administration and production units.

Lighting: The production units are naturally lit through glass louvre windows on the walls and also through roof by the admission of north light enhanced by the use of reflectors and light diffusers. At the welfare unit regular and high bay glass louvre windows supply natural lighting. LED lamps and T5 tubes are used for supplementary artificial lighting. The auditorium is naturally lit through operable glass windows and doors and is supplemented by the use of LED lamps and T5 tubes with the exception of stage spot and flood lights.

Ventilation: The production units are cross ventilated and the air temperature is kept cool by the use of evaporative cooling units. Cross and stack ventilation supplemented by the use of ceiling fans is used at the welfare unit. A package unit air-conditioning system is used at the runway auditorium.

Telecommunication: A private branch exchange (PBX) telephone system will be used to for easy communication at the facility. It has advantages of, Conferencing, Forwarding, Call Pick up

Groups, Intercoms, etc. Broadband internet connection will be provided at the administration block and other offices in the facility.

Security: The main gate to the facility will be operated electronically from the main security point. Searches at the security points will be done manually however a closed circuit television system will be installed in the auditorium and production units. The CCTV installation for the auditorium will be monitored from the indoor security points on the first floor while the production units will be monitored from the production manager and supervisor cubicles. An automated clock-in and out system will be employed at the entry to the various production units. Routine compound checks will be done physically by security personnel connected by radio phones. Outdoor lights are strategically positioned around the compound to ensure safety at night.

Fire Protection: A smoke detector, alarm, and water sprinkler system will be employed in the auditorium and administration block. Circulation areas will have portable fire extinguishers at 12 metre intervals. In the production units such fire extinguishers are used in addition to two fire hoses installed in the courtyard. Fire extinguishers are used in the welfare unit as well. Emergency exits have been provided in each building for escape routes. Sluice valve type fire hydrants will be strategically positioned for fire fighting around the compound for effective combating of fire.

Waste management and disposal: Litter bins will be placed at vantage points for use by the public. Routine cleaning of the compound will be done daily by an employed cleaning company. The same company will be responsible for collecting refuse from the facility and disposing of it in a manner approved by the Accra Metropolitan Assembly off the clothing factory premises. At

the end of Phase 1 of the project sewage will be channeled into water tight septic tanks. However at the end of the entire project the waste will be processed at the proposed anaerobic digestion plant.

6.7 Phasing

Due to financial constraints anticipated in the setting up of industries, the following phasing plan is proposed for the completion of the production and marketing facilities. The phasing is primarily based on economic benefit, worker comfort and the AGOA expiration date.

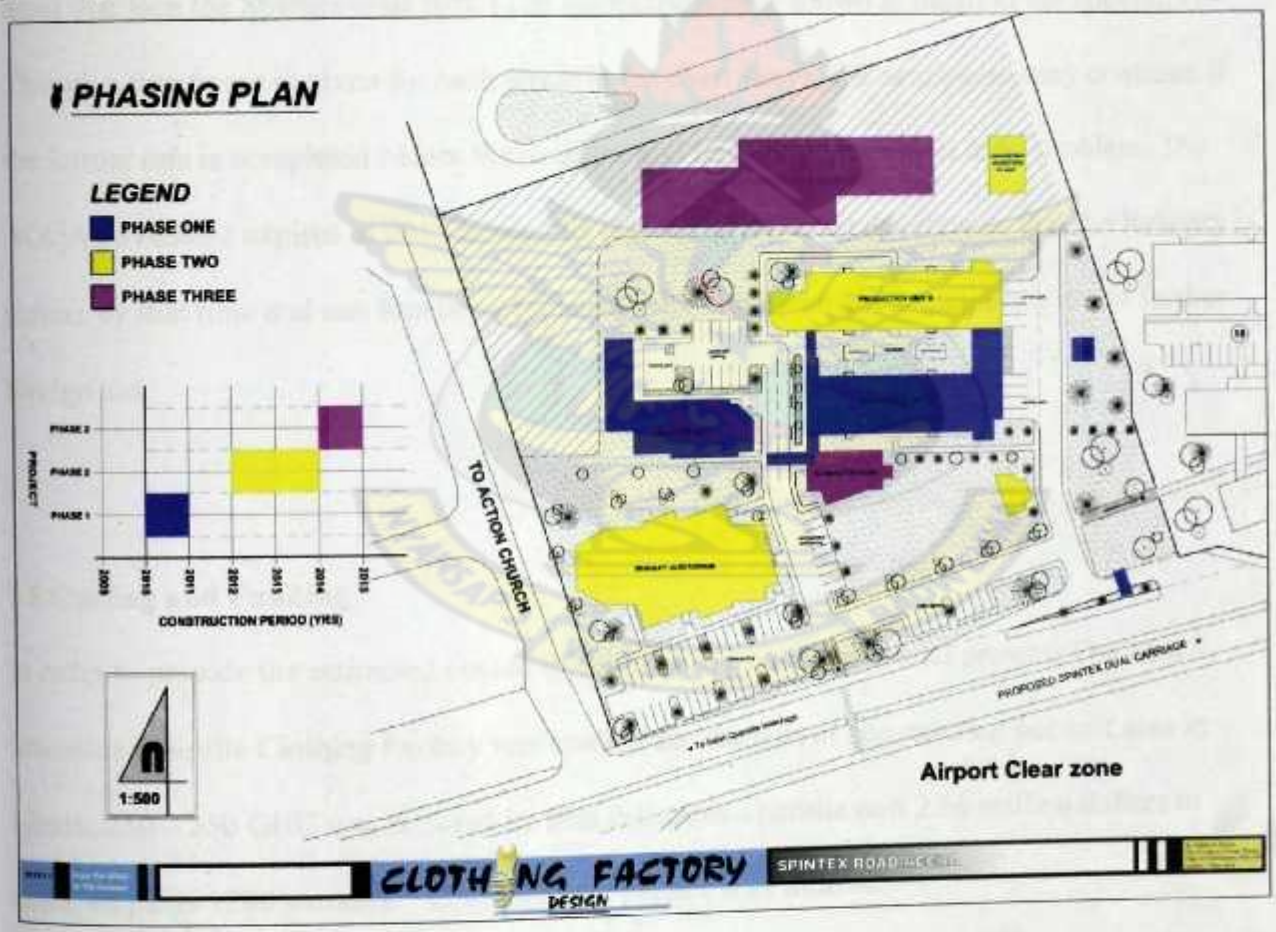


Fig 6.5 Phasing plan

Phase 1 comprises the completion of security points, the power room, one production unit, and the welfare unit.

Phase 2 comprises the completion of the runway auditorium, focal point on the lawn, a second production unit and the anaerobic digestion plant

Phase 3 involves the completion of the main administration block, another production unit and warehouse.

Landscaping will be done continuously through the phases but priority will be given to finishing areas that face the Spintex road first. (The landscape plan is shown in detail in the appendix) Though a timeframe is given for each phase in the chart above, the next phase may continue if the former one is completed before the deadline and financing the project is no problem. The AGOA advantage expires in 2015 hence this is given as the latest deadline so that the industry is mature by that time and can function efficiently with international competitors without further foreign aid.

6.8 Costing and Funding

In order to provide the estimated cost of this project, the cost of a similar project; The Mas Intimates Thurulie Clothing Factory was studied and the cost of construction per unit area in Ghana; 250 – 350 GHC was factored in. Mas Intimates Thurulie cost 2.66 million dollars to build, employs 1200 workers. [4] Costing of the project is as follows.

Phase One	GHC 1.0 MILLION
Phase Two	GHC 1.5 MILLION
Phase Three	GHC 0.7 MILLION
Roads/ Services/ landscaping	GHC 0.4 MILLION
TOTAL	**GHC 3.6 – 4.0 million** or USD 2.4 – 2.7 million

My clothing factory proposal costs about the same as Mas Intimates though it will employ 750 workers only. However, this makes sense because Mas Intimates does not have a Runway Auditorium.

Funding for the project could be obtained from the *Tyra Banks and Oprah Winfrey Foundations*.

6.9 Environmental Impact Assessment

The environmental impact of the proposed clothing factory is assessed by using the yardsticks set by the Holcim Foundation for Sustainable Construction as explained in the literature review in Chapter 2.

1. *Quantum change and transferability:* The use of stabilized earth blocks (made of laterite from the site) for construction of the production and welfare units in such an urban setting will change the misconception of earth being a village or poverty related material. The blocks and construction methods are affordable, simple and broadly applicable.

