MEGANIESE EN LUGVAARTKUNDIGE INGENIEURSWESE
MECHANICAL AND AERONAUTICAL ENGINEERING

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

PRAKTYKOPLEIDING MPY315 & MPY 415/ *PRACTICAL TRAINING MPY 315 & MPY 415*

EVALUERINGSVERSLAG/ *EVALUATION REPORT*

Naam en Van/ *Name and Surname*	DPM Ternent.
Studentenommer/ *Student number*	13120842.

Nota / *Note*	ASPEK/ *TOPIC*	UIT/ *OUT OF*	PUNT/ *MARK*	Ja / *Yes*	Nee / *No*
1	Organisering van materiaal / *Organisation of material*	15	✓		
2	Tegniese versorging / *Technical impression*	25	✓		
3	Taalversorging / *Language*	25	✓		
4	Algemene versorging / *General impression*	15	✓		
	Subtotaal / *Sub-total*	80	✓	√	x
5	Verslag oor Personeelbestuur/Beroepsveiligheid *Report on Personnel Management/Health and safety*	20	✓	√	x
TOTAAL / *TOTAL*		**100**			

Notas / *Notes*

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2	Kandidaat se vermoë om te kommunikeer oor tegniese werk/resultate. Duidelikheid van tegniese kommunikasie, insluitende diagramme. *Candidate's ability to communicate regarding technical work/outcomes. Clarity regarding technical communication, including diagrams.*
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Datum/ *Date*	25/9

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INDIVIDUAL COVER SHEET FOR PRACTICALS / INDIVIDUELE DEKBLAD VIR PRAKTIKA

Module code / Modulekode: MPY 315		**Module:** Practical Training	
Practical number: **Praktikum nommer:** 1		**Date of submission:** **Datum van inhandiging:** 05/08/2015	
Student / Student	**Initials / Voorletters** DPM	**Surname / Van** Ternent	**Student number / Studentenommer** 13120842

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1	Plan and conduct his/her investigation/experiment in an appropriate and scientific manner?	10		√	×
2	Perform the necessary analyses and interpretations and/or derived valid information from the data?	50		√	×
3	Draw conclusions based on the evidence or data obtained?	20		√	×
4	Communicate the purpose, process and outcomes/conclusions in a technical report in a coherent manner?	20		√	×
	Total for outcome 4 (minimum of 50% to pass)	100			
	Is the student capable of applying research methods, planning and conducting investigations and experiments using appropriate equipment – *if the answer is "NO" a mark of less than 50% must be awarded*			√	×

Marked by	
Signature	
Date	

PRACTICAL TRAINING REPORT

MPY 315

DPM Ternent
13120842

Summary

The following document is a report on the work performed and experience gained during practical training during the period of June 2014 to April 2015. This report also includes a section on personnel management.

The purpose of the practical training is to provide the mechanical engineering Student with an insight into how engineering theory is applied in real world scenarios as well as to allow the student to gain crucial hands-on experience for a various engineering related tasks and challenges. Aside from this, the practical training also seeks to develop the mechanical engineering student's knowledge of human relationships in the work environment.

The practical training that this report covers was performed at the workshop on the Sandstone Estates (Pty) Ltd (hereafter referred to as Sandstone Estates) premises at the Hoekfontein Farm, situated about 20 kilometres from the town of Ficksburg in the Free State, South Africa. Sandstone Estates has a number of operations, including the steam locomotive workshop in Bloemfontein and an operational farm in the United Kingdom.

During the course of the training period, both the work performed during each day and tasks given were recorded both in a paper journal book and on a note application on a tablet for future reference.

Acknowledgements

The author wishes to thank the founder of Sandstone Estates, Mr Wilfred Mole, and director Mr Mike Myers for providing the opportunity to work on the Hoekfontein Farm premises as well as for the guidance and feedback provided throughout the time spent on the above mentioned premises.

In addition, the author wishes to thank Desmond Clarke (Farm Manager), Leigh Sanders (Office Manager) and Larissa Clarke (Event Co-ordinator) for their help and guidance throughout the training period.

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1. Introduction

During and after the second year of study, every mechanical engineering student is expected to undergo 6 weeks of practical, hands-on training. This is a requirement of the Engineering Council of South Africa with respect to the training of engineering students. The aim of this practical training is to develop a student's engineering related skill sets as well as to improve their knowledge of company structure, interaction and implementation. The student is free to choose where the practical training will take place but is encouraged to find an environment in which they are exposed to a variety of tasks.

