UNIVERSITY OF CANTERBURY

# CAVALTECH Ltd

## Development of Horseshoeing Technology

**Chris Bloomfield**

**Master in Engineering Management Feb 2012 – Feb 2013**

CAVALTECH is an equestrian automation company, owned by the student, which aims to automate the horseshoeing process. Horseshoeing is the art of attaching material to a horses hoof in order to protect it from wear and tear that it would not be subjected to in the wild. Horseshoeing is very expensive, hard-work and inconsistent. This project is about developing technology to assist in improving the horseshoeing process. The report summarises the planning processes involved in the project, reports the results and then makes comparisons between the two. The project is testament to the need for adaptive planning when undertaking novel projects as well as the need to be efficient and effective with the time available.

**Prepared By**

| Document Owner(s) | Project/Organization Role |
|---|---|
| Chris Bloomfield | MEM student |

## Assignment Version Control

| Version | Date | Author | Distributed to | Change Description |
|---|---|---|---|---|
| 1 | 23/01/13 | Chris Bloomfield | Chris Bloomfield | Initial Draft |
| 2 | 29/01/13 | Chris Bloomfield | Tom Harding | Touched up after review |
| 3 | 1/02/13 | Chris Bloomfield | Piet Beukman<br>Trevor Johnston | Final version |
| 4 | 8/02/13 | Chris Bloomfield | Piet Beukman | Final version 1.1 |

# I. Acknowledgements

I would like to thank Trevor Johnston for his on-going support of the project and endeavours as a whole. He has been very encouraging and patient throughout the process.

I would also like to thank Rob Lawrence form CECC, for supporting the project and helping me through the funding process. He supported the project from the very beginning and I hope to have his support in the future.

I would also like to thank my parents for their support. Thanks to my father, Rob Bloomfield, for providing technical know-how and advance and, also, to my mother, Carol Bloomfield, for helping me with my accounts and keeping me in line.

Finally I would like to thank Piet Beukman for a great year in MEM 2012 as well as his support for my project. It has been a steep learning curve but very rewarding and there are plenty of lessons that I will take with me into the future. I also appreciate his honesty, frankness and ability to make us think outside the box.

# II. Executive Summary

CAVALTECH is an equestrian technology company which is aiming to automate the horseshoeing process. It was founded in 2011 by Chris Bloomfield, who is also the student undertaking this MEM project.

Horseshoeing is the art of attaching material, usually steel, to the bottom of a horses hoof to protect it from wear and tear. Domestic horses require shoes as they are subjected to conditions that would not be required of them in the wild.

Horseshoeing, a job completed by farriers, involves three main processes; analysing the hoof, trimming the hoof and then fitting a shoe to the hoof. It costs an average of $130 to get a horse shod and costs more that $1000 to keep the horse shod for an entire year. Horseshoeing is very labour intensive and farriers are often inconsistent and unskilled.

The project is designed to help improve the horseshoeing process by focussing on increasing the efficiency and effectiveness of the horseshoe fitting process. This is the most time consuming process for the farrier and is also the easiest to solve with technology due to the relatively low interaction with the horse.

The project involves designing and building a prototype machine that can gather data on the horses hoof and then shape a horseshoe to perfectly fit the hoof with minimal human input. The student received $10,000 funding for the project from MSI and subsequently began the planning process.

Firstly the project was broken down into the sub-projects identified in Table 1.

| | **Sub-Project** | **Description** |
|---|---|---|
| 1 | Hoof Profiling Device | Device which can capture hoof information cleanly and consistently |
| 2 | Hoof Profiling Software | Software which can identify the hoof in the captured data and fit a shoe to that hoof |
| 3 | Hoof Measuring Device | Device which can capture images of horses hoof that can be used to find important information |
| 4 | Hoof Measuring Software | Software that can determine the important measurements and aspects of the horses hoof from the captured images |
| 5 | Determine Best Shoe Material | Research and determine the best shoe material that can be rapidly shaped using a machine |
| 6 | Prototype Shoe Shaping Machine | Machine that is able to rapidly shape the custom horseshoes to perfectly fit the horses hoof |
| 7 | Control Software | The software that has overall control of the device requiring minimal user input |
| 8 | Market Research | Research to identify what the market wants in order to help design the device |
| 9 | Business Plan | Short high level business plan for commercialising the technology produced by the project |

Table 1: Sub-Project Breakdown

Then the project was broken down further and an extensive plan was formulated including expected hours and cost. These plans were compared with the actual outcomes of the project and is summarised in Table 2 below.

| Sub Project | Planned | Reality | To-Do | Comparison |
|---|---|---|---|---|
| **Profiling Device** | **54 hours** | **42 hours** | | - Went Smoothly<br>- Less time than expected<br>- More time spent designing resulted in less time constructing and testing<br>- Cost as expected |
| *Design* | *8 hours* | *16 hours* | | |
| *Build* | *16 hours* | *15 hours* | | |
| *Test & Develop* | *30 hours* | *11 hours* | | |
| Cost | $200 | $180 | | |
| **Profiling Software** | **70 hours** | **197 hours** | | - 30 hours spent fixing a bug<br>- More time available for ensuring quality due to reduction in hours for other projects<br>- No cost, software free |
| *Write Software* | *40 hours* | *87 hours* | | |
| *Debug & Refine* | *30 hours* | *110 hours* | | |
| Cost | $0 | $0 | | |
| **Measuring Device** | **62 hours** | **46 hours** | | - Design and build went to plan<br>- Device worked well<br>- Decision was made that it was unnecessary when almost finished<br>- Cost comparable to planned |
| *Design* | *8 hours* | *9 hours* | | |
| *Build* | *24 hours* | *27 hours* | | |
| *Test & Develop* | *30 hours* | *10 hours* | | |
| Cost | $400 | $250 | | |
| **Measuring Software** | **120 hours** | **10 hours** | | - Project cancelled and deemed unnecessary<br>- Freed up hours for other projects<br>- No costs |
| *Write Software* | *80 hours* | *10 hours* | | |
| *Debug & Refine* | *40 hours* | *0 hours* | | |
| Cost | 0 | 0 | | |
| **Best Shoe Material** | **60 hours** | **35 hours** | **15 hours** | - Polyurethane - Research required less effort than expected<br>- Already an established material in industry<br>- Cost greatly less than expected due to less effort |
| *Research Online* | *40 hours* | *30 hours* | | |
| *Consult Experts* | *20 hours* | *5 hours* | | |
| *Trial & Error* | - | | *15 hours* | |
| Cost | $1400 | $100 | $200 | |
| **Shaping Machine** | **204 hours** | **35 hours** | **40 hours** | - Brought CNC machine instead of building from scratch<br>- Freed up time for other projects<br>- No point in building form scratch when pre-built solution just as cheap |
| Cost | $1500 | $1200 | | |
| **Control Software** | **80 hours** | **-** | **80 hours** | - Will be completed Feb 2013 as planned<br>- CNC machine has own software so will focus on connecting profiling software with CNC<br>- No reason why it won't be completed on time |
| Cost | $0 | $0 | $0 | |
| **Market Research** | **60 hours** | **182 hours** | | - Significantly extended due to a reduction in time on other projects<br>- Above and beyond Scope for benefit of CAVALTECH<br>- Cost much greater due to more research |
| *Research Online* | *30 hours* | *53 hours* | | |
| *Talking to Customers* | *30 hours* | *79 hours* | | |
| Cost | $200 | $1350 | | |
| **Business Plan** | **40 hours** | **45 hours** | | - Went without an issue<br>- Most of the time spent deliberating |
| Cost | $0 | $0 | | |
| **Overall Hours** | **750 hours** | **592 hours** | **135 hours** | - On time, on budget<br>- Change of scope<br>- Eliminated unnecessary, focused on important |
| **Overall Cost** | **$3700** | **$3080** | **$200** | |

Table 2: Summary of Plan vs. Reality

The variations between plans and reality resulted in many lessons learned:

- Good, well thought out design speeds up the development process.
- Use external software libraries as much as possible (Outsource) – saves time in the long run.
- Software always takes longer than expected, especially debugging and testing.
- Ensure that there is a well-defined purpose for a project before undertaking it.
- It is better to quit an unnecessary project mid-way and concentrate on more important tasks than to finish the project just for the sake of it.
- It's hard to plan research because outcome is unknown.
- There is no point "re-inventing the wheel".
- Concentrate on the aspects of the product that are unique and outsource as much of the non-unique aspects as possible
- Market research is very important and has a major influence over the project as a whole.
- It is better to validate any new concept via market research before undertaking the development of that project.
- Adaptability is important when planning for a project that is unique.
- Need to ensure that the project has the ability to creep in either cost or time otherwise there is the potential for significant pressure to build up, especially with a unique project – again adaptability.
- It is important to keep on top of time creep in order to insure that tasks do not build up and become overwhelming.

Overall the project remained on schedule and under budget however, differed substantially from the planned course of action. This was down to two main reasons; the inexperience of the student in project planning and the relative novelty of the project being undertaken.

Market research deemed some of the tasks unnecessary and others were shortened significantly when more effective methods were discovered. This provided extra time for the more critical and novel tasks and allowed for the scope to be stretched in areas that would have benefits for the company beyond the realm of the project. With novel projects, risks are always going to exist therefore it is important that plans are made which can be adapted when the situation inevitably changes.