2. *Ecological quality and energy conservation:* No toxic waste is produced at the factory. The facility conserves finite resources such as water through rainwater harvesting and greenhouse emissions are very low. Photovoltaic cells used store solar energy and supply power for low energy consuming but highly efficient LED lamps and T5 tubes. Direct-drive servo motor operated equipment also saves energy. All the above in addition to the use of anaerobic digestion and extensive soft landscaping creates a healthy environment.
3. *Ethical standards and social equity:* The addition of informal relaxation areas and landscaped open spaces, personal lockers, a welfare unit, comfortable workspaces etc addresses basic urgent needs of the users of the facility. Such a stimulating environment raises awareness of important values, inspires the human spirit, and bonds society.
4. *Economic performance and compatibility:* From the costing above, the project is relatively cheap. Phasing of the project will reduce financial stress. The addition of marketing facilities and other ancillaries will also generate income for finishing and running of the project. The facility will employ a total of 750 workers hence establishing long-term new bases for livelihoods, stimulating local economic activity, and paving the way to broader economic integration.
5. *Contextual and aesthetic impact:* An attractive, comfortable, and functional indoor environment is created. The facility enhances its surroundings, fits functionally and arguably will set a trend in an area that lacks architectural identity. [4]

6.10 Recommendations and Conclusion

To ensure a high and sustained growth rate of any country, industrialization is crucial. The clothing industry is a good re-start point for Ghana in the transition from an agrarian state to an industrial one due to the comparatively low capital required. This project could catalyze the development of clothing accessory factories for the production of footwear, belts, bags and jewelry etc, as well as the development of some non-related but economically viable industries.

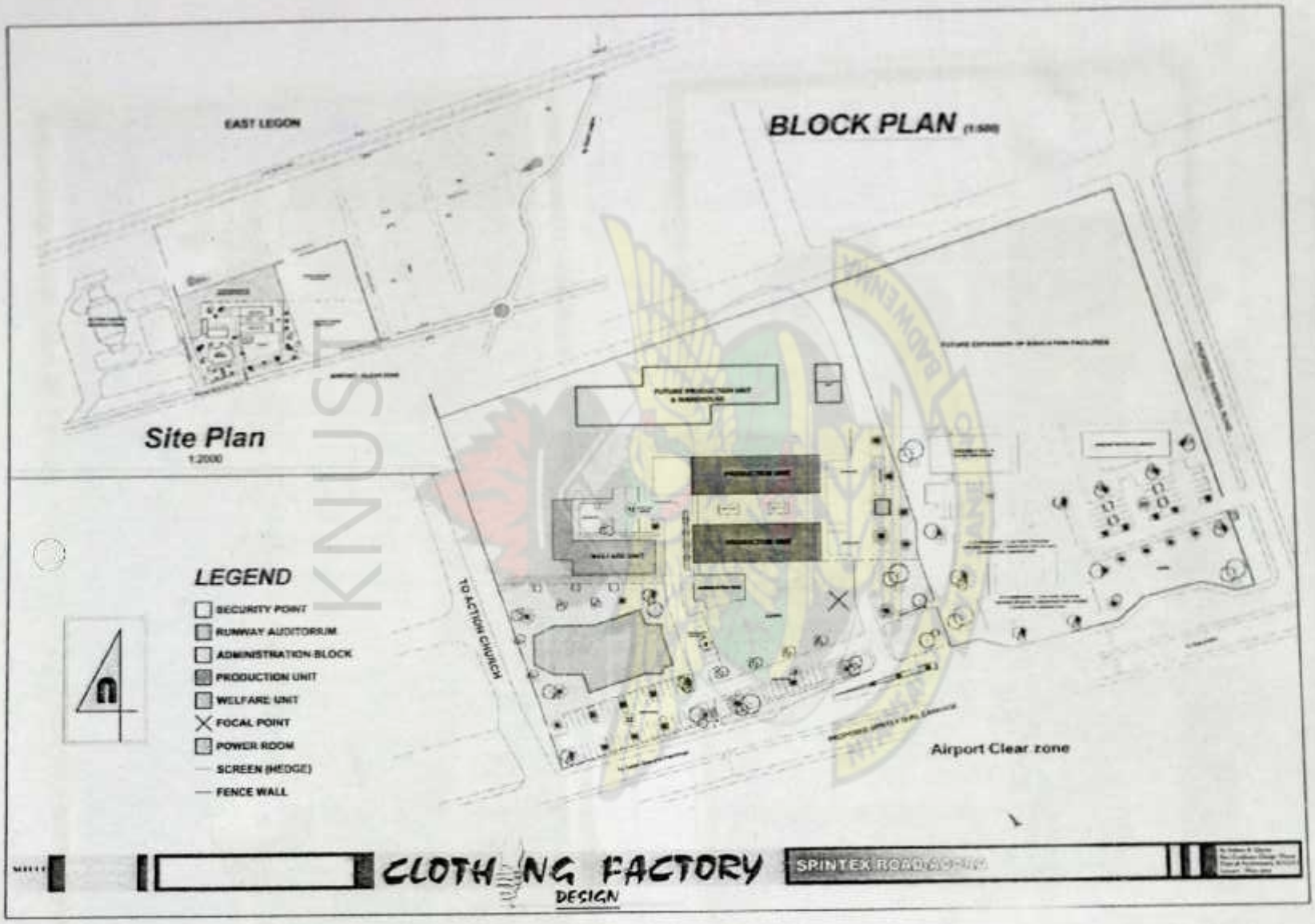
From an architectural perspective, I recommend that in future, facilities that are not detailed out in this project; such as the fashion design school, staff and student accommodation etc are designed and added on to create a ***fashion village*** since this clearly has the potential of generating millions for Ghana due to the symbiotic relationship between fashion and the billion dollar international entertainment industry.

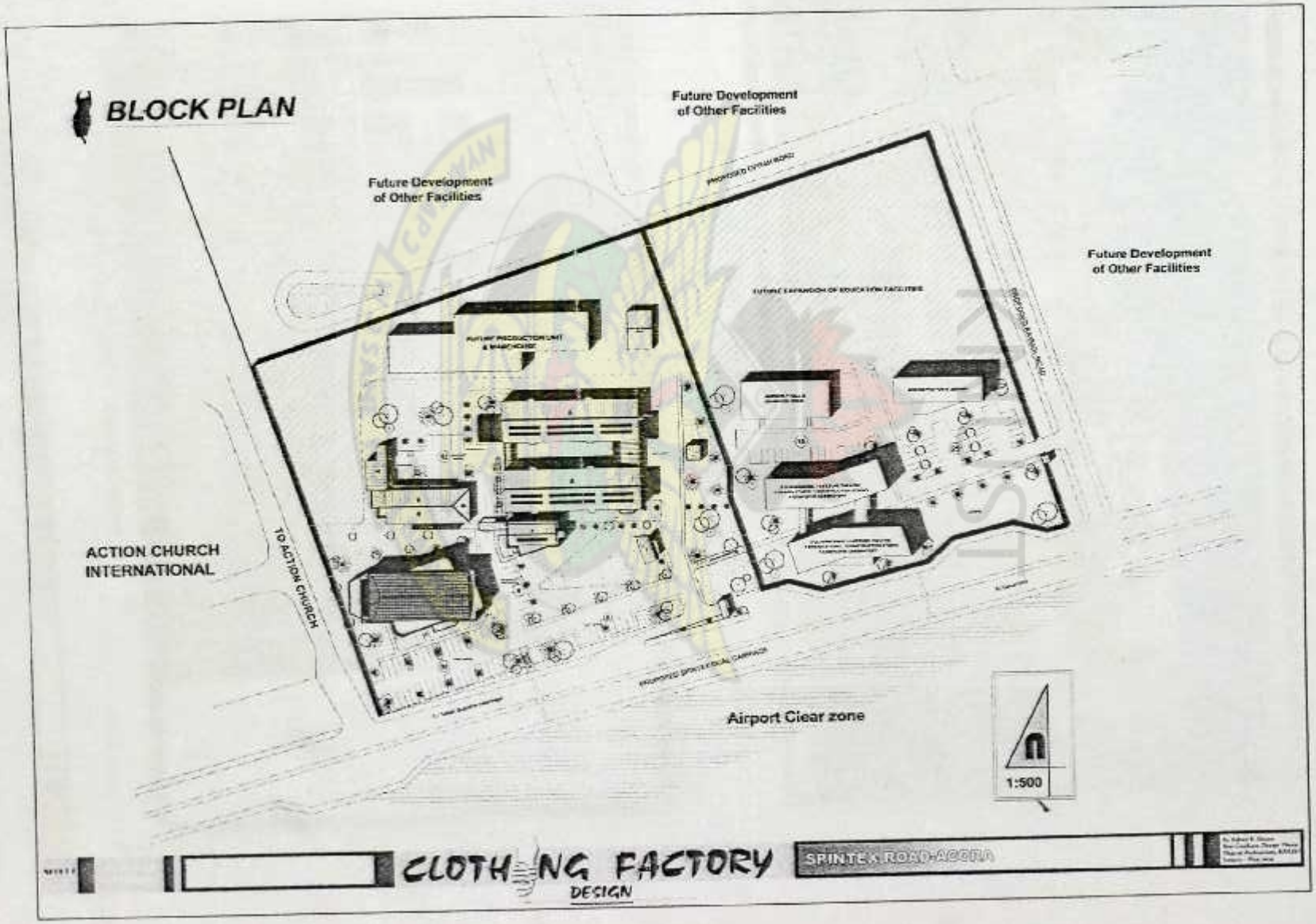
The success of this project will certainly provide employment, improve the Ghanaian fashion industry, generate foreign exchange and have several other positive ripple effects on Ghana's economy.

