THE APPLICATION OF RADIO FREQUENCY IDENTIFICATION FOR THE MANAGEMENT OF BEEF CATTLE

T J Mutenje

Literature Review and Project Proposal

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School of Bioresources and Environmental Hydrology
University of KwaZulu-Natal
Pietermaritzburg

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Declaration:

I declare that this is my own work and that all the sources I have used have been properly acknowledged.

Signed:____________________ Date:____________________

ABSTRACT

There are limitations in conventional beef cattle management practices in South African feedlots. This is due to a lack of an adequate system for monitoring and controlling activities when handling cattle. In order to find a solution to these limitations, this document outlines a literature review to investigate an alternative automated system using Radio Frequency Identification (RFID) as a management tool. Case studies indicate the success of application of RFID where labour costs, data control errors and handling time were reduced and thus promotes the integration of this technology in conventional cattle management systems. The application of an automated system for beef cattle management that utilises RFID technology, where animals will be identified, weighed and automatically sorted in order to achieve best practice, is proposed. It is also proposed that there be a comparison between the manual and automated management system in order to establish whether electronics can be used as alternative technology.

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1. INTRODUCTION

A feedlot is a closed and intensive feeding system for finishing cattle before slaughter. It comprises of pens and infrastructure for animal handling where all the management practices such as identification, sorting, feeding and dipping are carried out (Grandin, 2003). According to the South African Feedlot Association SAFA (2008) there are approximately 70 feedlots in South Africa which account for 75-85 % of all the beef produced in the country. The Census for Commercial Agriculture CCA (2008) reported that there are approximately 12 large feedlots comprising of more than 20 000 cattle and there are more than 50 small to medium feedlots with the mode being the range 2000 cattle and below. Ford (2008) highlighted the fact that lower profit margins of most feedlots in the range of 4000 cattle and below may be as a result of current management practices and further identified the shortcomings of conventional manual management systems as having long animal handling times, errors in the practice, low standards of record keeping of animal and less consideration of animal welfare.

In order to achieve the optimum levels of success it is important to incorporate the best management practice into cattle management systems. It is required that the management system incorporates precision and accuracy in its operation as compared to the conventional manually operated procedures being utilised in South Africa (Ratsaka, 2009). The use of electronics in the management of livestock improves data management, reduces animal handling time and enables easy planning of animal handling activities (SACO, 2008). Radio Frequency Identification (RFID) is defined in the RFID Journal (2005) as a wireless means of information or data passage from source to a user system. The most common example is information interchanges between electronic tags and a reader.

The NDA (2008) abstract for agriculture statistics highlights the need for a study that evaluates management practices currently being utilised in feedlots, documents their limitations and then develop and asses an alternative management system. This document contains a review of the application of RFID technology and is essential in developing solutions that may be applied to address these shortcomings.

The aim of the study is to develop a cattle management system as an alternative to the current manually based. The objectives of this research are (i) to investigate limitations in the current management practices that are being utilised in feedlots (ii) to review, through the use of case studies and experience from other countries, the benefits of incorporating RFID technology in animal management and (iii) to develop and assess an alternative management system that incorporates electronics, in particular RFID technology for the South African feedlot industry and compare it to the manually based system.

This document contains a literature review of basic feedlot concepts, handling facilities, current local management practices, electronic identification and advantages of control practices in other countries, and a project proposal of how the advantages can be used to address current limitations in intensive cattle management in South Africa through the use of electronic RFID ear tags. Chapter 2 contains the general concept and components of a feedlot system and highlights the importance of the handling facility section in the successful management of cattle. The structural components of the handling facility are explained and how the management practices affect the handling of the animals. The electronic management of cattle is introduced in Chapter 3 in which all the experimentation and tests that were performed in other countries to establish the feasible electronic devices to use in animal production facilities is explained. Chapter 4 contains case studies from other countries where the idea of electronic livestock management is being utilised to the advantage of the producers and feedlot owners. In this chapter the relevant apparatus necessary for successful identification and control of cattle is explained and results of the applications summarised. Chapter 5 contains a discussion of the findings from the literature review and highlights the gaps in the application of RFID in the local industry. It is proposed to undertake a study that applies RFID technology to the South African context to investigate the practicality, applicability and the benefits thereof. The project plan for this study is contained in Chapter 6 whereby the proposed methodology of establishing a technology that will be installed in a feedlot setup for local industry is explained. The chapter also contains information on the components of the proposed technology in order to achieve activities such as automated cattle identification, weighing and automatic sorting.

2. BEEF CATTLE FEEDLOT SYSTEMS

A feedlot refers to facilities for intensive cattle finishing operations before slaughter. Concentrated animal feeding operations can accommodate hundreds of cattle in pens arranged in a special way in order to achieve the best management practices (Grandin, 2003). In order to have a better understanding of electronic management, it is necessary to review relevant literature in the feedlot applications (Collyer and Viljoen, 2002).

2.1 Working Cattle in Feedlots

According to Breedt (2003) construction of cattle feedlots should be on a slope of between 3-6 % taking into consideration the soil type, prevailing winds, possible future extensions and space for pollution control dams. Grandin (1999) explained that a typical layout consists of feedlot pens where the animals are kept, handling facilities where management practices are performed, a unit for storing and processing feed, an office and workshop area, manure, waste and drainage handling structures. Refer to APPENDIX A: TERRAIN PLAN FOR CATTLE FEEDLOT for the general layout of a feedlot and its components.

A feedlot setup should also include facilities for staff and business operations (Meuling, 2006). According to NDA (2008), 95 % of South African feedlots are manually operated with little or no automation thus relying on human accuracy for their success.

Butchbaker *et al.* (1999) highlighted that it is important to review the management practices that are undertaken in the handling facility as they may limit profitability and hinder smooth running of the enterprise. Hence it is important to also review the processes of animal identification, weighing and sorting of cattle in facilities.

2.2 Handling Facility for Cattle

According to Grandin (2004) the handling facility is the section where the cattle are initially received into the feedlot system. The rest of the management activities occur after this stage. Collyer and Viljoen (2002) highlighted that under the current manual management practices, once the animals are received in the handling facility the sequential activities are weighing, tagging and dehorning, sorting, followed by dipping and lastly inoculation. Handling facilities comprises of the following basic handling zones: leader crush, weighing area, neck and body clamp, sorting pens, spray race or dipping passage, working area, feeding area and loading/ offloading zones (Fulwider *et al.* ,2003).

Meuling (2006) defines crush pens as channels or passages where cattle move throughout the handling zones, i.e. from sorting to the loading platform or even in the reverse direction. These pens are usually provided with moveable gates that are used for leading the cattle into the crush. The gates restrict the area behind the animal such that the animal moves forward to where it is led. A funnel-type crush is usually used in handling facilities with a rectangular layout.

Figure 2.1 is a typical funnel shaped crush pen, with a passageway that directs animals from the off-loading ramp to the scale where their weight will be measured and recorded (Collyer and Viljoen, 2002). According to Collyer and Viljoen (2002), in the conventional method the animals are manually driven through the passageway to the weighing scale prior to tagging and identification. Fulwider *et al.* (2003) cautions that, the practice is likely to result in difficulties in animals identification as they would have been weighed without tagging and identification.

Figure 2.1 Funnel shaped crush pen (after Grandin, 2003)

2.2.1 Cattle weighing system

It is important to choose and place scales in a manner that is easy and effective for animal handling. There are basically four categories of scales namely; spring balance scales, hydraulic scales, oil bath scales and electronic scales (Grandin, 2003). Cattle arrive at the weighing area where their weight is captured. If an electronic scale is used the reading is displayed on the dial and if an analogue scale is used the animal's weight is indicated by the counter weight it balances (Ford, 2008). The observed reading is manually recorded in the data book by the attending registrar/clerk for later compilation and information storage. There are limitations associated with this manual capturing of cattle weight data which include the risk of loosing information recorded during weighing, risk of data mix-up as identification and tagging is done after weighing and the risk of recording or capturing incorrect reading from the scale as influenced by the skill and fatigue of the operator obtainable by re-measuring the obtained information and verification (Collyer and Viljoen, 2002).