The project is testament to the need for an adaptable plan when undertaking novel projects. It is also testament to the value of extensive and on-going market research which will ensure that the result of the project is useful and adds value to the company as a whole.

# III. Table of Contents

I. Acknowledgements ..... ii
II. Executive Summary ..... iii
III. Table of Contents ..... vi
1. Introduction ..... 1
2. Background ..... 2
a. Horseshoeing history ..... 2
b. Horseshoeing industry ..... 3
c. CAVALTECH ..... 3
3. Project Plan Formulation ..... 4
a. Pre-Project ..... 4
b. Funding ..... 4
c. Plan ..... 5
4. Project Plan Implementation ..... 6
a. Hoof Profiling Device ..... 6
b. Hoof Profiling Software ..... 8
c. Hoof Measuring Device ..... 9
d. Hoof Measuring Software ..... 11
e. Determine Best Shoe Material ..... 12
f. Prototype shaping machine ..... 13
g. Control Software ..... 14
h. Market Research ..... 15
i. High Level Business Plan ..... 17
j. Overall ..... 18
5. Conclusion ..... 19
6. Recommendations ..... 20
a. Similar Projects ..... 20
b. MEM Specific ..... 20
7. Personal Reflection ..... 22
8. Works Cited ..... 23
Appendix A: Horseshoeing and its History ..... **Error! Bookmark not defined.**4
Appendix B: Trends and Issues of the Horseshoeing Industry ..... **Error! Bookmark not defined.**4
Appendix C: Work Breakdown Structure ..... **Error! Bookmark not defined.**4
Appendix D: Summary of Profiling Software ..... **Error! Bookmark not defined.**5

Appendix E: Synthetic Horseshoe Material Analysis ..... **Error! Bookmark not defined.**8

Appendix F: Market Research ..... **Error! Bookmark not defined.**1

Appendix G: Commercialisation Strategy of Horseshoe Shaping Device**Error! Bookmark not defined.**6

# 1. Introduction

CAVALTECH is an equestrian technology company which aims to revolutionise the horse shoeing industry by ultimately producing an automated horseshoeing device.

Horse shoeing is one of the only industries that has remained mostly unchanged for the past few hundred years. Currently horse shoeing is a very labour intensive, costly, and time-consuming job. It is a job that is completed by "farriers" who are often inconsistent and unskilled. The project involves undertaking the development of horseshoeing technology to meet the needs of the farrier industry.

The Ministry of Science and Innovation (MSI) has provided the company with $10,000 to produce a **proof-of-concept prototype device** which can profile a horse's hoof, determine the shape of the hoof and then shape a custom plastic shoe to fit the hoof.

In order to ensure the product meets the needs of the marketplace **market research** is also being undertaken. This involves talking to farriers, horse owners and shoe manufacturers who are all potential customers for the resulting product. All of these factors lead to the formulation of a **high level business plan** for taking the farrier technology to market.

This Report will:

- Provide a background understanding of the technical concepts involved in the project
- Describe the plan for the project and outline the options and reasoning that lead to the chosen course of action.
- Describe the project budget and reasoning behind the numbers
- Compare the planned course of action to reality and discuss the reasons for the differences.
- Provide a high level understanding of the technical deliverables for the project
- Provide conclusions and recommendations that will be useful for anyone undertaking a project of similar scope in the future.

The Appendices will:

- Expand on the technical detail produced during the project
- Provide extra background material for the readers interest
- Provide more in depth market research and analysis of the research
- Provide other written deliverables

# 2. Background

## a. Horseshoeing history

Horseshoeing is the method of protecting a horse's hoof by attaching some sort of protective material to the underside of the hoof. The material that is attached is called a horseshoe and, in modern times, is generally made in a U shape from metal (generally steel) which protects the outer capsule of the hoof called the hoof wall.

Horseshoes are needed to ensure the horse will remain "sound" whilst it is subjected to conditions that would not be required of it in the wild. Captivity and breeding schemes have meant that domestic horses tend to have softer hooves than wild horses, therefore require extra protection. Sometimes shoes also provide extra grip when undertaking complex manoeuvres which would cause the natural hoof to slip (1).

Attempts have been made to protect the horses hoof ever since the horse was domesticated 6000 years ago however they were largely ineffective until iron came into use in the Roman times (0 – 500 AD) (2) (3). The first metal horseshoes were the "Hipposandal" which consisted of a metal plate strapped to the horses hoof. It was mainly designed to work on Roman roads and was generally only used on draught animals (4).

Horseshoes were first nailed to the horses hoof around 500 AD and subsequently became widespread throughout the known world by 1000 AD (5). The nailed shoe afforded the horse much greater freedom than the Hipposandal and the effects were seen instantly. Cavalry became the most effective form of warfare and remained so throughout the Middle-Ages (500 AD – 1500 AD) (6). Countries came to depend on their Cavalry significantly for protection and warfare which has come through in many legends and proverbs seen today. Due to the value of iron throughout this period, horseshoes were an accepted method if paying taxes (7).

The development of mass produced horseshoes in the early 1800s saw the demise of blacksmiths, the traditional makers of horseshoes, and the horseshoe become a commodity. 100 years later the motorcar became popular which significantly decreased human's dependence on horses and in turn horseshoes. The horseshoeing industry has still remained a large industry due to an ever increasing sport and leisure horse population (8).

The latest innovation in the horseshoeing industry is the use of synthetic shoes and glue (9). Synthetic shoes are currently used commonly for "special" cases and have yet to cross the chasm into main-steam market due mainly to a lack of a dominant design. New technology resistance is also a big factor as horseshoes have remained mostly unchanged for the past millennia and techniques have been ingrained into the industry. Despite this synthetic horseshoes are the future of horseshoeing and it is just a matter of time before they become common place.

For a more detail about horseshoeing and the history of horseshoeing see **Appendix A.**

### b. Horseshoeing industry

Currently most horse shoeing is done by a qualified farrier. Sometimes horse owners also choose to, either, do all of, or part of the process themselves. It costs between $110 and $180 to employ a farrier to shoe a horse (10). This needs to be repeated every six weeks to compensate for the growth of the hoof, which means it costs more than $1000 to keep a horse shod for an entire year.

Horse shoeing involves three main steps; analysing the hoof, trimming the hoof and attaching the shoe. Analysing involves deciding on the best means of trimming and shoeing the horse so that the horse's natural balance and posture is maintained. The hoof is trimmed with a pair of very sharp nippers and then the appropriately shaped shoe is nailed on.

Horse shoeing is a very labour intensive and time consuming job. It is hard on the back and farriers frequently end up with back problems. Often it can be difficult to find a farrier who is both skilled and consistent at shoeing a horse in a manner that allows it to be comfortable and perform to its potential (10).

There are 200,000 horses and 490,500 shoeing events per year in New Zealand. With an average shoeing cost of $130, there is $63,800,000 spent on horse shoeing ever year in NZ (11).There are a further 1.2 million horses in Australia, 1 million in the UK and 9 million in the US, so it can be seen that the farrier industry is a very large marketplace worldwide. The equestrian industry as a whole is worth $1 Billion Dollars to the NZ economy $6.3 Billion to the Australian economy and $102 Billion to the US economy (12) (13) (14).

For more information regarding the horseshoeing industry including current trends and issues as well as references see **Appendix B.**

### c. CAVALTECH

CAVALTECH Ltd was formed in 2011 after successfully winning the UC Entre 75k challenge with the idea of "Automated Horseshoeing". The win provided the company with some resources to begin the commercialisation journey, with the ultimate goal of automating the horseshoeing process.

The company currently consists of:

- **Chris Bloomfield** – the founder and major shareholder of CAVALTECH. Chris completed his Degree in Mechatronics Engineering at the University of Canterbury in 2011 and decided to follow this up with an MEM in 2012. Chris has grown up with horses and shoes his own horses using current farrier methods.
- **Trevor Johnston** – mentor, shareholder and director. Trevor is also the project mentor for this project. He has more than thirty year's progressive experience in the growth and development of small to medium size enterprises. He started and owned his own manufacturing and retail company with a start-up capital of $5,000 and built it into an operation with a staff of 22 and revenues of over $2.5 million.
- **Rob Bloomfield** – advisor, shareholder and director. Rob is a self-trained equine farrier and has a BVSc and a MRCVS from Massey University. He is a veterinarian with 31 years' experience in all animal types. Rob is a member of the Equine Practitioners Branch of The NZ Veterinary Association and is involved in extensive on-going training in equine radiology, equine medicine and equine podiatry.

# 3. Project Plan Formulation

## a. Pre-Project

Developing a complete automated horseshoeing machine in one year was going to be too much to ask of a team of engineers, let alone a single student. Therefore, it was decided that the project needed to be broken down in order to identify what part of the process could be developed, within the single year timeframe, by the student working alone.

To maximise the effectiveness and efficiency of the project two questions were asked. These were:

- 1. What part of the horseshoeing process is the most time consuming?
- 2. What part of the horseshoeing process would be the easiest to solve using technology?

It turns out that the answer to both of these questions was the process of **shaping the metal horseshoes** to perfectly fit the horses' hoof.

- 1. It is the most time consuming process because the metal horseshoes must be heated to red hot temperature and shaped by the farrier using hammer and anvil. At the same time the farrier runs back and forward between anvil and horse to ensure the shoe will be a perfect fit.
- 2. It is also the easiest process to solve using technology due to its relative low interaction with the horse itself which, at the best of times, can be very unpredictable.