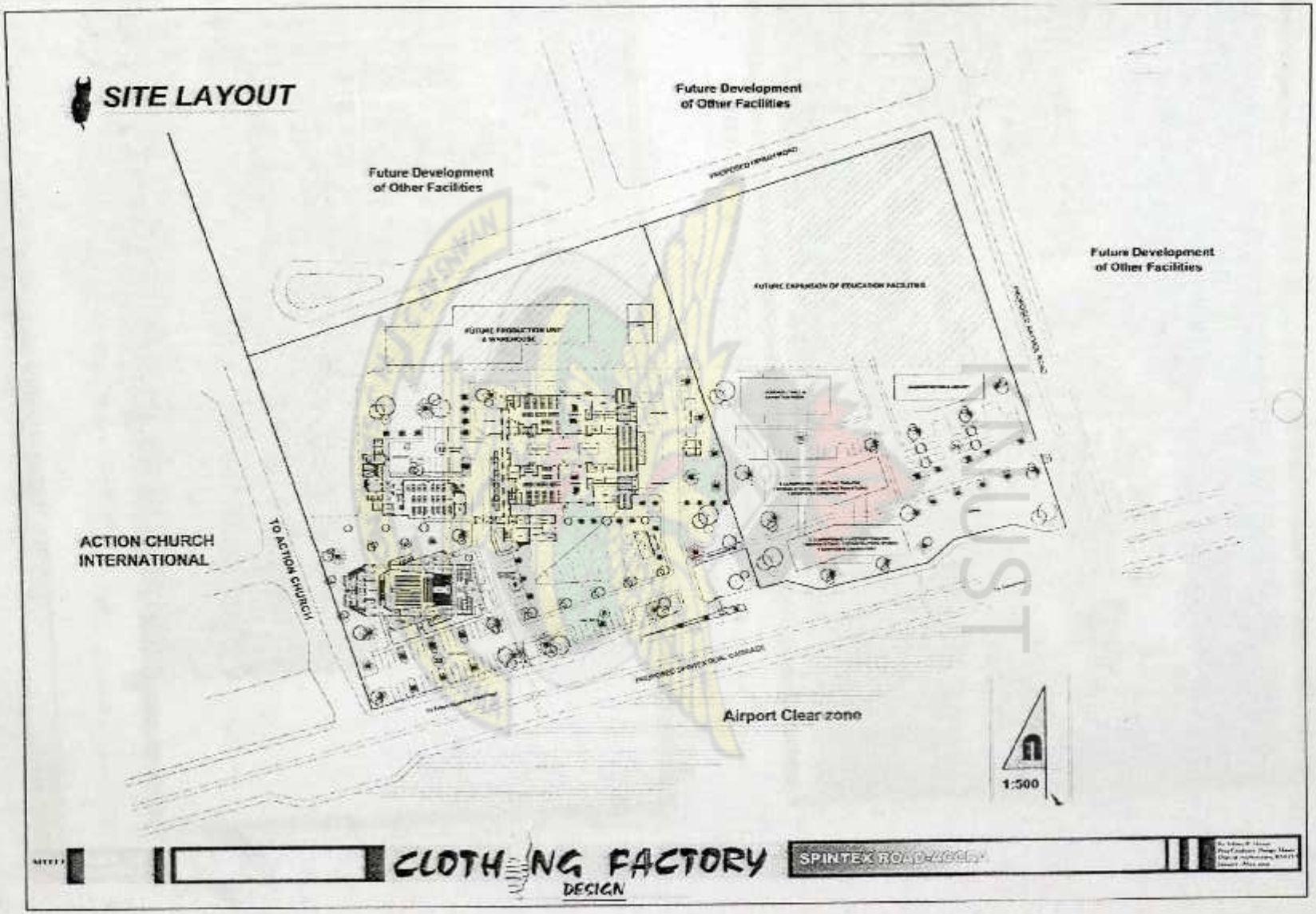
BIBLIOGRAPHY

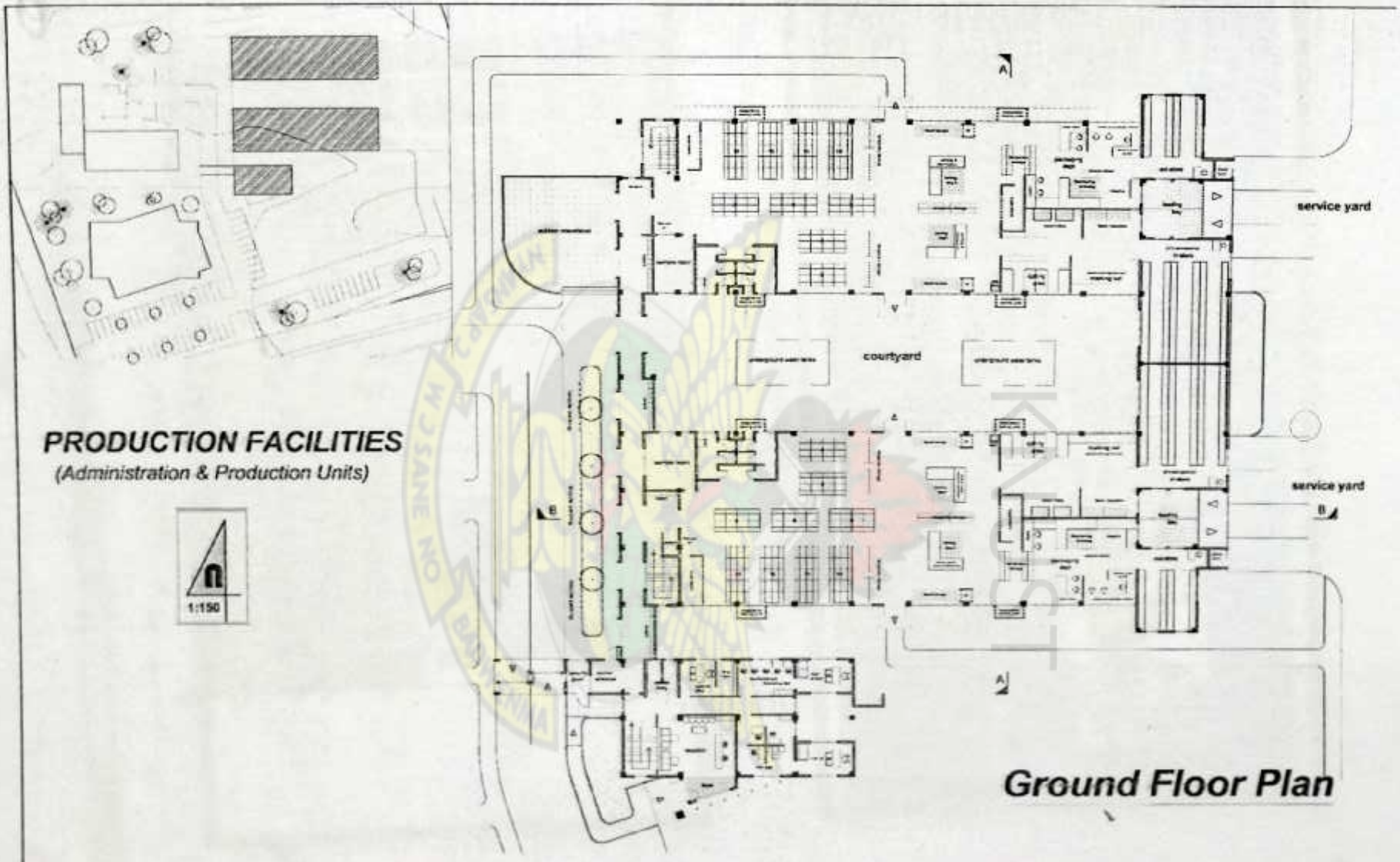
1. Aaron McRee and Nancy L. Cassill, Ph.D; Sub-Saharan Africa: Potential Source for Textiles and Apparel in: Journal of Textile and Apparel, Technology and Management, Volume 2, Issue 3, Summer 2002.
2. Cock Valerie; Dressmaking Simplified, Wiley-Blackwell, Third Edition. 1991
3. Ghana Ministry of Trade and Industry (GMOTI) Report. 2004
4. Holcim (Lanka) Limited, Colombo; Clothing Factory in Sri Lanka, Mas Intimates Thurulie.2008
5. Neufert Ernst and Neufert Peter, Architects' Data. Blackwell Scientific Publication, Third Edition. 2002
6. Oppong-Danquah Thomas, Human Resource Manager, Global Garments and Textile Ltd. Ghana
7. Quartey Peter, Dr; The Textiles and Clothing Industry in Ghana in:Herbert Jauch / Rudolf Traub-Merz (Eds.) The Future of the Textile and Clothing Industry in Sub-Saharan Africa. Bonn: Friedrich-Ebert-Stiftung, 2006
8. Wright Susan, Clothing and Textiles Specialist, New Mexico State University; Designing a Sewing Centre. 2001
9. www.AGOA.info
10. www.atlaslightingproducts.com
11. www.greenlife.info
12. www.Holcim.lk
13. www.miga.org The Multilateral Investment Guarantee Agency Report, January 2007