2.2.2 Tagging and identification

Tagging of an animal refers to the placement of identifiers on the cattle's ear. The identifier could be a unique plastic tag with a code or a number written on it (Meuling, 2006). Tagging and identification is done when the animal is held in the neck and body clamps which are located in the working area of the handling facility. The layout of a typical cattle working area is illustrated in APPENDIX B: CATTLE HANDLING FACILITY DETAILS.

Figure 2.2 shows a typical working area showing the neck clamp where the animal is restrained during the tagging process.

SAFA (2008) stated that there is a risk of having two or more animals with the same identity number or code which could have been as a result of tagging after data acquisition. After tagging and identification, the animals are then forwarded to the sorting gates for them to be allocated to their respective pens.

Figure 2.2 Typical working area (after Breedt, 2003)

2.2.3 Cattle sorting

Sorting refers to the allocation of cattle to a holding pen according to various categories such as weight and stage of growth (Grandin, 1997). The sorting system comprises usually of gates that lead to different pens from a central passage where the tagging and identification was done.Figure 2.3 shows a typical plan view of a sorting gate leading from a neck and body clamp and APPENDIX B: CATTLE HANDLING FACILITY DETAILS contains details of the positioning of the sorting facility

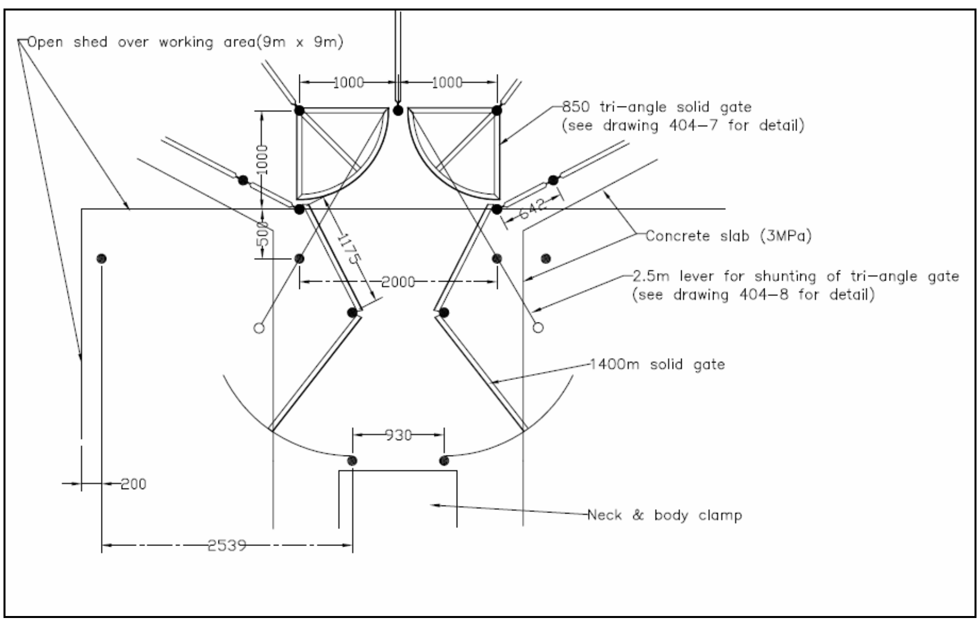

Figure 2.3 Typical sorting gates leading from clamp (after Mutenje, 2009)

A decision of how the animals are to be sorted is based on the weight data and the management requirements (Breedt, 2003). According to Ratsaka (2009) due to the fact that errors and mistakes are not easly verified along the procedure a manual system increases the chance of incorrectly sorting animals as a result of mistakes carried over from the identification and weighing systems. After sorting the animals are either directed to the feeding troughs or to the dipping system.

2.2.4 Feeding and dipping system

According to Butchbaker *et al.* (1999) a fully grown cow consumes approximately 6-10 kg of dry matter and between 40-50 litres of water per day. Conventional feeding uses a community feeding method whereby the animals feed from a common trough without rationing feed quantities and without limiting or monitoring individual consumption (Ford, 2008). NDA (2008) highlights that in a setup as described data on individual animal feed consumption would not be available to aid good management practices for the successful operation of the enterprise. After feeding, cattle can either be directed to the holding yards, or if treatment is required, then the animal is sent to the dipping facility. SAFA (2008) highlighted that many cattle diseases are transmitted by ticks and, in cases of a serious infection, it can cause anaemia. In South Africa the widely used control methods are: spray race, immersion dipping, and pour-on remedies (Ratsaka, 2009). The major limitation of this management practice is that the remedies are administered from a manually calculated instruction which is based on the measured animal data, thus a mistake is carried over from the initial data to treatment system.

2.2.5 Management practice summary

In the European community it is mandatory to follow certain management guidelines in order to be issued an operating licence. From the final report of Joint Research Commission to the European Commission is proposed that an electronic management system be introduced in order to improve the current management practice in developing and underdeveloped countries (IDEA Project, 2003). SACO (2008) states that electronics management of cattle is being practised in many developed countries whilst only less than 5 % of the South African feedlots make use of the technology. It is thus necessary to evaluate electronics management as applied in other countries and adapt it for local applications in South Africa.

3. ELECTRONICS FOR LIVESTOCK MANAGEMENT

The technology that has to do with electronic identification (RFID) of livestock is currently available in simple or complex forms (Artman, 1999). It works with both an identifier and an interrogator. The transponders and readers are the most common components. A transponder is a device that transmits and responds to electronic interrogation by a reader panel. A reader panel is a device that interrogates a transponder by sending an electromagnetic signal thereby activating it for data transmission (RFID Journal, 2005b). Some of the identifiers currently utilised include implantable chips, rumen boluses and ear tags. Implantable chips consist of identifying integrated circuits that are implanted underneath the animal's skin. Rumen boluses are electronic devices for identification that are placed in a container and administered to the cow through the mouth. Electronic ear tags may be made up of plastic or metal tags which house an integrated circuit that has an identification number or code. These are pinned onto the cattle's ear cartilage for identification (IDEA Project, 2003).

According to IDEA Project (2003), the three main types of readers are hand-held, portable and stationery readers. It is essential that the reader creates a field and as soon as the identifier enters the field it is activated and the reader then receives the signal that comes from the transponder. Stationary readers as illustrated in Figure 3.1 are widely used for mobile animals and where the animals are unattended. This unit is placed in a chute where the animals will pass through for optimum handling.

Figure 3.1 Reader panels for dynamic animals (IDEA Project report, 2003)

Aarts *et al,* (1989) states that for optimum working conditions the readers should be placed 750 mm apart. This will enable one cow to be in the readers' range at a time and avoid collisions which are caused by having two identifiers in the reader's range at a particular moment. Normally the transponders are best read if travelling at a speed of no more than 10 $km.hr^{-1}$ (Aarts *et al.,* 1989).

3.1 Reading of Electronic Identifiers and Control Interfaces

The IDEA Project (2003) recommended that reading be undertaken by a skilled operator to avoid mistakes and errors. The identifier is first tested before it is applied to the animal to ensure that it is not defective. As a rule of thumb, an identifier that shows signs of damage or fault must not be applied to the animal as it may not be reliable when in use.

Stationary or static reading involves the use of hand held readers on an animal that is restrained. This method is time consuming and tiresome as it requires the reader to be passed exactly over the identifier's positioning and it is thus mainly utilised for small herds (IDEA Project, 2003). Hanton (1992) states that in dynamic reading the animals pass through a single file raceway where the panel readers will be on the sides of the corridor. As the transponder comes into the field of the reader it is activated and identified.

3.2 Applicability of Electronic Management in Cattle

According to Lambooij and Merks (1989), the technology of electronic identification can be utilised in the recording and identification for good farm practices. According to the tests and research done at the Grange Research Centre (GRC) in Dublin, Ireland, it was concluded that implantable electronic transponders, also referred to as IETs, offer a more reliable system in individual animal identification compared to visual tags alone (Lambooij and Merks, 1989). From about 150 experiments conducted under different conditions and climates, the tests resulted in a 97.5 % success and recovery of the technology after use. Before 1989 there was still controversy on the implantation site for the various IETs. Studies were then undertaken by Aarts *et al.,* (1989) on four sites on beef cattle. Different sites on the cattle body were chosen as tests sites in the initial phase and only 4 remained after the ethics, health and animal safety considerations were adhered to. It was concluded that the most suitable position on which the RFID tag was to be applied is under the scutiform cartilage of the ear. This was first recommended by Fallon and Rogers (1991) and confirmed as suitable by Hasker *et al.* (1992).