2. Practical Training

2.1 Work Environment and Related Challenges

The Sandstone Estates Hoekfontein farm site is a large agricultural farm of over 7000 hectares that is also home to the Sandstone Heritage Trust. The farm is situated on the border with Lesotho, roughly 20 kilometres from the nearest town, Ficksburg, in the Free State. *Figure 1* below shows the Hoekfontein farm compound. The building surrounded by the red box is the Farming Machinery Workshop where practical training took place.

Figure 1: Aerial photograph of the Hoekfontein farm compound (Google Earth imaging, 2015)

The Sandstone Heritage Trust is a private restoration and conservation operation that deals with vintage farming, commercial transport, rail, industrial and military equipment. It was established on the Hoekfontein farm, bought by the Mole family in 1995. Of special interest is the narrow gauge railway on the Hoekfontein farm, being the longest of its kind in South Africa.

The workshop on the Hoekfontein farm, situated in the middle of the main compound services both the current, advanced Modern Farming fleet and the Sandstone Heritage Trust collection of equipment, vehicles and other assets. Despite its small appearance in *Figure ()*, the workshop at the Hoekfontein farm is well equipped to deal with all the equipment and machinery of the Modern Farming operation as well as the Heritage Trust fleet. The workshop is a building consisting of a storage room, office area, workbenches, metal lathe, 7 work bays and a main central work area. The door to the workshop is tall enough to allow combine harvesters and other large vehicles to drive into the main central work area for inspections, maintenance or repairs. The workshop has a permanent staff component of 5, a remarkably small number responsible for ensuring all vehicles and equipment remain operational. In *Figure 2* below, the workshop as mentioned above can be seen. This view can be seen if standing on the road at Hoekfontein farm where the bottom edge of the red box stands drawn in *Figure 1.*

Figure 2: Modern Farming Workshop at Sandstone Estates

Winter in that area in the Free State can be bitterly cold. During one of my stays at the Hoekfontein farm, the lowest temperature that was recorded was -16° Centigrade. Sights such as the one depicted in *Figure 3* below are commonplace in winter and present their own set of issues. This presented a number of unique problems, from health and safety concerns (at that temperature, working on any metal surface without the correct protective equipment such as gloves is to be avoided as damage can result from contact of metal to skin) to vehicle and equipment issues (at that temperature, diesel fuel often gains a jel-like consistency, making it impossible for the fuel pumps to transfer the fuel to the engine.

Figure 3: Visual indication of sub-zero temperatures

On one occasion, a tractor – the articulated tractor shown in *Figure 4* below - was started inside a shed, driven outside for a short period and promptly stalled, the diesel having turned to jel).

Figure 4: Articulated Tractor

In addition to the cold, in winter the crops become very dry, posing a major fire risk. During the average winter, at least one fire per day must be extinguished. These fires are especially dangerous when occurring in wheat or maize fields due to the ease at which these crops burn. This results in

these fires spreading at a staggering pace- being able to far outrun any tractors or combine harvesters, causing huge economical losses.

This problem is exacerbated by illegal immigrants coming across the Caledon river from bordering Lesotho. On at least two occasions, fires were discovered to have been caused by camp fires getting out of control in temporary rest stops set up by those crossing the border.

On a number of occasions, very specific areas experienced a much greater number of fires than the rest of the farm. This was the result of Lesotho farmers setting those areas alight in order to stimulate the growth of plants that their cattle feed upon.

Working hours of workshop staff depends heavily upon the farm's mode of operation. During harvesting (winter months), the workshop opens at 7:00am and closes once the last combine harvester, tractor or truck returns to the storage sheds, anywhere between 6:00pm and 12:00pm. Emergency repairs required late at night, such as depicted in *Figure 5* below are a frequent occurrence during the busy winter harvesting season.

Figure 5: Late night repairs

During planting season (summer months), the workshop opens at dawn (between 5:00am and 6:00am) and remains open throughout most of the night, only closing when planting ceases pre-dawn (around 4:00am). Between these crucial times, the workshop keeps 'general' working hours, opening its doors at 7:00am and closing between 5:00pm and 6:00pm. Regardless of season, there is a tea break between 10:00am and 10:30am and lunch between 12:00pm and 1:00pm.