APPENDIX




BLOCK PLAN
Future Development of Other Facilities
Future Development of Other Facilities
Future Development of Other Facilities
ACTION CHURCH INTERNATIONAL
TO ACTION CHURCH
Airport Clear zone
1:500
CLOTHING FACTORY
DESIGN
SPINTEX ROAD-ACCRA


SITE LAYOUT
Future Development of Other Facilities
Future Development of Other Facilities
Future Development of Other Facilities
ACTION CHURCH INTERNATIONAL
TO ACTION CHURCH
Airport Clear zone
1:500
CLOTHING FACTORY
DESIGN
SPINTEX ROAD



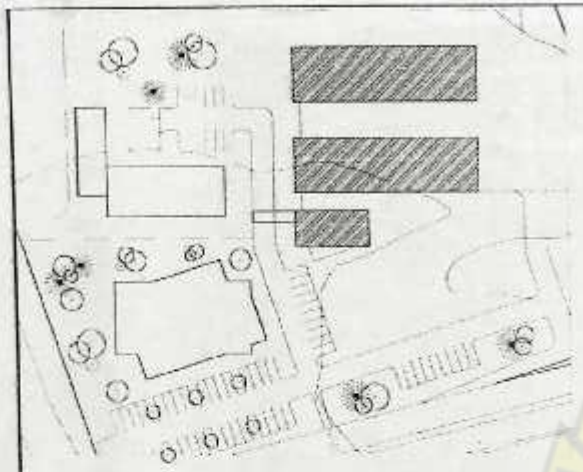
PRODUCTION FACILITIES

(Administration & Production Units)

Ground Floor Plan

CLOTHING FACTORY DESIGN

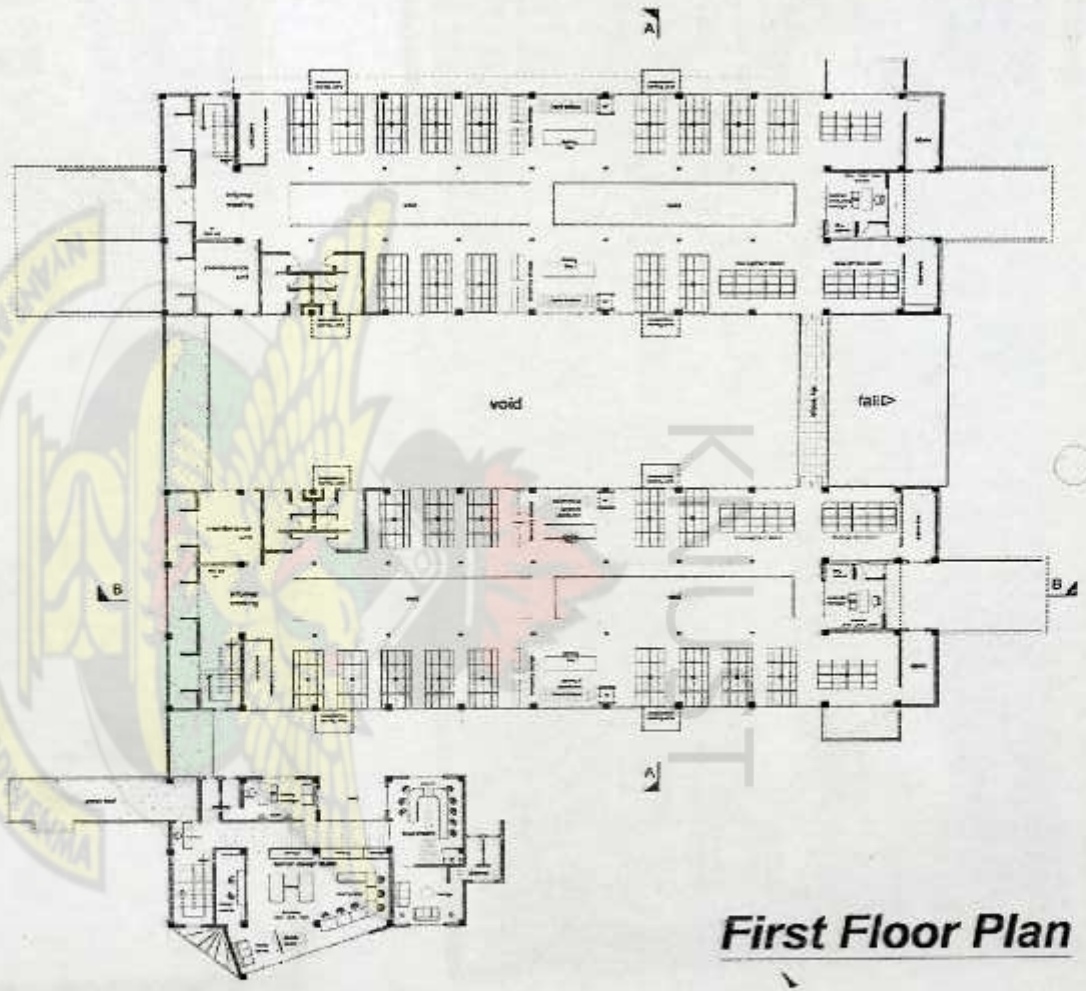
SPINTEX ROAD



PRODUCTION FACILITIES

(Administration & Production Unit)

1:150



First Floor Plan

CLOTHING FACTORY DESIGN

SPINTEX ROAD-ACCRA

ELEVATIONS: Production Facilities (1:150)

East Elevation

West Elevation

CLOTHING FACTORY DESIGN

SPINTEX ROAD

ELEVATIONS: Production Facilities (1:150)

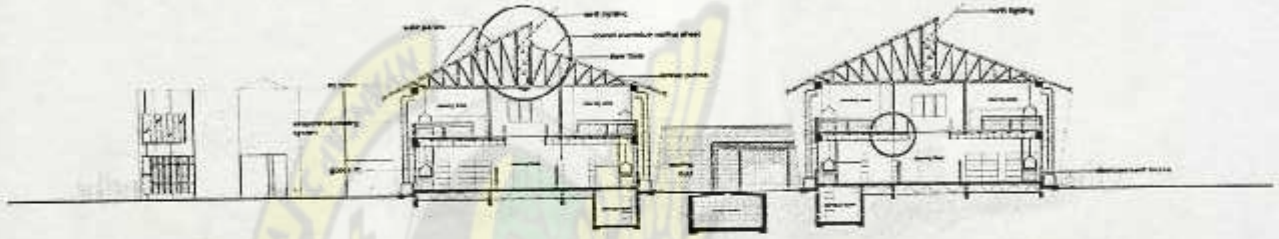
South Elevation

North Elevation

CLOTHING FACTORY

DESIGN

SECTIONS : Production Units (1:150)