3.3 Experience in Electronic Management

Hanton (1991) in highlighted that a drawback of the utilisation of injectable transponders was that there is risk of not recovering the device after slaughter and thus IETs are usually regarded as an unacceptable method of identification. The other experiments conducted showed the possibility of utilising a rumen bolus as a means of identification. However, according to Lambooij and Merks (1989), careful consideration is required when selecting the type of identifier to use between the rumen bolus and ear tag as they both have similar advantages. When comparing the rumen bolus and the ear tags it was found that reading a bolus was more difficult when applied to hand held readers.

3.4 Electronics Tags and Bolus Comparison

According to Eradus *et al.* (1999), an experiment to compare the use of electronic tags and rumen boluses as means of identification was conducted at the Teagasc, Grange Research Centre. In this experiment 1120 cattle were used in the study. The categories varied from beef cows, 1-5 weeks old calves, weaners, replacement heifers and feedlot cattle that were due for slaughter within 100 days. The experiment made use of rumen boluses and tags supplied from key manufactures, namely Allflex and Nedap (Allflex, 2009). The experiments started in September 2000 and the results after 7 months are as contained in Table 3.1. From these results it was concluded that boluses are more durable and reliable as compared to electronic ear tags.

Table 3.1 Results of bolus and tags comparison (after Eradus *et al.* 1999)

PERIOD (When readings were taken)	ALFLEX (Units still active)		NEDAP (Units still active)	
	Bolus	Ear tag	Bolus	Ear tag
Day 0	510	511	511	510
Day 7	510	511	511	499
Day 28	510	506	511	489
Not reading at 7 Months	5	8	5	23
After 7 Months	505	503	506	487
% Change	0.98	1.57	0.98	4.51

Eradus *et al.* (1999) conducted a holistic analysis that included economics, applicability and effect on animal welfare of the boluses and tags. They concluded that although boluses seem to be more durable, analysing all other factors like cost, reading distance and applicability, the result favoured the use of electronic ear tags as they are easily available, cheaper than bolus and also easy to administer.

According to Walker (2009) electronic ear tags in cattle makes use of radio waves operating at a low frequency. The waves are able to pass through living tissue. ISO 11784 is the set of guidelines that explains the identification code itself whilst ISO 11785 focuses on the technicalities of the tag and reader to ensure compatibility. Normally the 134.2 kHz band is the operating frequency in animal identification. Information interchange between tag and reader is based normally on either a half duplex or a full duplex defined and symbolised by (HDX) AND (FDX-B) respectively. After the transponder sends a signal to uniquely identify itself it reverts back to its passive state waiting to be activated again by a reader field.

The limitations in the conventional manual feedlot management practices have been discussed and the need of an automated system has been highlighted. The next chapter uses case studies where the suggested RFID technology has been applied in other countries to evaluate the performance and success thereof.

4. APPLICATION OF RFID TECHNOLOGY

RFID technology is used globally and its current popularity as a tool for better management of cattle could possibly lead to it being utilised for beef cattle management in South Africa (SACO, 2008). Dean *et al.* (1992) stated that electronic ear tags are the most widely used identifiers and they consist of two basic components, namely the internal integrated circuit and the outside shell holder that is fastened onto the animal's ear. An animal is fitted with two tags, an electronic tag attached to the left ear and a visual tag on the right ear.

4.1 Application in RFID Tags to Cattle Management

According to Naas (2002) the use of RFID electronic ear tags has many advantages for management of feedlots. Naas (2002) stated that electronic tags can be regarded as a great improvement compared to the visual reading of codes and numbers. The reduction of labour cost is highlighted as one of the major advantages of the use of RFID tags. Artman (1999) concluded that the use of RFID tags reduced incorrect readings from 6 % to 0.1 %.

According to Geers (1997) the use of electronic tags in animal production and management practices opens possibilities for the monitoring of more complicated tasks such as automatic sorting, feeding and health treatments as evident from tests and experiments that were conducted by Artman (1999) where specific technology was developed and tested successfully for the management practices.

4.2 Animal Identification, Weighing and Automatic Sorting Applications

The first case study entails the application of electronic ear tags equipped with TROVAN ID-100A tags (TROVAN, 2009) and visual tags for the management of a 35000 head of cattle at Campo ranch in Argentina. A GR-100 GRIP computer and management software were utilised in the study. It was found that the processing of animals was 60 % faster with consequent less strain on the animals and time saving in the operations (TROVAN, 2009).

The second case study was on the application of RFID on a dairy farm in Dublin, Ireland (Dairymaster's, 2009). RFID technology operating at 125 KHz with passive tag and short read range was used. The objective of the study was to identify cattle using RFID technology and use the information in cattle management practices of dairy cattle. This was applied in the identification of cattle when weighing, milking, feeding, dipping and sorting. The system also incorporated management software that recorded data and also performed feeding schedules based on the software instructions. The feed was also quantified and rationed for each animal according to the milk yields. There was a reduction in labour costs as the labour requirements were reduced from 13 to 6 personnel where one operator could milk 800 cows in a period of 3.5 hours compared to manually managed systems.

In a study in Route d'Arles, France, the Institute of Natural Resources Arles INRA (2009) in collaboration with the WALLACE foundation developed and tested an automatic sorting system for sheep using RFID. The technology which made use of electronic tags in sheep sorting resulted in time and manpower savings. As indicated in their test the system was able to sort an average of 700 ewes in 20 minutes which is 80 % faster than manual sorting, resulting in a reduction of an equivalent of almost 200 labour hours per week. Figure 4.1 shows a plan view of a sorting system that was developed by INRA and which makes use of RFID technology. As explained by the INRA (2009) experts, the sheep are passed through the RFID detector and an RFID compatible electronic scale system after which, through the use of management software, the sheep are sorted to either camp A or B based on the sheep's weight. Should the device fail to be read then the animal is taken to a device error channel where it is marked by an ink for further attention.

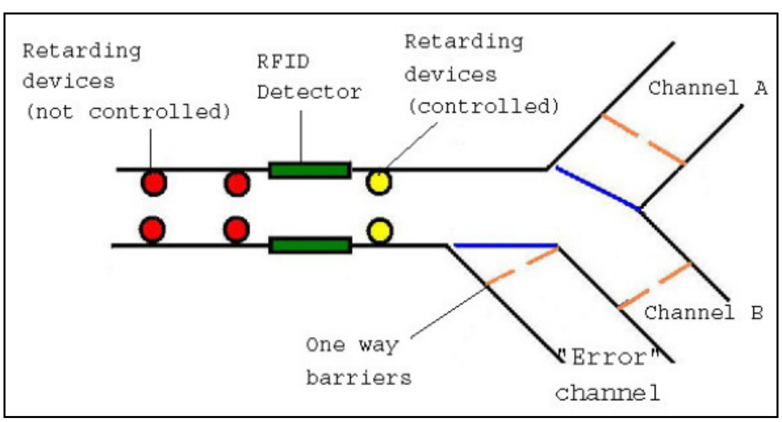

Figure 4.1 Sorting unit making us of RFID technology (INRA, 2009)

According to Boote and Mavundza (2009) a four way automated sheep sorter was developed at a cost of less than R50 000-00 and which is capable of sorting an average of 720 sheep per hour on weight basis. Boote and Mavundza (2009) report that the sheep sorter was designed and constructed to be portable to the extent that it only required two health people to be able to lift it into the back of a truck. Mavundza (2009) highlighted that the sorting module was part of the electronic management of livestock using RFID technology project of the ARC-IAE and the idea would be adopted for cattle systems.