The technological solution to this problem is to build a machine which can obtain the profile of a horses' hoof and then automatically produce a shoe to fit that hoof, eliminating the need for an anvil and repetitive horseshoe-shaping work.

This technology seemed like a much more realistic and achievable goal for the student within the one year timeframe therefore was chosen as the basis of the MEM project.

## b. Funding

CAVALTECH is a start-up company with minimal resources therefore, if the student wanted to be paid for the project, they needed to find funding from an external source. This is where MSI (Ministry of Science and Innovation) came in.

Rob Lawrence from CECC (Canterbury Employers Chamber of Commerce) came to talk to the 2012 MEM students on the very first day of class and outlined some potential options of government funding for our project via MSI. One of these options was a "Capability Grant" for PhD and Masters Students which could provide the student with up to $20,000 per year.

The major conditions of the funding were:

- The project must have a technical focus.
- The student must spend a minimum of 50 percent of their time within the company, and the company must have suitably skilled staff and the time to mentor the student (15).

The technical focus condition was not an issue because the project is about development of technology, however, the second condition was. CAVALTECH has no physical premises and no staff.

Luckily, thanks mostly to Rob Lawrence's support for the project and also to Trevor Johnston stepping into the mentoring role; the funding was able to be approved.

$12,500 of funding was provided by MSI; $2,500 to the University of Canterbury for administering the project and $10,000 to the student, Chris Bloomfield, paid over the course of 6 months (September 2012 to February 2013).

### c. Plan

The first step in the planning process was to break the project down into sub projects of manageable size. For the purposes of reporting to MSI, the technical objective was broken down into 7 sub-projects shown in Table 3: Summary of the projects sub-projects The process of choosing these sub-projects was simple. The technical deliverable was broken down into what appeared to be (at the time) the most obvious technical outcomes that, when pieced together, made-up the project.

For simplicity, these sub-projects were reused for the purposes of the MEM project with the non-technical aspects of the project, the market research and the business plan, making up the last two sub-projects.

| | |
|---|---|
| 1 | Hoof Profiling Device |
| 2 | Hoof Profiling Software |
| 3 | Hoof Measuring Device |
| 4 | Hoof Measuring Software |
| 5 | Determine Best Shoe Material |
| 6 | Prototype Shoe Shaping Machine |
| 7 | Control Software |
| 8 | Market Research |
| 9 | Business Plan |
| 10 | MEM Report |

**Table 3: Summary of the projects sub-projects**

The sub-projects were further broken down into sections depending on the type of work that needed to be done so a more detailed plan could be made. An illustration of this can be seen in the WBS (Work Breakdown Structure) shown in **Appendix C.**

Using the student's minimal project management experience coupled with concepts learnt in class, each of the project sections was assigned timeframe and a budget for the duration of the project. This was then processed using Microsoft Project and presented in a Gantt chart that can also be seen in **Appendix C**.

These plans were developed to the best of the ability of the student with limited project management experience. The next section, Project Plan Implementation, will provide and insight into how well the project was planned by comparing these plans to reality.

# 4. Project Plan Implementation

This section compares the planned course of action with the real course of action.

Each sub-project is analysed separately and split into four separate sections:

- **Sub-Project Outline** – this describes desired deliverable for the particular project (from the project plan).
- **Outcome** – describes what actually happened and what was produced.
- **Plan vs. Reality** – compares how the actual course of action differed from the planned and analysis the reasons behind this difference.
- **Lessons Learned** – identifies the lessons that were learnt by the student through undertaking each of the sub-projects.

## a. Hoof Profiling Device

### *Sub Project Outline*

This involves building a device which can gather images of the underside of a horses hoof in order to calculate the profile (or shape) of the hoof.

- The device will need to be durable in order to withstand abuse from both human and horse.
- There will need to be a minimal amount of chords or parts of the device that the horse could be caught up in.
- The device will need some way of standardising the image size and distance to make the software's job much simpler.
- The device will need substantial testing and development.

### *Outcome*

**Figure 1: Resulting Profiling Device - Author**

The resulting device can be seen in Figure 1. The right image shows its correct positioning for collecting a photograph of the hoof.

The device positioned at **A** is a web camera which collects the images of the horses hoof. **B** is a high powered LED light with a red lens which projects red light onto the hoof enabling the software to identify the hoof. **C** is a metal shaft which maintains an equal distance between the camera and the hoof. **D** is a triangular piece of material which is lined up with the frog, a soft triangular shaped area of tissue, to ensure correct positioning every time.

On the whole the device meets the specifications described in the outline:

- The base of the device is a solid 4mm steel RHS member with aluminium structures bolted on to support the electrical components. The camera in its current position is rather vulnerable however, due to the simple but effective design; this can easily be remedied with a protective aluminium structure.
- There is only one chord coming from the device. Ultimately the device will need to be wireless however, the current configuration is good enough for the proof of concept stage.
- Components **C** and **D** help to standardise the image by providing a guide for the user to place the device in the same position on the hoof every time.
- The device stood up to testing only and only undertook one major developmental change. The original design had a white screen attached that went behind the hoof in order to make it easier for the software to identify the hoof. This was, however, too big and awkward so was replaced with the much more compact and elegant red LED solution.

## *Plan vs. Reality*

| | **Planned** | **Reality** |
|---|---|---|
| **Hours Total** | 54 hours | 42 hours |
| *Design* | *8 hours* | *16 hours* |
| *Build* | *16 hours* | *15 hours* |
| *Test & Develop* | *30 hours* | *11 hours* |
| **Cost** | $200 | $180 |

The development of the hoof profiling device went very smoothly. It took less time than was expected and cost slightly less.

More time was spent designing the device than was originally planned. This meant that the device was very well designed to begin with which had a follow on effect for the rest of the sub-project. It meant that substantially less testing and developing was required to get a useful product and, as a result, the total time spent was much less than planned.

## *Lessons Learned*

- Good, well thought out design speeds up the development process.
- Simple is better.

# Hoof Profiling Software

## *Sub Project Outline*

This involves designing and writing the software which will analyse the image retrieved by the Profiling Device and then determines the profile of the hoof. It will then identify the most appropriate shoe shape to fit the particular hoof that has been profiled.

- The software will need to be able to identify the hoof within the image and determine the circumference of the hoof that requires the shoe.
- It will then require an algorithm that can determine the best fitting shoe for the hoof and also the most appropriate position for any nail holes in the shoe if they are required.
- The software will need to be very simple to use and require minimal user input so it can be used by people with a low technical ability.

## *Outcome*

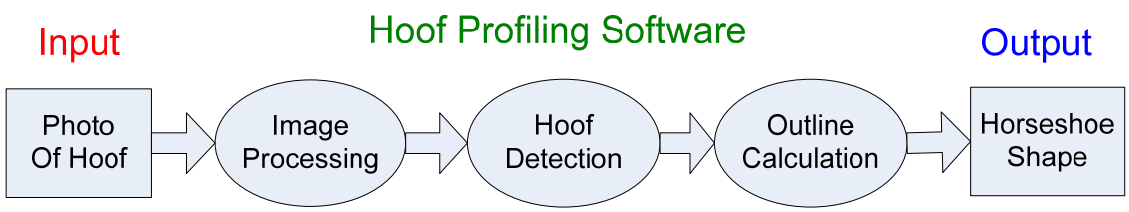


**Figure 2: Block Diagram of Profiling Software Structure - Author**

The software for the profiling device was written in C++ using a library called OpenCV which does most of the image processing. It currently runs on a PC computer for proof of concept purposes.

Figure 2 illustrates how the software works on a very basic level. It takes the image of the hoof from the profiling device as its input, uses image processing techniques to detect the hoof, calculates the outline of the hoof and then determines the best fitting horseshoe shape and saves the data to hard disk. It also determines the nail-hole positions as required.

The software is very simple to use and requires almost no human input other than to take the photo and ensure the photo is good enough quality. It has undergone extensive testing to ensure that it will work every time for a user with any level of technical ability.

For a more detailed breakdown and description of the software see **Appendix D.**

## *Plan vs. Reality*

| | **Planned** | **Reality** |
|---|---|---|
| **Hours Total** | 70 hours | 197 hours |
| *Write Software* | *40 hours* | *87 hours* |
| *Debug & Refine* | *30 hours* | *110 hours* |
| **Cost** | 0 | 0 |

Writing the profiling software took considerably longer than expected for two main reasons:

1. A major bug occurred during the process of writing the software which cost more than 30 hours to solve. It was an incredibly frustrating situation with an unknown cause. Frustrating bugs in software are generally caused by a very simple and obvious mistake that can be found after taking a break from coding and returning at a later stage. This particular bug, however, was not a simple problem and several experts were consulted with no result whatsoever. The problem was eventually solved after several programs and libraries that the software depended on were painstakingly reinstalled. It is still unknown to this day what the exact problem was.
2. Extra time was made available when some of the other sub-projects were shortened for reasons explained later in this document. This meant more time could be spent refining and developing the code. This has resulted in a much more stable, solid and bug free program. This particular sub-project was the benefactor of extra available time due to the relative novelty, therefore, is critical to the project's success.

This sub-project had no direct cost as all software and library dependencies were obtained for free.