Section A-A

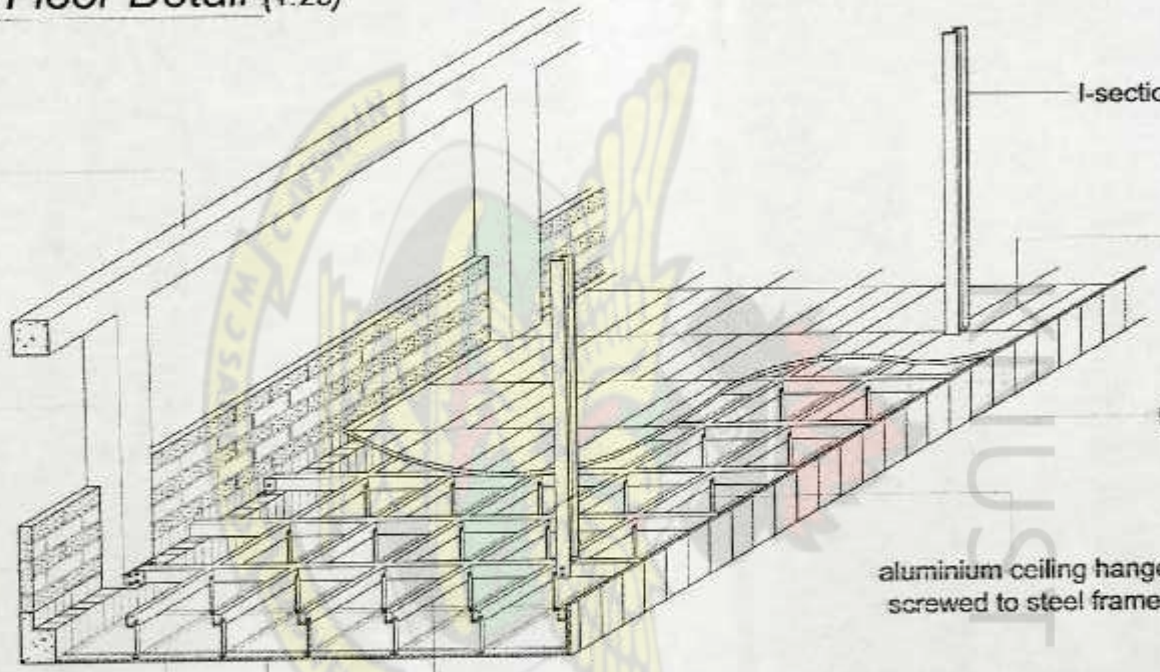
Section B-B

CLOTHING FACTORY DESIGN

SPINTEX ROAD-ACCRA

DETAILS

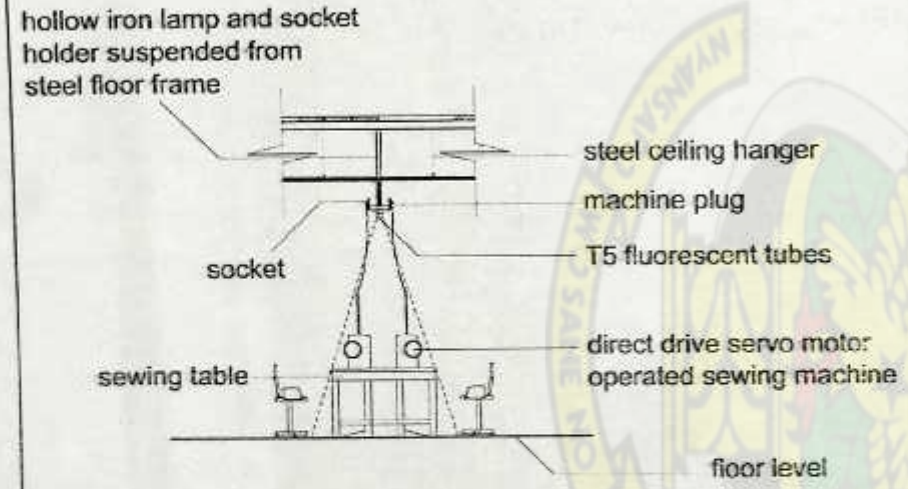
Mezzanine Floor Detail (1:25)



CLOTHING FACTORY DESIGN

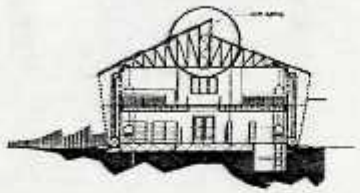
SPINTEX ROAD ACCRA

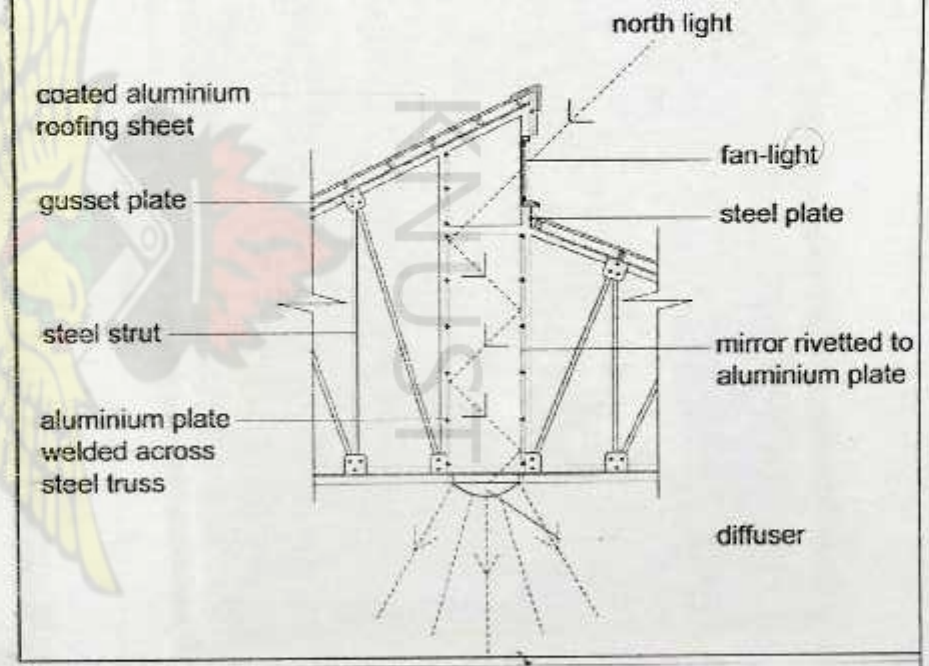
DETAILS



Power Supply & Artificial Lighting Detail (1:25)

North-Lighting Detail (1:25)





CLOTHING FACTORY DESIGN

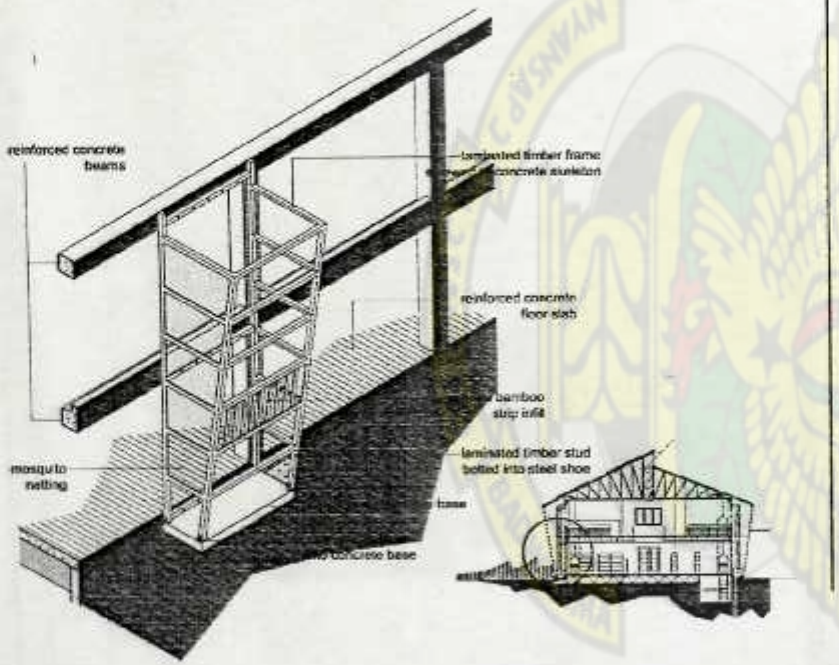
SPINTEX ROAD-ACCRA

10

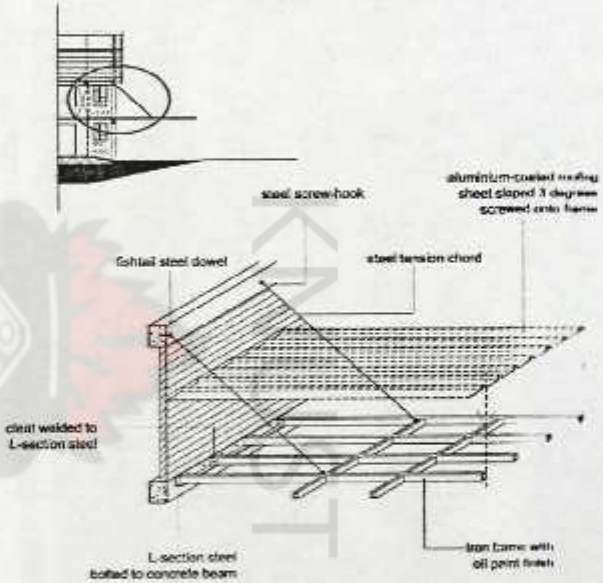
95

DETAILS

Cooling Duct Detail (1:50)