4.3 Case Study of Total Management System

Another case study for investigating the benefits of using RFID ear tags to complement individual animal record-keeping was conducted at Corona Range and Livestock Research Centre (Cox *et al.,* 2006). In the investigation they made use of visual and electronic ear tags, a reader system, a compatible electronic scale, indicators, various management software suites (e.g Beeflink, Cow sense, CattleMax2) with RFID compatibility, an image capturing device and a computer system. In their research and testing they established a system which included capabilities such as records of individual animal performance, automated electronic weight recording, monitoring performance during weighing, and information interchange with herd management software without any information loss.

It was also established that a comprehensive recording system working on 150 head of cattle would cost an equivalent of US$ 4393-00, excluding the feeding and dipping mechanism. In the 3 year duration of the project, of the 150 electronic tags fitted to cattle there was 100 % responsive tags and only one tag was lost, whilst the replacement rate for the visual tag was in the range of 2.7 %. Cox *et al.* (2006) argued that the use of RFID technology/tags also come with a price to pay in maintaining the technology as there is need of regular servicing of all the equipment, software upgrades, computer maintenance and upgrades and keeping up with technology. It was observed that the technology reduced the labour force by almost 50 % and reduced data recording errors by almost 5 %. It was also discussed that this management practice reduced sorting time by 3-4 h per day for 500 cattle, which in turn reduced animal stress and worker fatigue, thus increasing the operations profit margins.

A discussion and conclusion of the reviewed literature follows. This will lead to the best possible application of technology.

5. DISCUSSION AND CONCLUSIONS

In order to successfully monitor and manage animal growth and production, it is necessary to have good data for the entire feedlot operation. There is a challenge in the management of cattle feedlots in South Africa as the conventional methods used are limited to manual techniques for identification, weighting, sorting, feeding and dipping of animals. South African feedlots are operated manually and use very little to no electronics in their operations. It has also been shown from the studies done that manual management practices result in high labour costs, high operation costs, is time consuming, can result in inaccurate records and storage of data and sometimes takes less consideration of animal welfare thus causing injuries and harm to the animal. From the studies reviewed, it can be concluded that the current manual management practices in South Africa are a less effective way of cattle management for optimum production.

The two key aspects in successful management are good identification and control systems. The importance of RFID technology as applied to animal management was highlighted in the operations included in the case studies. In the case studies it was demonstrated that RFID technology application in an operation reduced data handling errors by more than 5 %, reduced labour costs by almost 50 % and reduced animal stress through reductions in handling and sorting times. There is great potential for the adaptation and use of electronic ear tags as a management tool in the South African context which has 95 % of the feedlots currently utilising manually based systems that have limitations and hence may benefit by adopting the new technology.

It is thus necessary to research the development and assessment of an alternative management system that incorporates electronics, in particular Radio Frequency Identification ear tags, for the South African feedlot industry, as outlined in the project plan. This research into technology development will achieve quantifiable results for different cattle management systems like automatic identification, weighing and automatic sorting applications. All these modules will be tested mainly for their effects on cattle management. The major aspect or characteristics that will be tested need to show how the electronic system compares with the manual operation in reducing capital and operational costs, labour costs, animal stress, handling/sorting time and reduction handling stress.

6. PROJECT PLAN

The development of a system that makes use of RFID electronic ear tags as a tool for cattle management is proposed to solve the limitations that are associated with the current conventional manually based management practices.

6.1 Background Information

Current management practice have high operational costs, mainly due to high labour costs, long animal handling time, inaccurate data handling and less consideration of animal welfare of which that can be overcome by can be overcome by incorporating electronic management in the identification and control of animals. Two feedlots are under construction in Limpopo province and in North West province South Africa which would be manually and electronically operated respectively. The proposed technology would be incorporated into the 500 cattle feedlot in Jericho Village, North West Province whilst the Blouberg 500 cattle feedlot would be manually operated. Comparative analysis would be done as to the effects of incorporating electronics into cattle management as compared to the manual system.

6.2 Research Objectives

The aim of the proposal is the development of a cattle handling system that utilises RFID technology as an alternative to the manually based system currently widely utilised in South African and also to compare weather automation aids cattle management by reducing cost.

The objectives of the study are:

i. to develop an automatic cattle weighing and sorting system that use RFID tags for identification when managing cattle in handling facilities, and
ii. to assess how effective the proposed RFID system will be to reduce operational costs and data handling errors incurred in identification, sorting and handling of cattle in a South African feedlot

6.3 Proposed Methodology

For the objectives to be realised, the results from the literature will be used as a guide to the technology development, this include the project proposal, theoretical design, construction and implementation then evaluation and report writing. This section, including APPENDIX D: HOW THE OBJECTIVES WILL BE ACHIEVED contains information on how the synthesis of relevant literature, techniques and methods adopted from literature will aid in achieving the objectives of the research. There is need of giving consideration to how the system would flow prior to the actual design, thus the need of a design consideration report.

6.3.1 Design considerations

In order to achieve the above mentioned objectives, a process and system needs to be followed from cattle entering the feedlot, initialisation of the system and the technology at work and data storage, as shown in APPENDIX E: PROPOSED RFID FLOW CHART, which represents a flow chart of the proposed system where cattle enter the feedlot as passes through all identification and control management practices. The cattle are passed on to the handling facility where initialisation takes place and they are fitted with electronic ear tags and initial data of the animal is recorded. Management practices follow and the information is later recorded and stored for future use. The use of RFID as a replacement to manually based systems will form the focus of this study. APPENDIX E: PROPOSED RFID FLOW CHART shows the procedures and the proposed technologies to be utilised. The system will include identification (indicated as system 1), automatic weighing (indicated as system 2) and automatic sorting (indicated as system 3) as illustrated. All measurements and processing will occur in the chute that has controlled gates after which the animals are sent to pens for feeding sessions of which they may be put into various categories as per the system requirements.

Using a management tools (e.g. such as Beef Link Software or Possum Gully Software) the initial measurement and historical data will be used to make individual analysis and projections for each animal. Following the management software's decision, sorting (indicated as system 3) in APPENDIX E: PROPOSED RFID FLOW CHART, can be into four groups such as ready for market, to feed stall, to dip applicator or to holding pens for further management practices. Automation and direction of animals into their pens will be done as they exit the controlled passageway. In order for the systems to communicate it is necessary to discuss the interface that is essential to the whole system, which is the RFID interface.

6.3.2 The RFID interface

The interface will consist of two components, which are the identification means and the data processing and control system. The electronic identifier will be made up of an electronic tag and a holding button. In its application the ear of the animal is punched with a tag driven through and fastened onto the holder. The tag will be in a passive form and will be activated by a signal that comes from the reader as soon the tag enters the reader's field. The tag sends a unique identification code and thus the animal is identified by the control system. The data processing and control system will comprise of a central control mechanism, for example a computer, which will collect and store all the detailed data, and information relayed from the receiver system. A microprocessor can also be adopted to store all the animal data. Each of the gates is controlled by an actuator which in turns responds to the signals received from the process controller microprocessor. The gate will sort cattle in camps as determined by the control interface and management software's response to input data. Cattle can either be sent to a holding camp where animals requiring attention are placed, to a dipping camp, to a feeding stall camp or to a camp those ready for market. APPENDIX F: SUMMARY OF COMPLETE RFID DESIGN contains a summary of the processes involved in this management practice and the systems utilised in order to achieve the required objectives.

6.4 Proposed Design Outline

The project implementation would be limited to a one year duration starting fro the 5th of January 2010. The project will have two components; a new technology design component and an existing technology manipulation component. APPENDIX G: PROPOSED TECHNOLOGY OUTLINE illustrates the new and old technology components of the project.

6.5 Project Budget and Required Resources

The project is funded in totality by the ARC-IAE. The designs of this project will be implemented and evaluated in the two identified sites of Limpopo and North West province, namely Blouberg in Limpopo and Bojanala in North West. The man hours required will be provided by Mr Mutenje and selected team members from ARC. Construction materials will be provided by various suppliers which include RG Burton Control cc. APPENDIX I: REQUIRED MATERIALS AND RESOURCES breaks down the main components required to complete the project. All the activities of the project will be performed as indicated in the project plan, as shown in APPENDIX J: TOTAL PROJECT PLAN. The project should be complete by the end of November 2010. However the during of each task might change due to administrative performance and further research of the project, this include the communication between the student, supervisors and examiners. It is thought that the time frame of the project is satisfactory for the MSc degree offered by the School of Bioresources Engineering and Environmental Hydrology. The estimated costs and material required is presented in APPENDIX C: PROJECT BUDGET ALLOCATION PLAN.