2.2 Work Performed

The daily scope of the work performed by a member of the workshop staff is varied and unpredictable and ranges from replacing burst tyres on maize trailers to rebuilding vintage cars and performing maintenance on modern military vehicles.

Figure 6: Ruptured JCB tyre

The failed tyre depicted above in *Figure 6* is an example of an every day challenge experienced by the workshop at Sandstone Estates. The rough terrain in parts of the farm is tough of machinery and such failures are not uncommon.

Work to be completed falls into two distinct categories. The first is daily maintenance and long term projects and the second is emergency repairs:

Daily maintenance refers to normal servicing, upgrading and regular inspections of all vehicles and equipment on the property including new vehicles and equipment brought to the farm. Long term projects cover restorations, rebuilds and overhaul of vehicles or equipment that is pre-scheduled and requested by management.

The below *Figure 7* depicts both an example of daily maintenance and a long term project. The red bailer on the left of the figure is undergoing routine maintenance and the old V8 Ford in the center is due for an engine overhaul in order to return it to service.

Figure 7: Old and new, side by side

Emergency repairs includes tasks such as changing flat wheels, replacing drive links on combine harvester header chains, welding broken supports, recovering stuck vehicles, swopping out flat batteries and other similar tasks. In *Figure 8* below, one such emergency repair can be seen. Here, the quick-coupling for a John Deere 9400 tractor (the same tractor as seen previously in *Figure 2*) is being reinforced following a failure.

Figure 8: Emergency repairs underway

During the planting and harvesting periods, emergency repairs comprise the majority of the work performed on an average day. This is as a result of all involved machinery working overtime for extended periods. Consequently, the quieter months between these two periods are dominated by normal, daily maintenance and long term tasks.

Following a long trip to the Sandstone Estates itself, the first day of practical experience was a very clear indication of the hard work that lay ahead. Arriving well into the evening, operations on the farm were far from easing up. In the process of harvesting maize, a combine harvester bogged down and beached on its belly pan in the black, soft soil common to certain areas of the area in which the farm is located. The greatest hurdle when attempting the recovery of a combine harvester is weight. Without a crop payload, large combines such as those used at Sandstone Estates weigh in the region of 17 000 kilograms. Combine this standard weight with a grain tank capacity of around 10 000 litres and the challenge of recovery soon becomes very difficult, with a very substantial amount of force being required to move the stricken vehicle. With the modern farming vehicles available at Sandstone Estates, the amount of force required is not a problem. The consequences of fielding such vast amounts of force, however, can be an issue. In discussions with a number of Sandstone Estates farm workers present at the recovery, it is not unheard of for a combine harvester, trapped in similar circumstances, to be torn almost in half by the forces generated during the recovery (personal communications, 30 June, 2014). The figure below, *Figure 9*, illustrates the aftermath of the first attempt at the night-time recovery of the trapped combine harvester.