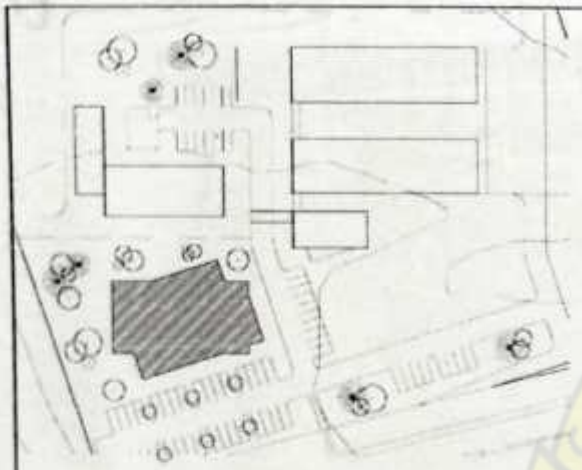


Hood Detail (1:50)

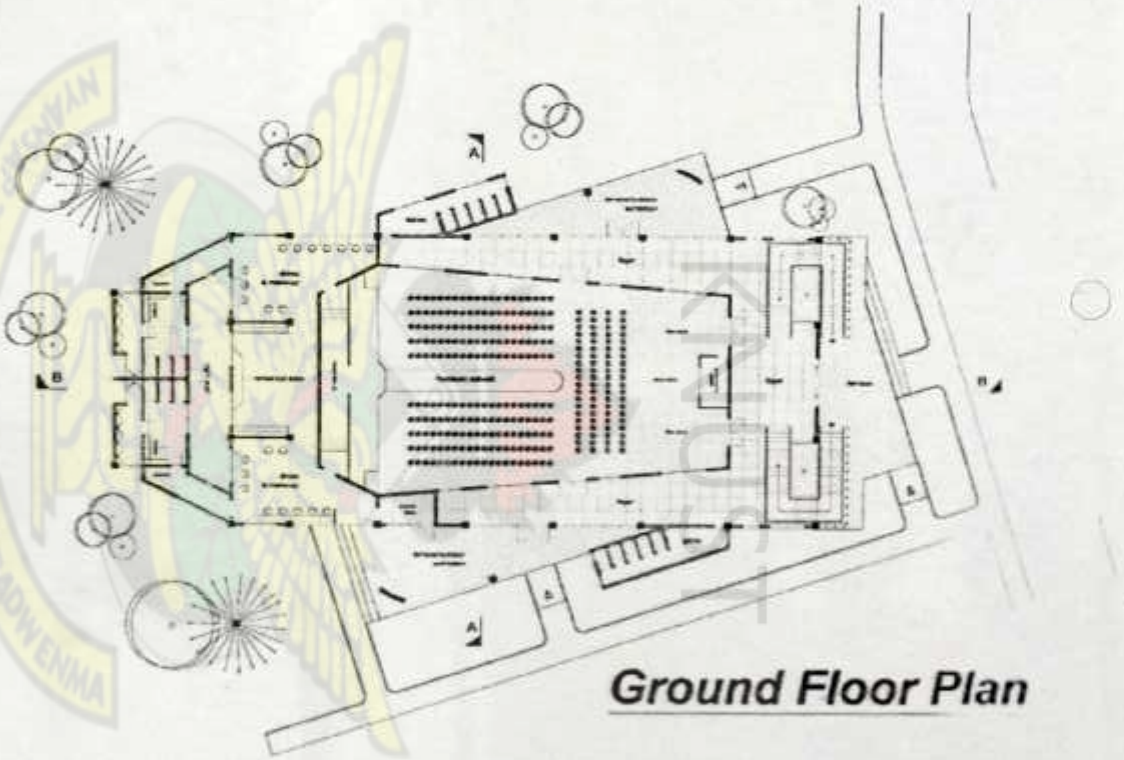


CLOTHING FACTORY DESIGN

SPINTEX ROAD-ACCRA



RUNWAY AUDITORIUM & ANCILLARIES



Ground Floor Plan

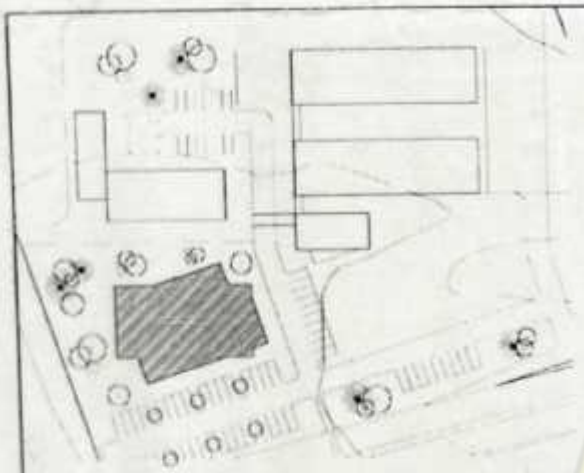
CLOTHING FACTORY DESIGN

SPINTEX ROAD

RUNWAY AUDITORIUM & ANCILLARIES

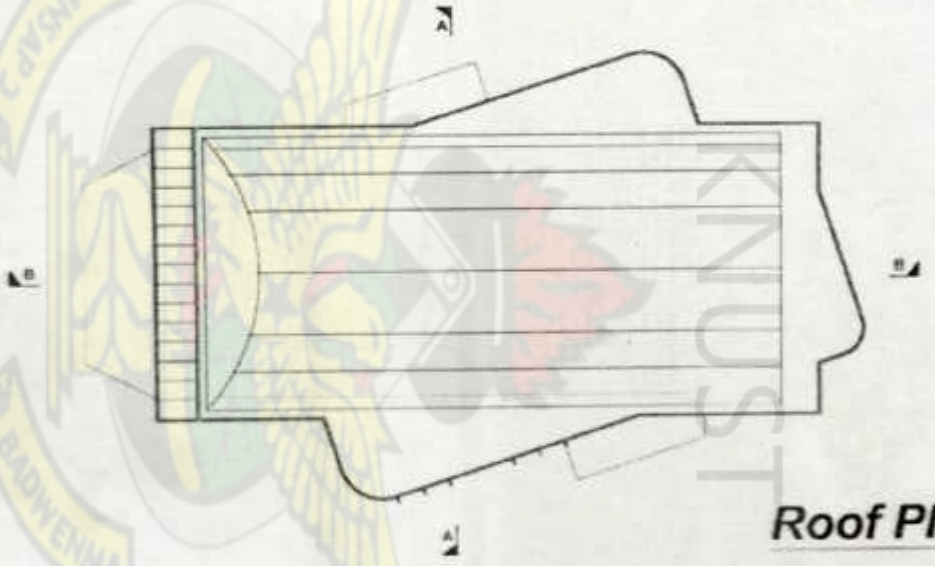
First Floor Plan

CLOTHING FACTORY



RUNWAY AUDITORIUM & ANCILLARIES

1:150



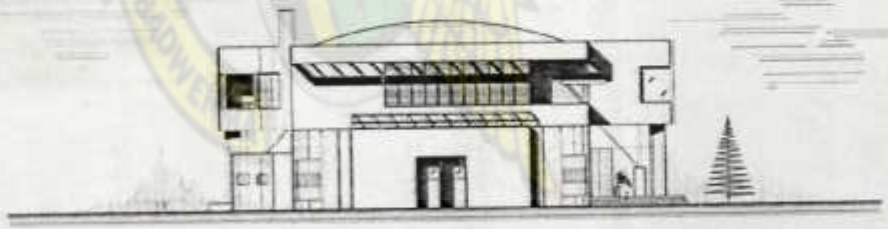
Roof Plan

CLOTHING FACTORY DESIGN

SPINTEX ROAD

ELEVATIONS: Runway Auditorium (1:150)

South Elevation



West Elevation

CLOTHING FACTORY DESIGN

SPINTEX ROAD-ACCRA

15

100

ELEVATIONS: Runway Auditorium (1:150)