6.6 Method of Evaluation and Expected Results

The outcome of this research is expected to be an analysis of the outcomes of two systems (both the manual and the automated) and their responsiveness to handling errors, handling time, labour cost, animal welfare, start-up capital and other operational costs. A herd size of 500 cattle would be used for the duration of the research both on a manual system and on the automated system. Measurements and tests would be conducted on both sites and the outcome analysed for the conclusion to be drawn as to whether automation can be a feasible replacement of the manual system. APPENDIX H: EVALUATION AND EXPECTED RESULTS contains information on how the evaluation would be conducted and the expected outcomes.

6.7 Health, Safety, Environmental and Ethical Consideration

The project will be tested on existing feedlots which pass health and safety standards required by the Health department. Since the technology is to be established on existing infrastructure then there won’t be any Environmental Impact Assessment required despite the fact that its infrastructure for more than 100 cattle. There are no new devices being developed in this technology thus no ethical clearance required. All the technology that is to be used in this design would be already registered and cleared technology and thus standard procedures set for administering the technology will be used.

7. REFFERENCES

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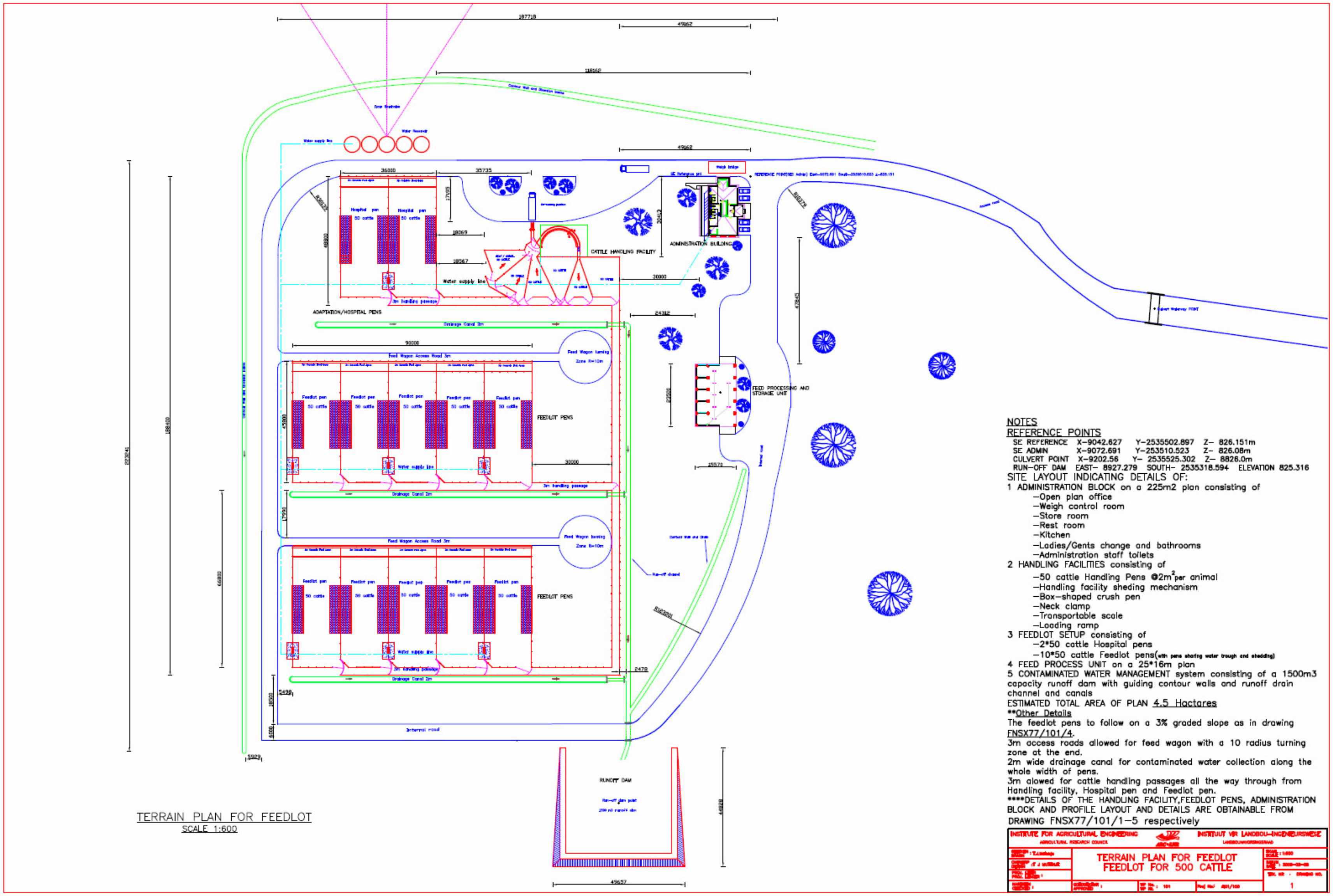
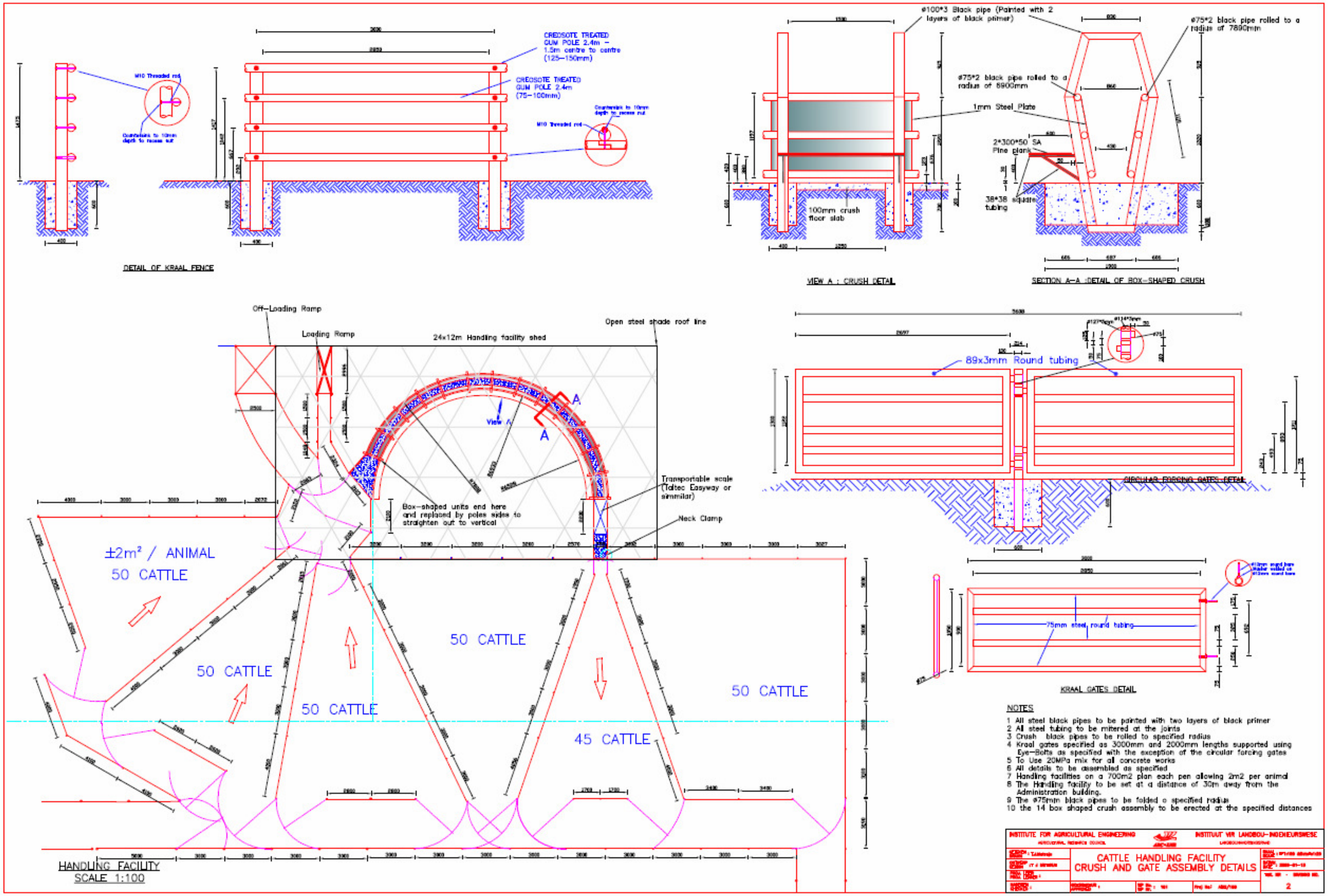
8. APPENDIX A: TERRAIN PLAN FOR CATTLE FEEDLOT