### *Lessons Learned*

- Frustrating bugs in software can usually be solved by adverting attention to something else for a while and returning with a fresh mind-set, however, sometimes they require a self-disciplined "brute force" approach to overcome the issue by simple, repetitive trial and error.
- Use external libraries as much as possible – saves time in the long run.
- Software always takes longer than expected, especially debugging and testing.

## c. Hoof Measuring Device

### *Sub Project Outline*

This involves building a device which can gather imagery of the hoof in order to measure the important angle and shapes of the hoof. It is likely that the hoof will need to be viewed form multiple perspectives.

- The device will need to gather images of the hoof that can be used to determine the critical angles of the hoof
- It will need to be strong and durable enough to withstand abuse form both human and horse
- Will need to have some method of standardising the images to make it easier for the software to do its job
- Is likely to include some sort of 3D analysis of the hoof e.g. stereo cameras or laser scanner
- The device will require repetitive testing and redesigning to ensure that it works consistently and reliably for the user

## *Outcome*

**Figure 3: Hoof Measuring Device - Author**

The resulting device is shown in Figure 3 above. It is made up of, **A**, a stereo camera configuration and, **B**, a cradle for the horse's hoof. The stereo camera setup is designed so that it can look down at the underside of the horses hoof and gather three dimensional data of the hoof. This data has the potential to be useful to the farrier or the computer program at a later stage in the shoeing process.

The cradle for the hoof is based on current designs that are standard in the industry for relieving the pressure of the farriers back and provide support for the weight of the horse's leg.

The design has been built from a combination of mild steel and aluminium to ensure that it is durable enough to stand up to any abuse from the horse or user, whilst at the same time maintaining its accuracy and integrity.

## *Plan vs. Reality*

| | **Planned** | **Reality** |
|---|---|---|
| **Hours Total** | 62 hours | 46 hours |
| *Design* | *8 hours* | *9 hours* |
| *Build* | *24 hours* | *27 hours* |
| *Test & Develop* | *30 hours* | *10 hours* |
| **Cost** | $400 | $250 |

The designing and building of the device was successful and functional.

During the testing stage of this sub-project, once the device had already been built, the decision was made to abort this particular component of the design. This decision was made of the back of various sources of market research deeming this sub-project an unnecessary waste of time. These sources were:

- Internet research and conversations with farriers established that most of the information the device was going to provide can be found by analysing a photograph of the underside of the hoof instead. This means that the profiling device (described above) is actually the only device required to obtain enough information about the hoof.
- Meetings and conversations with automation professionals determined that there were actually better and more accurate methods of getting the same results.
- Interviews with farriers established that they would not find the functions provided by the device useful and would therefore not pay for it.

### *Lessons Learned*

- Ensure that there is a well-defined purpose for a project before undertaking it.
- It is better to quit an unnecessary project mid-way and concentrate on more important tasks than to finish the project just for the sake of it.

## d. Hoof Measuring Software

### *Sub Project Outline*

The Hoof Measuring Software will take the images gathered by the Measuring Device and determine the critical angles and dimensions of the hoof. It will then calculate how much of the hoof needs to be trimmed away in order for the hoof to have optimum angles and dimensions.

- The software will need to identify important points on the images that can be used to determine the critical dimensions
- Ideally the software will be able to determine the points with no human input, however, there may be a trade-off between simplicity of code and simplicity of function i.e. it may be more practical to have some human inputs to determine some of the critical points
- The software will require a complicated algorithm that can calculate how much of the hoof needs to be trimmed away using the current dimensions of the hoof
- It will need to run the calculations in a very short time as a horse has very limited patience

### *Outcome*

None.

### *Plan vs. Reality*

| | **Planned** | **Reality** |
|---|---|---|
| **Hours Total** | 120 hours | 10 hours |
| *Write Software* | *80 hours* | *10 hours* |
| *Debug & Refine* | *40 hours* | *0 hours* |
| **Cost** | 0 | 0 |

As explained earlier it was decided that the development of this part of the project was unnecessary. The 10 hours indicated above was time spent before this decision was made planning and drafting the software that was going to be written. The advantage of the situation was that it freed up 130

hours of project time that could be better spent on other aspects of the project. The time was used for areas in the project that provided much better value to the company's overall goals.

### *Lessons Learned*

- Same as previous.

## e. Determine Best Shoe Material

### *Sub Project Outline*

This involves researching and testing materials, most likely plastics, which could be used as the material for the horseshoes that will be rapidly customised to the horses hoof.

- The material will need to be durable and last at least 80% of the lifetime of metal shoes
- The material will need to be able to be rapidly shaped
- The material will define the shaping technique i.e. moulding, milling or rapid prototyping
- The shoes will need to be no more than 120% more expensive than current metal shoes to produce

### *Outcome*

Polyurethane.

Internet research, as well as discussions with professionals, concluded that polyurethane is the best material to use for the custom horseshoes. It is the most commonly used material in currently available plastic horseshoes for a reason.

- It has a higher average lifetime than metal except on concrete and tar seal where it has 80% lifetime (16).
- Polyurethane can be rapidly shaped to fit a hoof by milling away the unwanted material.
- Costs are comparable to metal shoes (17).

The only issue is the grade of polyurethane to use. It is likely to be at the 'hard' end of the grade scale but will only be determined 100% through testing and trial and error.

For more detail into the shoe material research see **Appendix E.**

### *Plan vs. Reality*

| | **Planned** | **Reality** | **To-Do** |
|---|---|---|---|
| **Hours Total** | 60 hours | 35 hours | 15 hours |
| *Research Online* | *40 hours* | *30 hours* | |
| *Consult Experts* | *20 hours* | *5 hours* | |
| *Trial & Error* | - | | *15 hours* |
| **Cost** | $1400 | $100 | $200 |

The search for the best shoe material took less time than was expected due to the fact that polyurethane is already an established material amongst current plastic manufacturers. A fact that was unknown at the beginning of the project. Further consultation is still required with experts,

along with testing, to determine the best grade of polyurethane. Meetings have already been scheduled for early Feb 2013.

The other big difference between plan and reality was the cost. It was thought that money would be required for purchasing various brands and makes of plastic shoes in order to determine the best material. Also money was set aside to pay for professional advice into this area however, for reasons described above, neither of these actions were necessary to the extent that was planned. It is likely that only another $100-$200 will be spent for the remainder of this sub-project.

### *Lessons Learned*

- It's hard to plan research because outcome is unknown.

## f. Prototype shaping machine

### *Sub Project Outline*

This involves producing a proof of concept prototype that can rapidly shape a shoe to fit a horse's particular hoof.

- The workings of this device are highly dependent on the chosen material for the horse shoes.
- The machine shall shape a shoe to the correct shape in less than ten minutes.
- The machine will need to be portable enough to be transported in a van or on the back of a ute.
- The machine is not required to be perfect – just prove the concept.

### *Outcome*

**Figure 4: 3020T Desktop CNC Milling Machine - Author**

It was decided that it would be a much more effective use of time to just purchase a machine that could mill the horseshoes than to "re-invent the wheel" and build one from raw materials. The result was the purchase of the desktop CNC milling machine shown in Figure 4.

The machine has a milling area of 200x300x50mm, perfect size for milling the horseshoes. The machine is easily capable of milling polyurethane and is small enough to be carried about by hand, weighing less than 24kg.

### *Plan vs. Reality*

| | **Planned** | **To-Date** | **To-Do** |
|---|---|---|---|
| **Hours** | 204 hours | 35 hours | 40 hours |
| **Cost** | $1500 | $1200 | |

As would be expected, buying a machine took much less time than building one from nothing. The hours spent to date have been used researching the CNC machines and setting up the device for use. Further set-up and testing is required before the sub-project can be completed. As planned, this work will be completed in February 2013. Again, the extra time was used for projects that provided more value to the company in the end.

One surprising aspect was the fact that the purchase of the machine cost less than the expected cost of building the device from scratch. Initial research and advice from experts suggested that it was going to cost minimum $10,000 to purchase something with the ability to do the job. However, a very large quantity of research was completed which resulted in a very good price for the brand new machine.

### *Lessons Learned*

- There is no point "re-inventing the wheel". Better to purchase a solution that has already been well established than building one from scratch, as long as the budget can adapt.
- It is more efficient, when developing a new product, to concentrate on the aspects of the product that are unique and outsource as much of the non-unique aspects as possible – especially when developing a "proof of concept". This means that the ground-breaking/unique concepts can be "proven" within a shorter timeframe.

## g. Control Software

### *Sub Project Outline*

The Control Software is the software that will control the overall running of the machine, including the scanning, profiling and shaping.

- The software will be run of a PC and will require a simple and effective user interface.
- The software will provide a link between each of the devices and the shaping machine so that they work together as a system
- The software will require as minimal user inputs as possible, however, there will be a trade-off between computer automation and user inputs.

- The algorithms behind all of the software will need to work 100%, however, the control software is only required to allow the concept to be smoothly presented by a knowledgeable user.