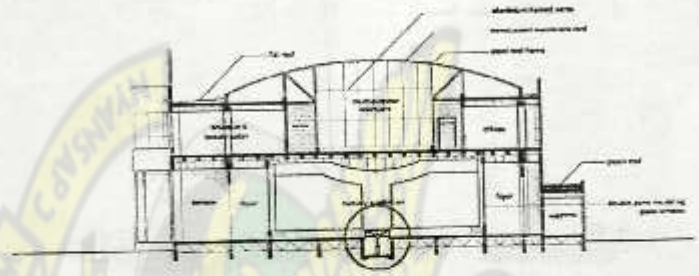
North Elevation

East Elevation

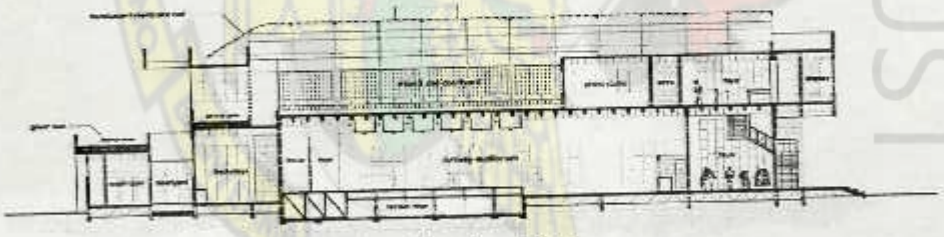
CLOTHING FACTORY DESIGN

SPINTEX ROAD-ACCRA

SECTIONS: Runway Auditorium (1:150)



Section A-A

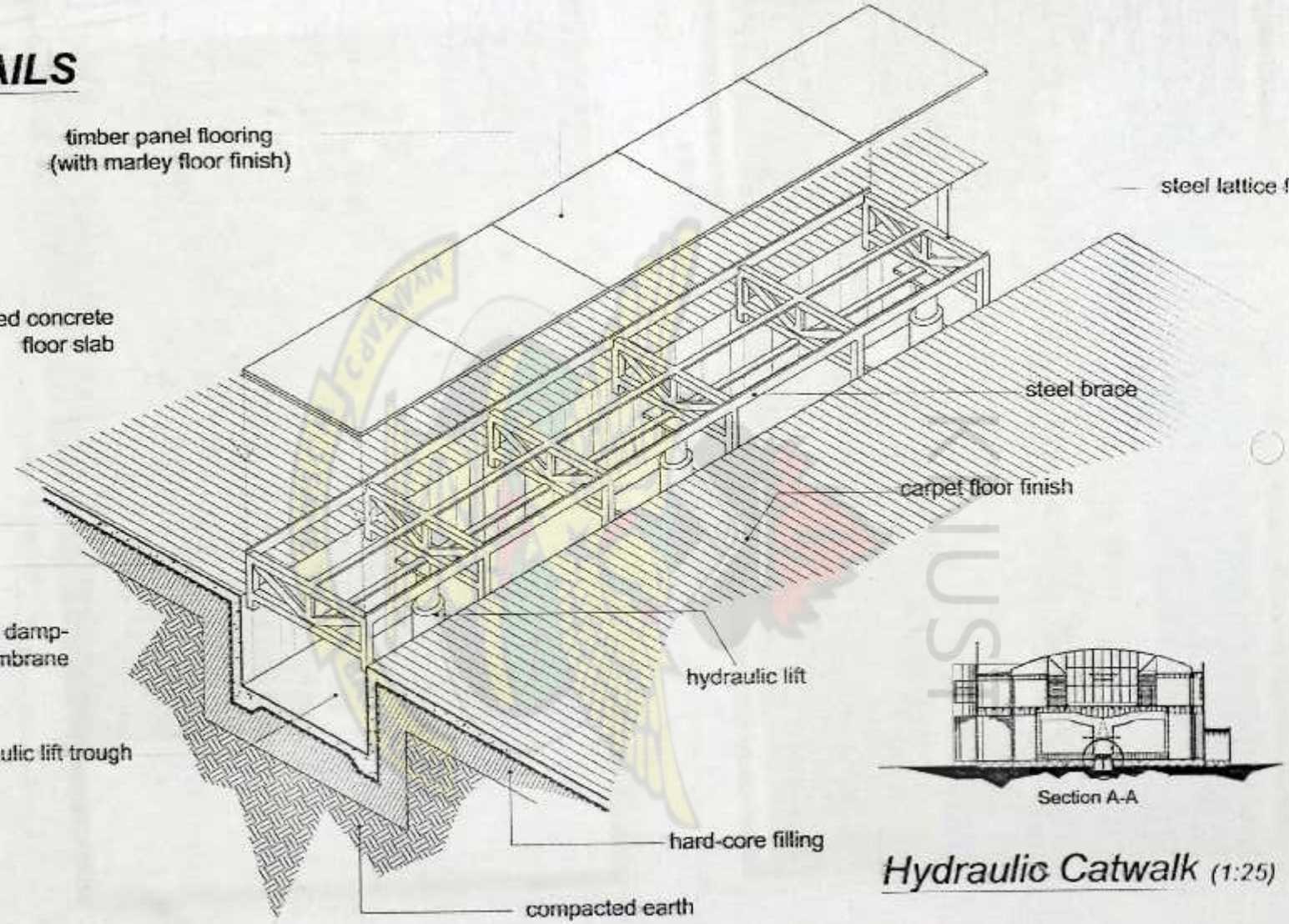


Section B-B

CLOTHING FACTORY DESIGN

SPINTEX ROAD-ACCRA

DETAILS



Hydraulic Catwalk (1:25)

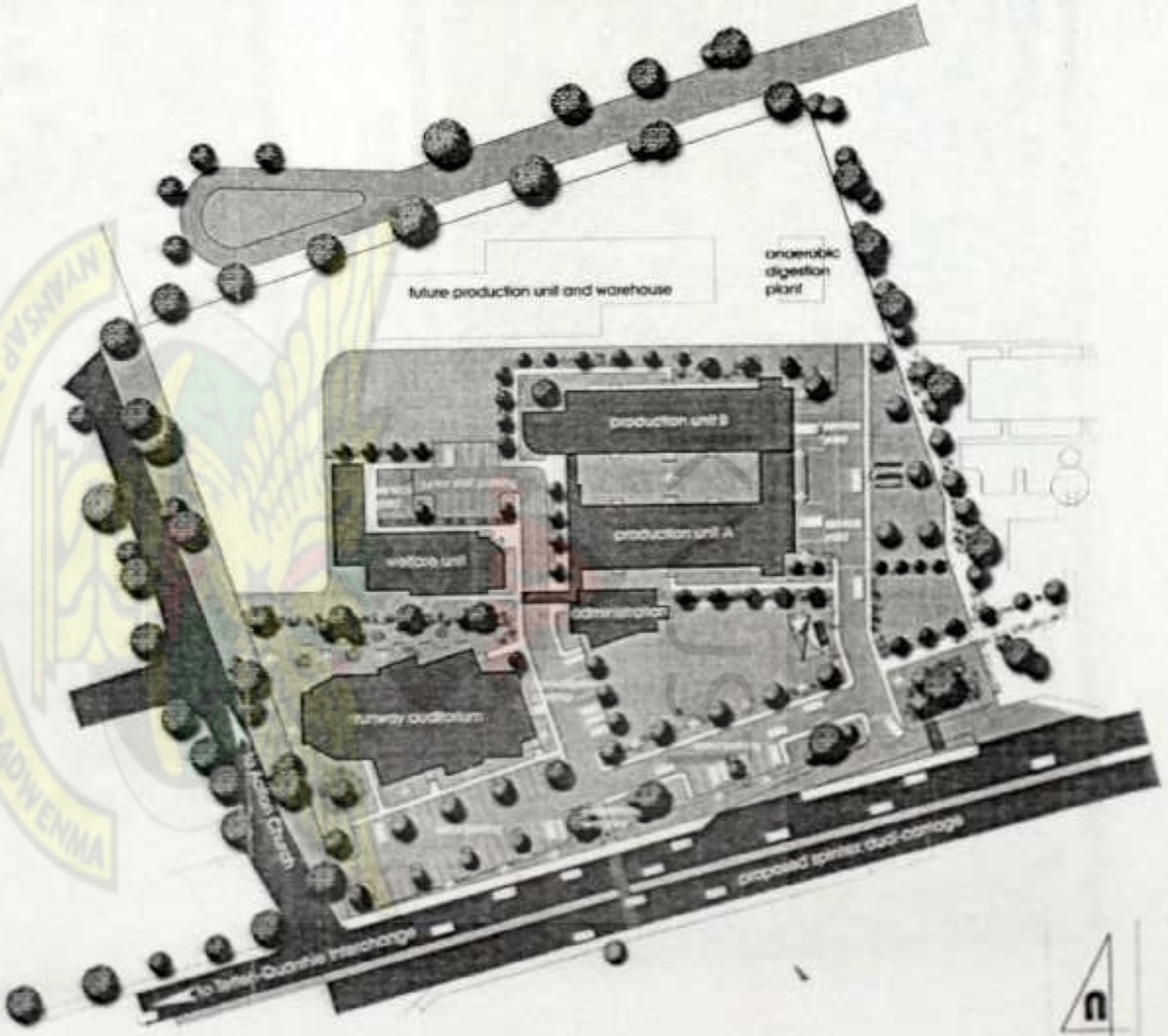
CLOTHING FACTORY DESIGN

SPINTEX ROAD-ACCRA

LANDSCAPE PLAN

LEGEND

- Fir, Douglas
- Bottle Tree
- Acacia, Bailey
- Evergreen hedge
- Garden lamps
- Existing roads
- Proposed roads
- Site pavement
- Off-site pavement
- Lawns
- Bicycle parking
- Garden seating