9. APPENDIX B: CATTLE HANDLING FACILITY DETAILS



10. APPENDIX C: PROJECT BUDGET ALLOCATION PLAN

PROJECT PLANNING:

PLANNING DATE:	09-Jan-08
PROJECT NO:	AI02/100
PROJECT TITLE:	Electronic management of livestock
PROJECT DESCRIPTION:	Literature review, reports, proposal, design, construction, evaluate and presentation of animal management technology using RFID
PROJECT LEADER:	T J MUTENJE
Personnel number	48067638
STARTING DATE:	2009/01/09
COMPLETION DATE:	2009/12/09
End Product:	Cattle Management Technology

Nr	Task	Task Nr	Task Leader	Start	End	Man Power		Expense	Risk Cost	Total per Task
						Hrs	Cost			
A	Engineering inputs into RFID technology	100	T J MUTENJE	2009/01/09	2010/10/09	120	300	0	0	36000
B	Research inputs into the project	100	T J MUTENJE	2009/01/09	2010/10/30	150	300	0	0	45000
C		200	T MAVUDZA	2009/01/09	2009/10/20	50	300	0	0	15000
D	Proposal writing and presentation	100	T J MUTENJE	2009/01/09	2009/09/30	50	300	0	0	15000
E		200	T MAVUDZA	2009/01/09	200903/03	50	300	0	0	15000
F	Sorting Mechanism module extras	200	T MAVUDZA	2009/07/20	2009/10/05	0	0	15000	0	15000
G	RFID Technology extras	100	T J MUTENJE	2010/03/03	2009/10//11	0	0	30000	0	30000
H										
I										
J										
K										
L										
M										
N										
O										
P										
R										
S										
T										
					Totaal:	420	1500	45000	0	171000

PROJECT COST	171000

COST ALLOCATION	%
Overhead	136020
Internal Capacity	
External & Inter-Institutional	100
Provincial	
Total (100 %):	136020

External & Inter-Institute	307020
15%Profit:	
Total with Profit:	307020
14% VAT:	42983
Total with VAT:	350003

Internal & Provincial:	R
Internal Capacity:	0
Provincial (No Profit taken)	0

BUDGETED INCOME
350 000-00

CLIENT
PROJECT AI01/98

REMARKS

TOTAL MAN-HOURS

	Post Level	Hours
J.G. van Gass	7	0
T.J. Mutenje	4	320
J. du Plessis	4	0
		0
T Mavundza	4	100
		0
		0
		0
		0
		0
		0
		0
		0
		0
		0
		0
		0
		0
	Total	420

Post level	Rate
K	370
W	170
1	100
2	100
3	150
4	200
5	300
6	400
7	500
8	500
9	600
10	700
Update: 2006/04/01	

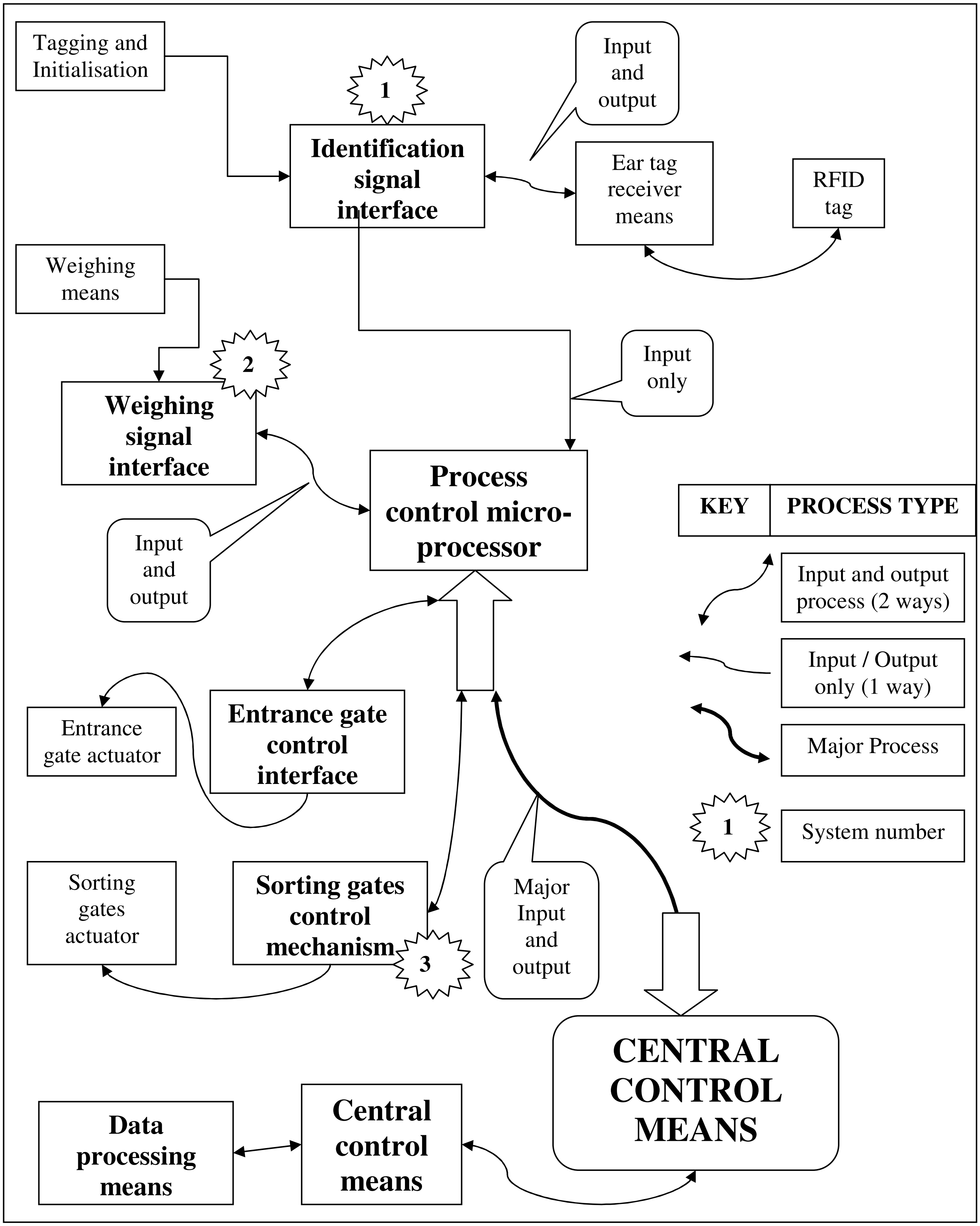
BUDGET PER FIN. CODE

	Description	Fin Code	Amount	Total
Capital	Machinery & Farm in	0067	0	0
	Computer equipment	0073	0	
	Lab. Equipment	0075	0	
Running	Entertainment	0331		136020
	S&T Local	0332	5000	
	S&T Abroad	0333	0	
	Conract workers	0351	0	
	Fleet transport	0360	3600	
	Cunsultation fees	0412	10000	
	Research consumab	0450	0	
	Statonery	0452	0	
	Printing	0453	0	
	Lab eqpmt under R1(	0456	0	
	Services by ARC Ins	0484	100000	
	Graphical services	0494	0	
	Advertisements	0528	10000	
	Maintenance: Grnds	0541	0	
	Maintenance: Machi	0543	0	
	Maint: Computer wa	0549	0	
	Maint: Lab Equipme	0551	0	
	Computer software	0560	2420	
	Literature	0570	5000	