### *Outcome*

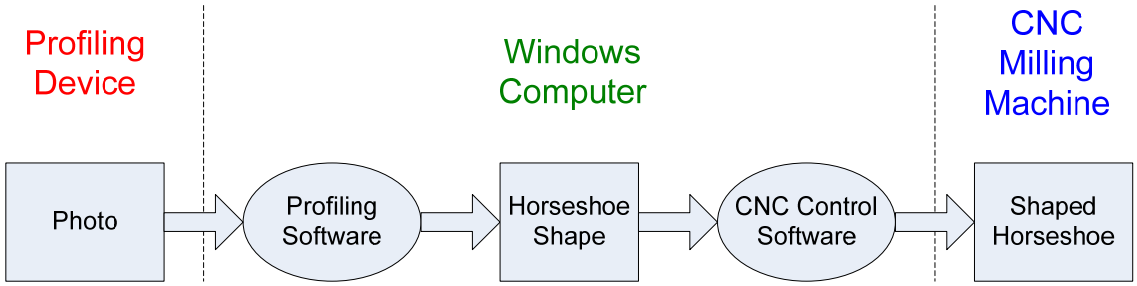


**Figure 5: Overall Control Sequence of the Device - Author**

The overall control of the system is a task to be completed as planned, in February 2013; however, the basic architecture is described above in Figure 5. The CNC milling machine came with its own control software so the project-specific software will focus on synchronising the profiling software with the CNC software. Ideally, when completed, the control of the system will require no effort on the user's behalf.

### *Plan vs. Reality*

| | **Planned** | **Reality** | **To-Do** |
|---|---|---|---|
| **Hours** | 80 hours | - | 80 hours |
| **Cost** | $0 | $0 | $0 |

The implementation of the control software has not yet been attempted however, at this stage; no reason can be seen that the task will not be completed on time. Due to the fact that the some control software came with the CNC machine it is likely that the task will be completed under the allotted time.

If it is completed early, then the potential exists to go slightly beyond scope and look into some sort of software for saving and storing hoof data and shoeing history over time.

## h. Market Research

### *Sub Project Outline*

The market research consists of determining what solutions currently exist in the marketplace as well as identifying the potential customer's needs.

- This will involve browsing sites, researching blogs, magazines and books for any information about the industry and how it works
- It will also involve talking to farriers and horse owners on a regular basis and gaining an understanding of their issues and needs
- Buying any products that relate and testing their usefulness will be very beneficial

- Learning as much as possible about current methods by reading, asking and doing

### *Outcome*

Substantial market research was undertaken during the project. This included:

- Interviews with farriers to determine the current issues and trends in the horseshoeing industry and where they see the industry going in the future
- Interviews with farriers to determine what technology they would pay for and what they would not.
- Reviewing relevant literature
- Surveys of horse owners to determine the issues that they currently have with farriers
- Extensive patent research to ensure any technology produced by the company is legal to sell and could potentially be patented
- A prior art search to determine what similar technology already exists for cautionary and inspiration purposes
- Extensive internet research into current players in the market place globally and the history of horseshoeing
- "Off the record" conversations with farriers and horse owners to gauge an understanding and a feel for the marketplace
- Meetings with industry professionals including CNC specialists, automation specialists and plastic specialists
- Large quantities of networking at horse shows and events around Canterbury, again, to get a feel for the marketplace
- Work shoeing own horses using traditional methods in order to maintain competency and know-how

A more detailed summary of the market research can be found in **Appendix F** and also traces of the extensive market research can be seen through all of the appendices present in the document.

### *Plan vs. Reality*

| | **Planned** | **Reality** |
|---|---|---|
| **Hours Total** | 60 hours | 182 hours |
| *Research Online* | *30 hours* | *53 hours* |
| *Talking to Customers* | *30 hours* | *79 hours* |
| **Cost** | $200 | $1350 |

Again, a reduction in time on some of the other sub-projects meant that the amount of market research that was completed was considerably more than what was planned. A lot of the research was over and above the scope of the specific MEM project however it will all contribute to the company as a whole. The market research was one of the areas chosen that would add greater value to the company in the long run.

The cost of the market research was also significantly greater than planned. The $200 that was set aside originally was designed to cover the travel costs of going and talking to potential customers. Obviously travel costs increased due to more than expected quantities of market research; however,

there were also other costs that were unforeseen. $300 was spent on patent advice, another $350 went to fees for attending horse shows and events, and a further $150 was spent on purchasing beverages for the professionals that were interviewed.

### *Lessons Learned*

- Market research is very important and has a major influence over the project as a whole.
- It is better to validate any new concept via market research before undertaking the development of that project. This ensures that the technology resulting from the project is actually useful at the end of the process and is not a waste of time.
- Market research has many unforeseen costs e.g. fuel and gifts for interviewees.

## i. High Level Business Plan

### *Sub Project Outline*

This will involve coming up with a high level business plan for taking the projects resulting technology to market.

- The substance of the business plan is highly dependent on the outcomes of the market research, the determination of the shoe material and the design of the shaping machine; mostly the market research.
- The plan will describe how money will be made from the product e.g. printer and ink model
- The plan will describe how the product will be taken to market e.g. early adopters followed by the mainstream market and/or NZ followed by Australia

### *Outcome*

The result was more of a commercialisation strategy than a business plan and is summarised as follows:

- Device will be taken from prototype to complete user friendly product
- Plastic horseshoes will be designed to work specifically with the device
- Device will be designed to only accept horseshoes that were designed for it
- Manufacturing will be set up for both of the products, ideally in NZ
- Machines will be sold at a low price and shoes sold with significant mark up to take advantage of the printer and ink model
- Marketing will be focussed on crossing the chasm and addressing the change adverse culture in the farrier industry
- Once the company has gained a foothold, the product will be taken to Australia and subsequently the rest of the world

For the full Commercialisation Strategy see **Appendix G.**

### *Plan vs. Reality*

| | **Planned** | **Reality** |
|---|---|---|
| **Hours** | 40 hours | 45 hours |
| **Cost** | $0 | $0 |

The development of the business plan went smoothly and nothing unexpected happened. Most of the time was spent discussing different scenarios with the business mentor Trevor Johnston and mulling over the options before a decision was made and the plan was put to paper.

### *Lessons Learned*

- The planning process requires large quantities of brainstorming, research and cross-examination of the options before solid decisions can be made.

## j. Overall

### *Outline*

To produce a **proof-of-concept prototype device** which can profile a horse's hoof, determine the shape of the hoof and then shape a custom plastic shoe to fit the hoof.

### *Outcome*

| | **Planned** | **Reality** | **To-Do** |
|---|---|---|---|
| **Hours** | 750 hours | 592 hours | 135 hours |
| **Cost** | $3700 | $3080 | $200 |

Overall the desired outcomes have been achieved so far and the project is on track to finish on time.

### *Lessons Learned*

- Adaptability is important when planning for a project that is unique.
- Need to ensure that the project has the ability to creep in either cost or time otherwise there is the potential for significant pressure to build up, especially with a unique project – again adaptability.
- It is important to keep on top of time creep in order to insure that tasks do not build up and become overwhelming.

# 5. Conclusion

The project to-date has run slightly under time and slightly under budget and is on track to be completed as planned. This outcome however is no reflection of how the project was run. The implementation of the project diverged substantially from the planned course of action.

The haphazardness of the implementation of this project was caused by two main factors:

1. The student's inexperience with project management and planning.
2. The relative novelty of the project meant that outcomes could not be predicted with any amount of certainty, consequently the project was hard to plan for.

The project had a clearly defined objective which meant the student was able to easily adapt the plan as the project unfolded and new factors appeared. This is testament to the need for on-going adaptability throughout any project which is novel and has risk of the unknown. A clear and solid objective provides flexibility to adjust the project plan without having an effect on the end result of the project. In this case, some of the sub-projects were either removed completely or reduced in importance significantly which freed up time for other sub-projects to be completed in a more thorough manner or, in some cases, above scope, however the overarching aim of the project was never threatened.

The changes in scope that occurred are also testament to the importance of market research and market validation. Some of the sub-projects were deemed unnecessary after the discovery that they did not add value to the project and potential customers would not pay for the product. This is something that has been stressed throughout the MEM course as being very important during the development and commercialisation of new technology. The project has proven this fact to be true.

For the purpose of efficiency, it was also very important to focus on the novel aspects of the project and reduce the menial non-novel tasks as much as possible. The novel projects are inherently more risky than non-novel projects due to the fact that the concepts are unproven and are therefore more critical to the success of the project. Non-novel projects are usually made up of menial tasks that can be done more efficiently by companies who specialise in that particular area. Outsourcing of these tasks means that the company can concentrate on the projects that are in line with the company's strengths and more likely to propel the company into a better competitive position.

Overall the project has successfully shown how the key concepts learnt in the classroom, like project planning, market validation and focusing on strengths, can be used to solve practical problems within a real life example.

# 6. Recommendations

These recommendations are aimed at assisting anyone who is either taking on a similar type of entrepreneurial project in a broad sense or undertaking a specifically similar technical project within the MEM programme.

## a. Similar Projects

As with any type of project that is breaking into new ground there are going to unknowns. The best way to minimise these unknowns is to do as much research as practically possible before making big plans and risking wasting money and time. This is especially true when building new products; you need to ensure that the market actually wants the product before jumping in and making the commitment.

A common phase when describing entrepreneurship goes like this (or words to the same effect): "Entrepreneurship is like jumping off a cliff and then building a plane on the way down". Obviously you want to have as much of the plane assembled before you jump but you are never going to be able to avoid the risks of first flight completely.

In regards to planning, it's best to have an overall skeleton of a plan in place with an end goal clearly defined. That way the plan is not rigid and can be adapted and changed when new challenges appear as the journey progresses. In other words, the destination remains the same but the path is continuously adapting to the landscape.