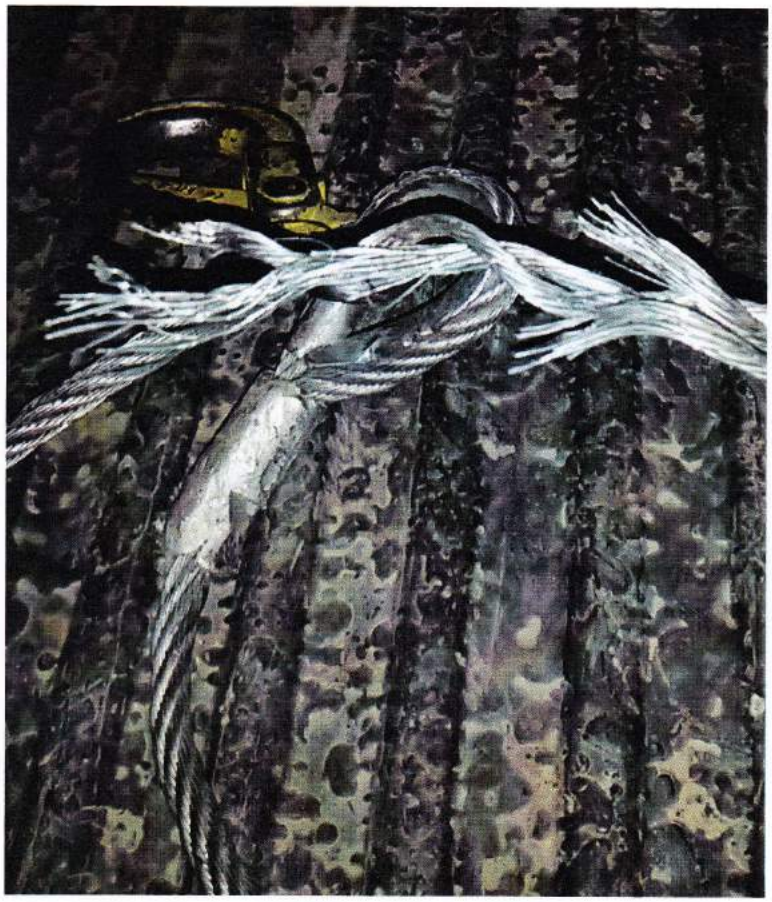

Figure 9: Failed tow cable

The first period of practical training coincided with a section of the harvesting cycle at Sandstone Estates. As a result, most of the work performed during the period of 30 June 2014 to 18 July 2014 focused on emergency repairs as mentioned previously. A few examples of work performed include replacing combine harvester header chains, replacement and repair of tractor tyres, welding repairs to the quick coupling of an articulated tractor and the inspection, removal and repair of a front hub on a medium size tractor.

Figure 10 below represents the consequences of a failed circlip falling into the planetary gear system in one of the front hubs of a John Deere 7710. Replacement parts had to be ordered from the Netherands. Due to the waiting time for parts, the hub was re-assembled without the gears in place, allowing the tractor to resume duty albeit at a decreased workload and pace.

Figure 10: Visual inspection of seized tractor hub

Apart from the emergency repairs, practical training also covered a long term project in the form of restoring and repurposing of an old Buffel Armored Personnel Carrier to be used as a diesel supply truck for the various farming machinery out in the field.

In *Figure 11* below, the Buffel can be seen in original paint and markings. As shown, the front right portal hub has been removed in order to repair an oil leak and inspect the condition of the gearing.

Figure 11: Refurbishment and repurposing of Buffel

One of the greatest challenges facing the workshop and its staff is access to spare parts. The Hoekfontein farm may only be about 20 kilometers from the nearest town but, due to the type of farming and vintage machinery, replacement parts often had to be order from either larger cities (such as Bloemfontein or Johannesburg) or abroad (such as the United Kingdom, the Netherlands or

the United States of America). The time spent waiting for parts to arrive has a major impact of the overall productivity of the farm. Due to narrow seasonal time constraints, delays such as those experienced waiting for parts must be avoided whenever possible. This strict time schedule means that sometimes it is not possible to wait for parts and a plan must be made. It is in these circumstances that many astonishing solutions can be observed. This is a testament to the problem solving and creative abilities of the workshop staff. This, on its own, was a significant lesson- mechanical systems are often constrained and governed by procedures and guidelines. However, these must at times be avoided and alternates found to ensure the efficient, continual operation of the greater system at work.

A somewhat unexpected component of practical training at Sandstone Estates was fire monitoring and control. This aspect to the training remained specific to the winter months when crops and surrounding brush was at its most dry. Fire teams worked on a rotational basis with at least one team on standby at any one time. The main firefighting equipment comprised of an old Unimog fitted with dual water tanks and pumps, crewed by up to 8 people (including the driver). Whenever possible, the crew were equipped with fire swatters or wet hessian sacks to beat back the fires. These tools, however, are only effective if the fire does not reach the crops. If a fire spreads to a crop field, the situation becomes much more dangerous, sometimes to such an extent that a fire is simply left to burn out in a field. Due to the rapid and efficient response of the various fire teams on duty, this never occured in the period that practical training took place.

The second period of practical training occured during the quieter months between the planting and harvesting seasons. This made for a completely different experience, with daily maintenance tasks making up the majority of work performed. During this time, a very important rebuild project had been started - that of a World War II vintage Ford Canadian Military Pattern (CMP) truck. This type of truck formed part of the backbone of Allied logistics during the Second World War.

This project was a ground-up rebuild, the entire truck having been stripped, the chassis inspected, repaired and repainted. *Figure 12* below shows the Ford CMP during the early stages of its restoration. At this point, the entire vehicle has been stripped and inspected, the chassis and suspension subsystems have been cleaned and repainted and the engine installed.