11. APPENDIX D: HOW THE OBJECTIVES WILL BE ACHIEVED

	The Objective	How its achieved
1	To develop an automatic cattle weighing and sorting system that use RFID tags for identification when managing cattle in handling facilities,	To meet this objective, an RFID interfacing system will be developed which will comprise of electronic ear tags fitted to the animal, panel readers and central control mechanism that will control all the management practices. These actuators will be developed specifically for identification and interlinking purposes at every management practice stage. An automatic identification, weighing and sorting system utilising RFID tags will be developed deriving the design concepts from the research and development of Boote and Mavundza. A central control mechanism would be included as a module to interface the weighing and sorting system with identification. The developed technology will be constructed and incorporated in a cattle feedlot handling facility for assessment.
2	To assess how effective is the proposed RFID system will reduce operational costs and handling errors incurred in identification sorting and handling of cattle in a South African feedlot	Tests and experimentation on the established technology will be conducted and documented for analysis. Some of the tests that will be conducted for both the manual and automated systems will include: handling time, accuracy of handling, weighing time, sorting time measurements, animal welfare considerations, start-up capital, operational costs and labour costs.

12. APPENDIX E: PROPOSED RFID FLOW CHART



13. APPENDIX F: SUMMARY OF COMPLETE RFID DESIGN

PROCESS INVOLVED	DESCRIPTION OF THE PROCESS INVOLVED	COMPONENTS SYSTEM TO BE USED
Initialisation and tagging	Cattle are fitted with electronic tags and the initial animal data is recorded	RFID tags, cattle management database and software are utilised.
Cattle identification interface	Animals follow a single file chute where there is a stationary reader and information synchronised with initial data	Electronic tags, reader, software and process control microprocessor are utilised.
Automatic weighing	Cattle pass to the automatic scale where the weight is captured and recorded on the database	Automatic electronic scale, process control microprocessor, holding gates and software are utilised
Automatic sorting mechanism	According to the obtained information and process control microprocessor and software the cattle are sorted into camps.	Sorting gates, process control microprocessor and software are utilised.
Central control means	All information passage and data manipulation and software are handled by a central control means.	Central control computer, data storage and processing means, software and microprocessor.

14. APPENDIX G: PROPOSED TECHNOLOGY OUTLINE

ITEM	SYSTEM COMPONENT	EXISTING TECHNOLOGY	NEW TECHNOLOGY DEVELOPMENT
1	Identification and management system	Identifiers: TX12102 FDX-B ISO Electronic tags will be used as identifiers on the left ear together with visual tag on the right. Readers: Complete Panel Antenna Series supplied from Dastron Technology or similar would be used together with its central reading unit. Software:	Connection and linking actuators would be designed to suit the Handling facility layout and the positioning of the readers, identifiers, reading unit and computer positioning.
2	Deterring system	Steel tubes of 30mm diameter black pipe would be used in the designing of all deterring mechanisms.	One way deterring steel gates 650mm(w)x1200mm(h) would be designed for stopping cattle before and after the electronic scales and before the sorting gates. The control system of these gates would also be part of the new technology development.
3	Weighing system	The Tru-Test 3000 Series weighing systems would be used. The weighing system comes together with all the management software and connection cabling.	The weighing control actuator system would be designed to suit the handling area outline.
4	Sorting system	Steel tubes of 30mm diameter black pipe would be used in the designing of all sorting gates frames and 3mm steel plate as closure	Two 700mm (w) x 1200mm (h) sorting gates would be designed to enable cattle to be sorted into 3 camps as per management requirements. The sorting control actuator would be part of the new technology development.

15. APPENDIX H: EVALUATION AND EXPECTED RESULTS

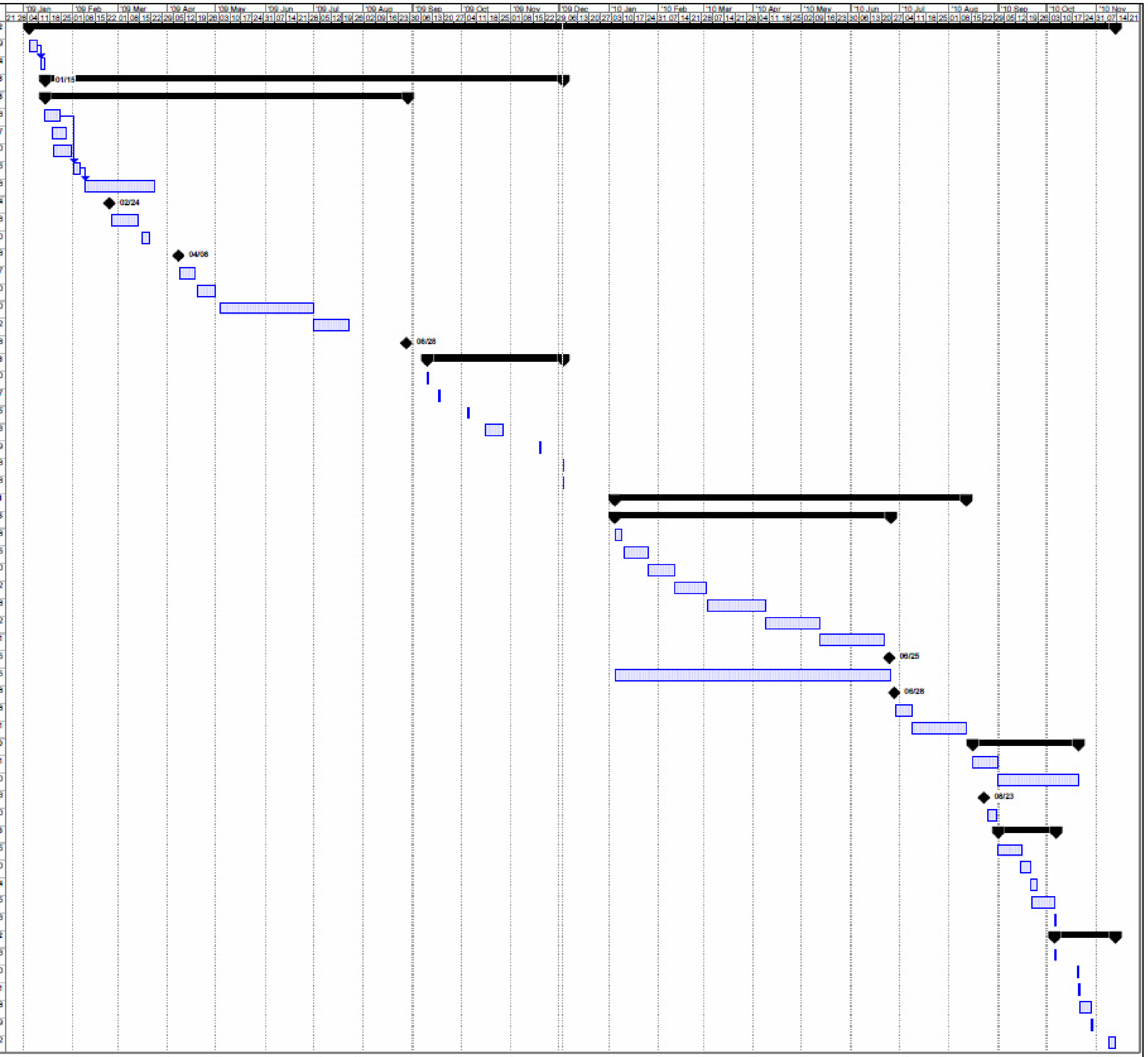
ITEM	DESCRIPTION	MEASURABLES	EXPECTED RESULT
	Manual and Electronic System		
1	Handling duration	For the 500 cattle the average time that is taken from the point where the tag is read to the time when the animal is released to the pens after sorting	The total time that is taken for the 500 cattle would be recorded and an average obtained per animal. It is expected of that the handling time for the manual system be more than that for the automated system.
2	Handling Errors	Since the sorting would be on weight basis into three camps. Re-measurement of the weights would be conducted after sorting in order to establish	Manual system is expected to be more precise and accurate compared to the automatic system since electronic management would be depended on a lot of factors.
3	Animal handling stress	As animals wait in the alley before handling stress level rises and would be measured(heart rate monitor method) for an animal sample of between 20 to 50 and an average obtained for comparison purposes.	It is expected that the stress level for automated handling be lower that that for manual systems
4	Labour requirements	The man hours required for the cattle handling process to be undertaken would be obtained based on how many people would be required for the management practice to be realised.	Expected to have less labour requirements for electronic management than the manual system.
4	Capital costs	Cost of the equipment for the management practice would be obtained with reference to items like, Scale, manual sorting gates, visual tags, recording books and other accessories.	It is expected that the initial capital cost for the electronic system be more than that of the manual system since a lot of electronic gadgets are required for the functioning of the system.
5	Operational Costs	Operational costs such as electricity, equipment maintenance and servicing would be obtained for duration and compared between the two systems.	In the long run it is expected that the operational costs for the manual system be more than that of the electronic system.