## b. MEM Specific

In regards to undertaking a mostly technical project for MEM, it is highly recommended that MSI funding is obtained. The ministry wants to provide funding for MEM students as long as you are able to dance through the loopholes and bureaucracy to get your project approved.

They have a grant called the "Capability Grant" which is aimed towards post-graduate students undertaking technical projects. This makes it tricky for an MEM student to obtain because MEM projects are not always technically focussed and will always require a "management" aspect as well. For this reason it is advised that the application is pitched as a purely technical objective whist also involving some management skills (i.e. marketing, business planning) for the MEM side of the project. This means there will be slightly different deliverables however, this is not an issue.

In order to take full advantage of the grant, it would also be advisable to apply for the grant at the beginning of the year. It is paid on a per-month basis, therefore, the longer the project the more payment is received. This was something that was not known by the author until it was too late.

The biggest hurdle with getting the MSI grant was the fact that the company was a start-up. The government prefers to back well established companies with a successful reputation and less risk than start-ups. The grant also required that there be sufficient mentoring capabilities within the company for the student. This required some re-arrangement of shares and duties within the company structure to overcome the bureaucracy and get the funding. It is recommend that any MEM in the future who wants to apply for this grant to talk to Rob Lawrence of CECC, who is always willing to assist in getting through the red tape and across the line.

Another issue that was a result of undertaking effectively an unsupervised report was motivation. A lack of a boss meant that it was very hard to focus on short term objectives due to lack of pressure. This was made even harder with the constant re-adjustment of the plan that was taking place. For this reason it is very important to continuously make short term goals and steadfastly stick to them or the project will creep. One thing that would have helped, in hindsight, was the fortnightly progress reporting initially recommended by Piet Beukman.

It was found that the technical aspects of the project were actually easier to focus on than the management type tasks because the outcome and progress was much easier to envisage. The exception to this was when the development, especially of the software, “hit a brick wall”. When the technical progress comes to a halt it is recommended that another task is attempted before returning with a fresh mind. If, however, this stalling of progress persists, a bulldozer approach will be required to get the task done.

## 7. Personal Reflection

The project as well as MEM as a whole forced me to grow as a person as well as teach me incredibly useful life and industry skills that will stay with me for the rest of my life.

- I learnt project management and planning skills. The concepts for these were learnt in class and were backed up personal experimentation, trial and error, and making plenty of mistakes.
- I grew confidence in talking to, meeting with and interviewing people from industry. The pressure of getting the tasks done forced me to make calls and contact people that I would have otherwise been uncomfortable to do. This forced me out of my comfort zone and gave me the confidence to do so in the future.
- I learnt the importance of keeping on top of tasks at hand. All too often the attitude "I'll do it tomorrow" appeared which caused task to pile up and become a last-minute frenzy which was not a pleasant experience.
- I became much more confident and polished at making presentations, especially "off the cuff". Meeting people from industry, as well as repeated presentation requirements of the MEM course helped me to relax in front of an audience and therefore improve my ability to think on my feet.

# 8. Works Cited

1. Preventing & Treating Hoof Cracks, Chips and Weak Walls. *Horse-Canada.* [Online] [Cited: 23 November 2012.] http://www.horse-canada.com/archives/preventing-treating-hoof-cracks-chips-and-weak-walls/.

2. [Online] [Cited: ] http://www.equisearch.com/horses_care/health/hoof_care/eqhorsesho610/.

3. [Online] http://www.horsetalk.co.nz/reviews/114-horseinhumanhistory.shtml.

4. [Online] http://web.archive.org/web/20090309102010/http://www.thenakedhoof.com.au/html/article-2000YearsOfShoeing.htm.

5. **Krebs, Robert E.** *Groundbreaking Scientific Experiments, Inventions, and Discoveries of the Ancient World.* s.l. : Greenword/ABC-CLIO. ISBN 0313313423.

6. [Online] [Cited: 21 November 2012.] http://imh.org/history-of-the-horse/legacy-of-the-horse/medieval-horse-476-c.-1450/battle-of-poitiers-begins-the-rise-of-cavalry-732.html.

7. The HIstory of Horseshoes. *Equisearch.* [Online] [Cited: 22 November 2012.] http://www.equisearch.com/horses_care/health/hoof_care/eqhorsesho610/.

8. Inventors - Horseshoes, Nails, Saddles, and Riding. *About.com.* [Online] [Cited: 22 November 2012.] http://inventors.about.com/library/inventors/blhorseshoe.htm.

9. *Vettec.* [Online] [Cited: 23 November 2012.] http://www.vettec.com/content/vettec-hoof-care-products-table.

10. **Bloomfield, Chris.** Survey Results. *Equestrian Market Survey.* Christchurch : s.n., 2011.

11. —. *Entre Venture Summary - Automated Horse Shoeing.* Christchurch : s.n., 2011.

12. *The University of Waikato.* [Online] [Cited: 28 November 2012.] http://www.waikato.ac.nz/news-events/media/2012/11study-finds-sport-horse-industry-worth-$1b.shtml.

13. **Gordon, Jenny.** *The Horse Industry - Contributing to the Australian economy.* s.l. : Centre for International Economics, June 2001. No 01/083.

14. *Casey Horseshoeing.* [Online] [Cited: 28 November 2012.] http://www.caseyhorseshoeing.com/documents/farrier_industry.html.

15. **MSI.** *Ministry of Science and Innovation.* [Online] http://www.msi.govt.nz/get-funded/build-your-business/what-we-offer/capability-funding/education-funding/.

16. FAQ. *Happy Hoofware.* [Online] [Cited: 15 1 2013.] http://www.happyhoofwear.com/frequently-asked-questions.aspx.

17. *Happy Hoofware.* [Online] [Cited: 15 1 2013.] http://www.happyhoofwear.com/product-category.aspx.

# APPENDIX A: HORSESHOEING AND ITS HISTORY

## WHAT IS HORSESHOEING?

Horseshoeing is the art of attaching some sort of material to horses' hooves in order to protect them from the wear and tear caused by the environment. The material is generally attached to the underside of the horse's hoof where it comes in contact with the ground and is shaped to fit the profile of the hoof. These pieces of material are called horseshoes.

Modern horseshoes are generally made from steel and formed into a U shape in order to protect the outer wall of the horses hoof whilst allowing the rest of the hoof to wear away naturally. Horseshoes can also be made from various types of metal including brass and aluminium, which is used for racing plates, as well as plastic composites, which have appeared in more recent times. The shoes are most commonly attached to the hoof by nailing to the hoof wall but can also be attached by gluing, or in ancient times before nails were invented, by strapping to the hoof/lower leg.

Horseshoeing is completed on most of the domestic horse population throughout the world and is a task which needs to be repeated at least every six weeks due to growth in the hoof wall. Horseshoeing is most commonly completed by a qualified farrier or blacksmith. A farrier is a tradesman who simply fits a pre-formed shoe to the horses hoof whereas a blacksmith forges the shoes form raw materials and then attaches them to the horses hoof. Blacksmiths have all but died out in modern times.

## WHY IS HORSESHOEING NECESSARY?

There is a magnitude of reasons why horses require shoes but the underlying factor is the fact that horse's hooves are subjected to unnatural conditions caused by domestication, which they have yet to evolve and adapt to.

"In respect to the horse's body, then, we assert that we must first examine the feet; for as there would be no use in a house, though the upper parts were extremely beautiful, if the foundations were not laid as they ought to be, so there would be no profit in a war-horse, even if he had all his other parts excellent but was unsound in his feet; for then he would be unable to render any of his other good qualities effective. No hoof, no horse" – Xenophon, 300 BC (1).

Sometimes the horses' hooves will wear away faster than they can grow back if they spend a large percentage of time on surfaces like gravel, concrete or tarmac. Often the domesticated hoof is much less tough than a wild hoof due to its living conditions. Wild horses spend 80% of their time wandering mostly dry, rocky, arid plains which harden their hooves and maintain a natural wear pattern (2). Domestic horses spend most of their time in stables or small enclosed paddocks which don't provide the extensive and varied terrain required to keep the hooves in good condition. In areas away from the equator, the paddocks are likely to be damp for most of the year which tends to weaken the hoof wall an increase the likelihood of cracks and other mechanical failures. It is good for the hooves to be wet sometimes, as they would in the wild, however; not for continued periods of time (3). In a stable environment, a horse will urinate and stand in the same spot and, despite the

fact that stables are generally cleaned out once a day, the ammonia in the urine will weaken the hoof wall (3).

Another major factor for horseshoeing is caused by breeding. Ever since domestication, horses have been selectively bred and not allowed to undergo natural selection. Due to the fact that most of the breeding has been purely performance driven, the overall quality of hooves has reduced over time and horseshoeing has compensated for this. There is also a large variation in quality of hooves with the different breeds. The cold-blood and warm-blood types, used more for work and competition, tend to have better feet than hot-bloods, like the thoroughbred, which was bred purely for speed and endurance with little attention given to the quality of its hooves (4).

Horseshoes can provide much more grip than the natural hoof which is helpful for surfaces which a horse is not designed for like ice, roads or mud. Studs can be added when the ground is very slippery or the horse is required to undertake tight turns and manoeuvres like in show-jumping or reining (5). High performance competitive horses undergo tests well above what would be expected of a horse in the wild and, even if the horse had perfect feet, shoes would be required to ensure the horse stays sound from competition to competition.