Figure 12: Early stages of Ford CMP restoration

Following this, the truck was rebuilt with parts either being repaired or replacements ordered from Canada. Throughout this, empahsis was placed on preserving originality. This is not an easy process to follow, as some original parts have become very difficult to source (being almost impossible to find locally). Fortunately, practical training included working on this project. A significant lesson learned from this experience was the importance and place of simplicity in design. Considering the number requirements during the War, it is understandable that most components and systems were created in as simple a form as possible, some components bordering on rudimentary. The result of this, however, was a platform that was easy to manufacture, reliable and, above all, easy to work on and maintain. In harsh environments with strict time and economic constraints, such systems result in minimal downtime due to repairs or maintenance, as long as correct operating and maintenance procedures are followed.

Figure 13: Ford CMP on display at the Stars of Sandstone 2015

The figure above, *Figure 13*, shows the Ford CMP following the rebuild and restoration at Sandstone Estates on display at the Stars of Sandstone 2015 event.

Practical training at Sandstone Estates fortunately included the event Stars of Sandstone 2015. This is the flagship event of Sandstone Estates, taking place over 10 days from the 2nd April 2015 to 12th April 2015 and attracts visitors and enthusiasts from around the globe. This event poses a number of unique challenges. Due to the structure and purpose of the event, it is required that almost all the operational vehices and equipment from every section of Sandstone Estates be on active display each and every day. Vehicles ranging from a pre-1920's wooden fire engine to a modern Ratel Infintary Fighting Vehicle and almost everything imaginable in between. During this event, all modern farming operations and long term rebuild and restoration projects cease in order to free up resources to tackle any challenges that appear pertaining to the event and involved vehicles and equipment. Besides emergency repair tasks, work during the event extends to the operation and transport of vehicles and equipment for various tasks as well as managing the operation of the airstrip and helipad facilities.

3. Conclusion

To learn theory at university, day by day, is one thing. To know that theory well places a student in good stead for their career outside of university. However, theory is simply not complete without the support of varied practical training and experience. Practical training and experience allows for designs that are easier to manufacture, easier to maintain and easier to operate – all in all, qualities that can make a system more efficient. The skills and experience gained during practical training is seen as invaluable, tools with which to improve engineering based thinking. Regardless of original outlook on practical training, students are changed by the practical training process, resulting in more well-rounded, balanced individuals. Practical training has its place as a crucial learning experience for mechanical engineering students.

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MECHANICAL AND AERONAUTICAL ENGINEERING
MEGANIESE EN LUGVAARTKUNDIGE INGENIEURSWESE

REPORT ON PRACTICAL TRAINING/VERSLAG VAN PRAKTYKOPLEIDING

Name of Student:
Naam van Student: DARREN TERNENT

Registration no:
Registrasie nr: 13120842

Year and branch of study/*Studiejaar en rigting:* MECHANICAL, 2nd YEAR

Name and address of Employer/*Naam en adres van Werkgewer:*
SANDSTONE ESTATES (Pty) Ltd
HOEKFONTEIN FARM, FICKSBURG, 9730

Period/*Tydperk:* **From/*Van*** JUNE 2014 **To/*tot*** APRIL 2015

Nature of work *Aard van werk*	**Number of days** *Aantal dae*	**Signature of employer/*Handtekening van Werkgewer***
Modern farming equipment maintenance, refurbish and repurpose old military vehicle (Buffel)	18	
Began rebuild of Ford CMP, attended workshop staff meeting, organised vintage tractor shed, discussed Jobcard system, modern farming equipment maintenance, inventory of workshop equipment	9	
Preparations for Stars of Sandstone 2015 event (checking and re-application of asset numbers, cutting helipad, ensuring all relevant vehicles in good working order, general land and equipment maintenance)	10	
Stars of Sandstone 2015 event - ordanising fuel for airstrip, airstrip maintenance, ferrying visitors, running repairs of vehicles involved in event, construction of attractions, general railroad track maintenance and clearing, helped out wherever possible with variety of tasks	10	

Remarks by Employer/*Kommentaar van Werkgewer:*

Signature of Employer en stempel:
Handtekening van Werkgewer en stempel

SANDSTONE ESTATES (PTY) LTD
Co. Reg. No. 97/2882/07

Date/datum: 04 August 2015