16. APPENDIX I: REQUIRED MATERIALS AND RESOURCES

Item	Description	Quantity	Estimated costs
Reading system	A device where by the reader will be installed and one cattle will be clapled	1	R 9,000.00
RFID tags	An electronic chip inserted into the cattle's ear. This device can be either active or passive operated. As it come closer to panel, it will send a signal to the reader.	500	R 18,000.00
Panel Reader	It is a device which ensure smooth communication of the RFID reader and the tags. The device will constantly send a signal at a cetain frequency, which will activete the tags as it approaches.	1	R 7,000.00
Control Interface	Control system, responsible for receiving, stroring and sending out signals to the pneumatic and the sorting system.	1	R 20,000.00
Deterring gates	Gates on the interence and exit of the Panel reader and Weighing scale, which will trap the cattle long enough, to identify, weigh and send the information to the control interface	4	R 6,000.00
Electronic scale	An electronic operated device to measure and record the weight of the cattle	1	R 15,000.00
Sorting gate mechanism	A number of gates (three) to ensure that one cattle is dealt with at a time	2	R 4,000.00
Pneumatic control system	To drive the gates to open the required camp. Consists of double acting cylinders	2	R 15,000.00
TOTAL			**R 94,000.00**

17. APPENDIX J: TOTAL PROJECT PLAN

ID	Task Name	Duration	Start	Finish
1	**Application of RFID to Beef Cattle Handling**	**488 days?**	**Mon 09/01/05**	**Fri 10/11/12**
2	Area of Research Selection	5 days?	Mon 09/01/05	Fri 09/01/09
3	Team formation	3 days?	Mon 09/01/12	Wed 09/01/14
4	**Project proposal**	**231 days?**	**Thu 09/01/15**	**Thu 09/12/03**
5	**Proposal Draft Document**	**162 days?**	**Thu 09/01/15**	**Fri 09/08/28**
6	Problem statement	7 days?	Thu 09/01/15	Fri 09/01/23
7	Objectives	7 days?	Mon 09/01/19	Tue 09/01/27
8	Design consideration and parameters	9 days?	Tue 09/01/20	Fri 09/01/30
9	Brainstorming	4 days?	Mon 09/02/02	Thu 09/02/05
10	Literature review	31 days	Mon 09/02/09	Mon 09/03/23
11	**Meeting with Supervisor**	1 day?	Tue 09/02/24	Tue 09/02/24
12	Alternative solutions	13 days?	Wed 09/02/25	Fri 09/03/13
13	Preffered solution	5 days?	Mon 09/03/16	Fri 09/03/20
14	**Meeting with supervisor**	1 day?	Wed 09/04/08	Wed 09/04/08
15	Project Budget	7 days?	Thu 09/04/09	Fri 09/04/17
16	Project plan	9 days?	Mon 09/04/20	Thu 09/04/30
17	Feasibility	42 days?	Mon 09/05/04	Tue 09/06/30
18	Method of evaluation	16 days?	Wed 09/07/01	Wed 09/07/22
19	Submission of Final	1 day?	Fri 09/08/28	Fri 09/08/28
20	**Proposal Final Document**	**61 days?**	**Thu 09/09/10**	**Thu 09/12/03**
21	Review of Draft Document	1 day?	Thu 09/09/10	Thu 09/09/10
22	Submision of Final Document	1 day?	Thu 09/09/17	Thu 09/09/17
23	Feedback from Eximiners	1 day?	Mon 09/10/05	Mon 09/10/05
24	Final correction	7 days?	Fri 09/10/16	Mon 09/10/26
25	Recommendation by supervisor(s)	1 day?	Thu 09/11/19	Thu 09/11/19
26	Meeting with supervisor and eximiners	1 day?	Thu 09/12/03	Thu 09/12/03
27	procedance agreement	1 day?	Thu 09/12/03	Thu 09/12/03
28	**Design**	**157 days?**	**Tue 10/01/05**	**Wed 10/08/11**
29	**Layout Design**	**124 days?**	**Tue 10/01/05**	**Fri 10/06/25**
30	Identification control interface	4 days?	Tue 10/01/05	Fri 10/01/08
31	Detering mechanism control	11 days?	Mon 10/01/11	Mon 10/01/25
32	Automatic weighing system control	12 days?	Tue 10/01/26	Wed 10/02/10
33	Central control interface	14 days?	Thu 10/02/11	Tue 10/03/02
34	Sorting gate activities	26 days?	Thu 10/03/04	Thu 10/04/08
35	Total system control mechanism	24 days?	Fri 10/04/09	Wed 10/05/12
36	Drawing	28 days?	Thu 10/05/13	Mon 10/06/21
37	**Meeting Supervisor**	1 day?	Fri 10/06/25	Fri 10/06/25
38	Compile Report	124 days?	Tue 10/01/05	Fri 10/06/25
39	**Milestone - submission of Draft**	1 day?	Mon 10/06/28	Mon 10/06/28
40	Review Design and Report	8 days?	Tue 10/06/29	Thu 10/07/08
41	Milestone - Final report submission	24 days?	Fri 10/07/09	Wed 10/08/11
42	**Implementation**	**46 days?**	**Mon 10/08/16**	**Wed 10/10/20**
43	Ordering materials	12 days	Mon 10/08/16	Tue 10/08/31
44	Construction	36 days?	Wed 10/09/01	Wed 10/10/20
45	**Meeting Supervisor**	1 day?	Mon 10/08/23	Mon 10/08/23
46	Re-design and Modification	4 days?	Wed 10/08/25	Mon 10/08/30
47	**Testing and evaluation**	**26 days?**	**Wed 10/09/01**	**Wed 10/10/06**
48	Measure and Record data	11 days?	Wed 10/09/01	Wed 10/09/15
49	Analyses	4 days?	Wed 10/09/15	Mon 10/09/20
50	**Milestone- Eximiners**	4 days?	Tue 10/09/21	Fri 10/09/24
51	Report writing	10 days?	Wed 10/09/22	Tue 10/10/05
52	**Meeting supervisor**	1 day?	Wed 10/10/06	Wed 10/10/06
53	**Project Handover**	**29 days?**	**Wed 10/10/06**	**Fri 10/11/12**
54	Thesis-Draft submission	1 day?	Wed 10/10/06	Wed 10/10/06
55	**Feedback from Eximiners**	1 day?	Wed 10/10/20	Wed 10/10/20
56	**Meeting with Supervisor**	1 day?	Thu 10/10/21	Thu 10/10/21
57	Compile and correction of Thesis	5 days?	Fri 10/10/22	Thu 10/10/28
58	***Milestone - Thesis Final Submission***	1 day?	Fri 10/10/29	Fri 10/10/29
59	Presentation	4 days?	Tue 10/11/09	Fri 10/11/12



Project: MSC - RFID Application to Ca
Date: Thu 09/12/03

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Page 1