## The History of Horseshoeing and its Impacts

Ever since the horse was domesticated 6000 years ago (6)attempts have been made to protect the horses hoof and provide better traction in environments that they have not evolved to cope with. The earliest forms of hoof protection were very crude and only mildly effective; the modern horseshoe was a relatively late invention (7).

### Early hoof protection (4000 B.C. to 0 A.D)

The first hoof protection offered was simply pieces of rawhide, leather or other material tied or wrapped onto the horses hooves. These were used for both wear protection and therapeutic purposes (2) and the earliest forms have been found in Asia. It is likely that these ancient forms of hoof protection were not particularly widespread and were only used in special circumstances due to their limited effectiveness and likely annoyance caused to the horse; however, they would have aided users in long journeys and military campaigns.

During this time the care of the hoof was of great importance and communications travel and military operations were all restricted by the wear and tear of the horses hoof. Cavalries that belonged to the likes of Alexander the Great and Hannibal were known to be unshod and records exist of them having to slow down or stop in order for their horse's hooves to rehabilitate (8). The distances that they could travel at once was restricted by the growth rate of their horse's hooves. An example of this is especially outlined in the siege of Cyzicus, by Mithridates the Great in 73BC, where the battle was delayed in order to allow the hooves of his cavalry to regrow (8).

### The "Hipposandal" (0 A.D . to 500A.D.)

The earliest use of iron for horseshoeing is thought to have been by the Romans (9).

It is hard to tell exactly when iron first appeared in horseshoeing due to the fact that iron was a very valuable commodity and would have been recycled as much as was practically possible. Iron is also very susceptible to corrosion which would have caused these artefacts to breakdown over time.

Despite this, archaeologists have discovered many iron artefacts from Roman times which were called Hipposandals (10). As seen in Figure 6, the devices consist of a flat iron plate, which protects the underside of the hoof, and some sort of hook and metal loop to attach the device to the hoof/lower leg with leather straps. It is likely that many variations of design for the Hipposandal would have occurred in the beginning but, for the reasons outlined earlier, little evidence of these has been found. There is no doubt that the design shown became the dominant design throughout the Roman rule (11).

**Figure 1: Roman Hipposandals**

Hipposandals also often came with patterns engraved into the bottom to increase grip on hard surfaces or studs for soft surfaces.

Due to the weighty awkward nature of the Hipposandals they tended to only be used on draught horses which spent their entire life walking and carrying heavy loads as a pace faster than a walk seems to have been impossible in Hipposandals (10). It is a well-known fact that the Romans were the first civilization to build extensive road networks and the Hipposandal greatly improved the effectiveness of these roads. As outlined earlier, roads tend to wear away the horses hoof at a rate faster than they can grow back and the Hipposandal was the Romans solution to this problem.

Hipposandals allowed the draught horses to work for much longer periods of time, day after day with minimal hoof wear and tear, which greatly improved the efficiency of trade within the empire (12). This then meant that larger cities could exist which encouraged even more trade, even more roads and then, in turn, even more cities. The Hipposandal also had a big influence on military campaigns where draught horses were used for both supplies and transportation of military equipment such as catapults, siege machines and iron weapons. The Hipposandal would have been one a factor in the Romans ability to overcome their opponents by shear firepower and superior technology (13). It is safe to say that, without the Hipposandal, the Roman Empire would not have been nearly as extensive as it was.

## Nailed Horseshoes (500 A.D. to Present)

The first known use of nails is thought to have been during the 5$^{th}$ Century. At this time the Romans were still using Hipposandals, however these quickly became obsolete and by the 10$^{th}$ Century nailed horseshoes were used throughout the known world (14). During this time the modern U shaped horseshoe was developed and became the dominant design for metal horseshoes right up until the

present day. The metal horseshoe has only developed incrementally since the 10th Century and the basic overall design has remained the same. This is can be seen in Figure 7 where shoes found in England throughout the second millennia are all very similar.

**Figure 2: English horseshoes from the 11th to 19th Centuries**

The design was a much more effective use of iron than the Hipposandal as it simply protected the outer wall of the hoof, which supports most of the horse's weight and is where the wear and tear occurs. Most of these horseshoes had 3 nail holes around the edge of the shoe so that they could be nailed directly into the insensitive hoof wall. This meant that the horse was much more comfortable than in a Hipposandal and had the ability to move at any pace – not just a walk. Consequently the horseshoe now had the ability to protect every type of horse and was especially effective on cavalry and messenger horses.

These new horseshoes allowed a much greater freedom of movement for the horse and the practicality of the horse increased dramatically. In warfare the innovation disrupted the balance of power enormously. Now horses could travel for much greater periods with much more reliability and, assuming they were healthy, were still fit to battle at the end of their journey. This tipped the balance of warfare to greatly favour cavalry throughout the Middle-Ages (500 AD - 1500 AD) and countries and kingdoms began to rely tremendously on their cavalry for protection (15). This cavalry obviously relied heavily on the use of horseshoes which meant that, as a follow on effect, countries and kingdoms were not safe without a good supply of horseshoes (16). During this period, due to the value of iron, horseshoes were even accepted as a payment for taxes (2).

An example of how cavalry depended on the use of horseshoes can be seen in The Battle of Hastings in 1066. William the Conqueror put approximately 3000 horses on to sailing ships and sailed to England to claim his right to the English throne. Logistically he had to take with him 8,000 – 12,000 horseshoes and around 50,000 – 75,000 horseshoe nails forged from 8 tons of iron. He also had at minimum 10 farriers working 10 hours a day, 7 days a week to affix the shoes to the horse's hooves (17). The English at this point did not have horseshoes and were easily beaten by Williams's army. William the Conqueror then introduced horseshoes to Britain.

It is no coincidence that the two most notorious equestrian campaign's in history occurred shortly after the horseshoe became widespread in the 10th Century. These were The Crusades (1096 – 1270) and Genghis Khans Mongolian Empire (1206 – 1294). The Crusaders travelled on horseback from throughout Europe to attempt to reclaim the holy lands. They favoured large Flemish war horses which had flat feet and required horseshoes at all times (18).The Crusades would never have happened to such an extent without the use of horseshoes

The Mongols conquered 16% of the Earths total area and had the largest contiguous land empire in human history (19) all of which was completed by nomadic horsemen. It is unlikely that Genghis Kahn had horseshoes to begin with however he would have acquired them as his empire increased and allowed him to conquer most of Asia and the Middle East using the hardy Mongolian horse (20). The Mongols depended on the horse to extend and maintain their empire, hence, depended on the horseshoe to do the same. 1 in 200 men in the world are directly related to Genghis Kahn (21), a feat that would have been impossible without the invention of horseshoes.

The nailed horseshoes also had a profound influence on the development of civilization and the population boom. They allowed horses to be housed in stables without significant detriment to the usefulness of their feet. This provided much more efficient communication, trade and transport within cities and allowed them to grow much larger than was previously possible. They also made it possible for cities to maintain a taxi system. Communications, trade and travel increased between cities and countries as well, which helped with the sharing of knowledge, technology and produce.

Another advantage was the ability to further develop civilization in colder, wetter climates where previously horse's hooves would have been weakened by the dampness for most of the year. The Romans were only able to maintain their empire in the warmer regions around the Mediterranean Sea and were never able to assert their dominance and develop large cities further north than Gaul. After the invention of the nailed horseshoe extensive cities began appearing in northern Europe where the climate was previously too damp for horses to perform efficiently all year round.

"During the High Middle Ages, which began after AD 1000, the population of Europe increased greatly as technological and agricultural innovations allowed trade to flourish and crop yields to increase" (22). The nailed horseshoe became widespread in Europe in the 10th century. It could be concluded from these two statements that nailed horseshoeing was the enabling technology for the population boom of the High Middle Ages. It would be naïve to suggest that horseshoeing was the only enabling technology for the population boom; however, there is little doubt that it was a major contributor to the technological and agricultural innovations described in the quote above.

The importance of cavalry began to die out in the 15th Century with the introduction of the English Longbow and the discovery of gunpowder not long after; however horseshoeing remained an incredibly important industry right up until the industrial revolution (23). After the American Revolution most of the world's horseshoe nails were made in England which made them difficult to obtain. Families often had small nail manufacturing setups in their homes in order to keep up with the demand for horseshoes. Thomas Jefferson wrote in a letter, "In our private pursuits it is a great advantage that every honest employment is deemed honourable. I am myself a nail maker." (24)

As it would be expected the most influential technology that enabled nail-on horseshoes was the invention of the horseshoe nail somewhere around 500 AD. Nails have existed since the Ancient

Egyptian times in 3400 BC and were widely used throughout the Roman Empire. At some point someone decided to try and nail into the horses hoof; however, this was not the breakthrough innovation. The breakthrough came when the actual horseshoe nail was invented. The horseshoe nail is not a conventionally shaped nail and, as can be seen in Figure 8, has a triangular shape that causes it to angle out the side of the hoof so it can be clinched back over on itself and therefore secure the shoe. Without the clinches the shoe will easily wriggle its way free due to repetitive stress and movement. A farrier must be careful not to insert the nail the wrong way round for risk of hurting the animal. A good understanding of the biomechanics of a horses hoof was also a major enabling factor for the nailed horseshoe.