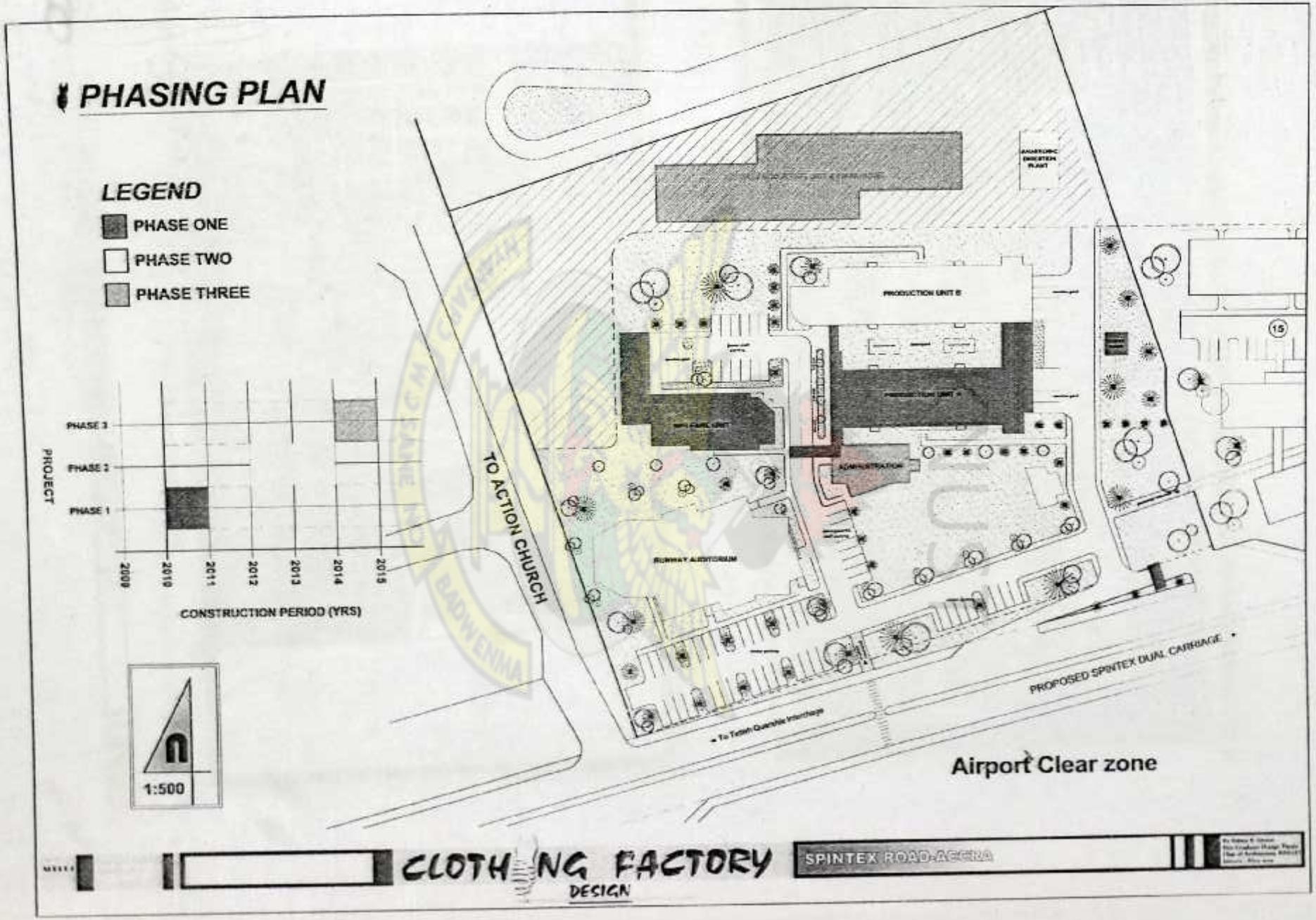
CLOTHING FACTORY DESIGN

SPINTEX

19

104

PHASING PLAN



CLOTHING FACTORY DESIGN

SPINTEX ROAD-ACCRA

VIEW FROM SPINTEX ROAD, Raymol Clothing

PEDESTRIAN ENTRANCE, Raymol Clothing

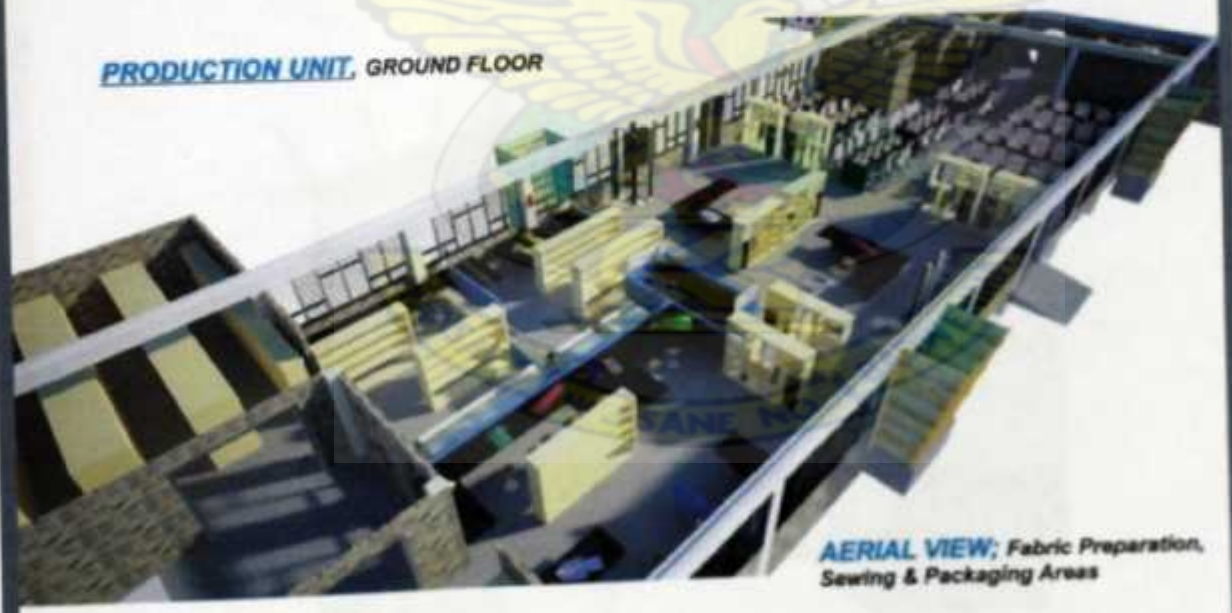
AERIAL VIEW FROM AIRPORT - CLEAR ZONE, Raymol Clothing

SOUTHWEST VIEW, Runway Auditorium

CLOTHING FACTORY

OUTDOOR RELAX-STATION, Raymol Clothing

PRODUCTION UNIT, GROUND FLOOR



AERIAL VIEW; Fabric Preparation, Sewing & Packaging Areas

CLOTHING FACTORY

PRODUCTION UNIT, FIRST FLOOR

AERIAL VIEW; Mezzanine Floor
Showing Sewing Stations

SECTIONAL PERSPECTIVE, Production Unit

CLOTHING FACTORY DESIGN

SPINTEX ROAD

SEWING FLOOR, *Production Unit*

FASHION DESIGN STUDIO, *Administration*

CLOTHING FACTORY DESIGN

SPINTEX ROAD AC

BOARD / PRESENTATION ROOM, *Administration*

RUNWAY AUDITORIUM

CLOTHING FACTORY DESIGN — SPINTEX ROAD