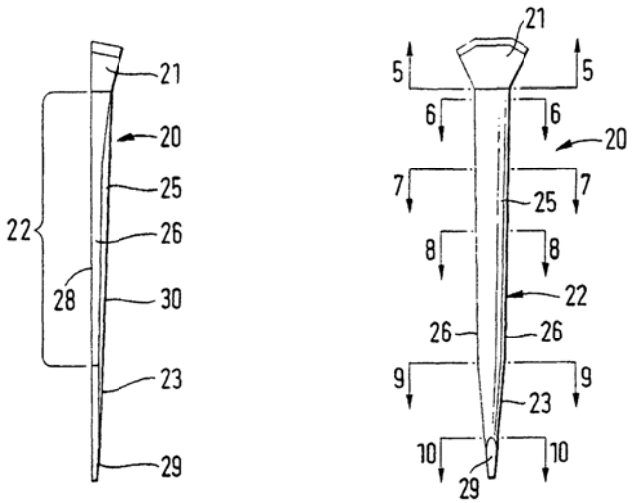


Figure 3: Side Elevations of a horseshoe nail

## Mass Production (1800 – Present)

Up until the early 1800s horseshoes and nails were produced by blacksmiths using hot forges and large quantities of hard work. During this time being a blacksmith was very highly regarded trade and blacksmiths were thought to have special powers due to their ability to work with elemental fire and magical iron (25). From the need for horseshoes, the craft of blacksmithing became "one of the great staple crafts of medieval and modern times and contributed to the development of metallurgy" (26). In 1835, the first US patent for a horseshoe manufacturing machine capable of making 60 horseshoes per hour was issued to Henry Burden (27). This was the beginning of the end for blacksmiths, and the art quickly died out for commercial use. Some competitions still exist for blacksmiths; however it has remained in existence only as a sport.

During this time the metal horseshoe and nails went through some slight incremental physical design changes but nothing that changed the design of either significantly. The main physical changes were driven by factors that simply made them easier to manufacture on a large scale. The biggest change that horseshoeing undertook was the fact that horseshoes went from being highly valued items to cheap commodities.

It was also at this point that farriers took over the sole responsibilities of horseshoeing. Farriers still use forges; however, they are only used for heating and shaping the already formed horseshoes so that the shoes can be fit perfectly to the horse that is being shod. Farriers also became responsible

for the wellbeing of the horses hoof and the knowledge of the hooves biomechanics increased greatly during this period. Farriers are expected to understand these biomechanics and the quality of horseshoeing has increased greatly since.

## Rise of the motor vehicle (1900 – Present)

The early 1900s brought the rise of the motor vehicle in developed countries and later the rest of the world. This greatly reduced the need of the horse for transport purposes and in turn the horseshoe. The number of horses per capita in developed countries decreased greatly around this time. The invention of tractors and other motorised machinery removed the need for draught horses in the mid-1900s further reducing society's dependence on horses and horseshoes.

The number of horses per capita worldwide dipped in the middle of the 1900s. The horse population is currently increasing due to larger disposable incomes in the developed world allowing more people to own their own sport and leisure horses. Horseshoeing is still a very important industry.

## Plastic and Glue (1970 – Present)

The latest innovation within the horseshoeing industry has been the use of synthetic shoes and glue. Plastic horseshoes come in a multitude of different shapes and sizes as seen in Figure 9. Currently they are only really used as speciality shoes if the horse is sore or uncomfortable in regular shoes. They possess much better shock absorbing properties than metal shoes and have a very similar Young's Modulus (a measure of stiffness) and tensile strength to the horses hoof (**Figure 5: Stiffness and strength of horseshoes**. This means they are more of an extension of the hoof rather than a shoe.

There is a large assortment of glues available for horseshoeing instead of nails. One adhesive in particular can be applied directly to the hoof without the need for a shoe and will protect the hoof for a couple of weeks (28). This, however, is not durable enough to become a viable replacement for the horseshoe.

The very first plastic horseshoes were rather impractical due to their short lifespan however the technology is rapidly improving and catching up to metal horseshoes but has not yet overtaken them yet due to cost, availability and lack of a dominant design. This is likely to happen within the next 5 to 10 years.

**Figure 4: Four different kinds of plastic horseshoes**

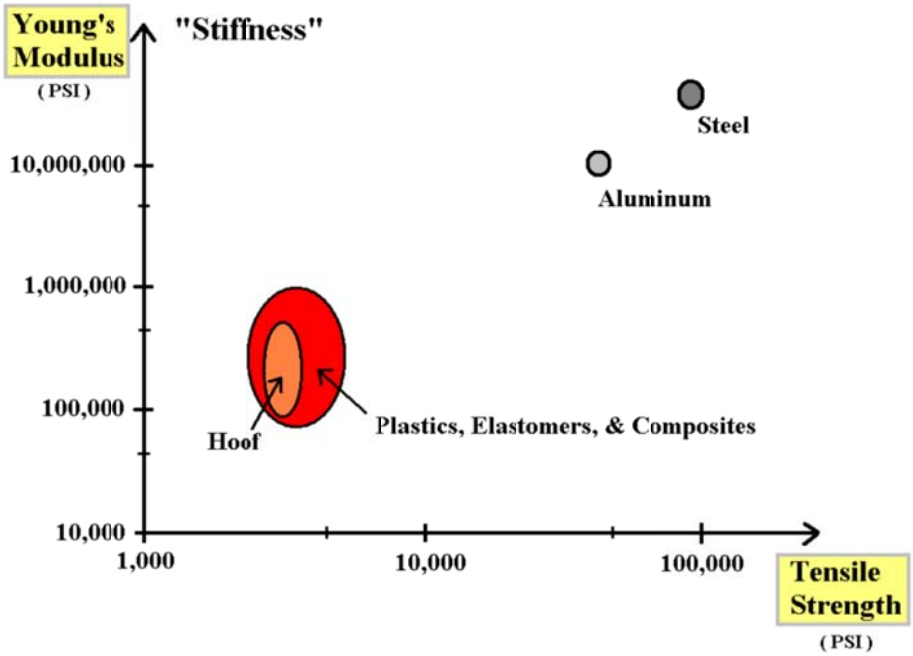


Figure 5: Stiffness and strength of horseshoes (28).

1. **Fleming, George.** Chapter I. *Horse shoes and horse shoeing: their origin, history, uses, and abuses.* 1869.

2. The HIstory of Horseshoes. *Equisearch.* [Online] [Cited: November 22, 2012.] http://www.equisearch.com/horses_care/health/hoof_care/eqhorsesho610/.

3. Preventing & Treating Hoof Cracks, Chips and Weak Walls. *Horse-Canada.* [Online] [Cited: November 23, 2012.] http://www.horse-canada.com/archives/preventing-treating-hoof-cracks-chips-and-weak-walls/.

4. [Online] [Cited: November 22, 2012.] http://www.grayson-jockeyclub.org/newsimages/bh_shelly_feet.pdf.

5. **Evans, J. Warren.** *The Horse Second Edition.* New York : Freeman, 1990. ISBN 0-7167-1811-1.

6. [Online] http://www.horsetalk.co.nz/reviews/114-horseinhumanhistory.shtml.

7. [Online] [Cited: ] http://www.equisearch.com/horses_care/health/hoof_care/eqhorsesho610/.

8. **ZIPPELUS, of Wurtzburg.** *Hostorical Development of the Horseshoe.*

9. [Online] [Cited: November 20, 2012.] http://news.sciencemag.org/sciencenow/2008/12/15-02.html.

10. [Online] http://web.archive.org/web/20090309102010/http://www.thenakedhoof.com.au/html/article-2000YearsOfShoeing.htm.

11. [Online] http://penelope.uchicago.edu/Thayer/E/Journals/CJ/29/9/Recent_Light_on_the_Roman_Horseshoe*.html.

12. *Sciencemag.org.* [Online] [Cited: November 21, 2012.] http://news.sciencemag.org/sciencenow/2008/12/15-02.html.

13. **Kelekna, Pita.** *THE HORSE IN HUMAN HISTORY.* s.l. : Cambridge University Press, 2010.

14. **Krebs, Robert E.** *Groundbreaking Scientific Experiments, Inventions, and Discoveries of the Ancient World.* s.l. : Greenword/ABC-CLIO. ISBN 0313313423.

15. [Online] [Cited: November 21, 2012.] http://imh.org/history-of-the-horse/legacy-of-the-horse/medieval-horse-476-c.-1450/battle-of-poitiers-begins-the-rise-of-cavalry-732.html.

16. [Online] [Cited: November 21, 2012.] http://www.everything2.com/index.pl?node_id=1097943.

17. [Online] [Cited: November 21, 2012.] http://imh.org/history-of-the-horse/legacy-of-the-horse/medieval-horse-476-c.-1450/the-battle-of-hastings-october-14-1066.html.

18. [Online] [Cited: November 21, 2012.] http://web.archive.org/web/19980208011824/http://www.horseshoes.com/advice/invtshoe/winvhrs.htm.

19. **Morgan.** *The Mongols.*

20. [Online] [Cited: November 21, 2012.] http://imh.org/history-of-the-horse/legacy-of-the-horse/medieval-horse-476-c.-1450/genghis-khan-and-the-mongol-horsemen-1203.html.

21. [Online] http://blogs.discovermagazine.com/gnxp/2010/08/1-in-200-men-direct-descendants-of-genghis-khan/.

22. [Online] [Cited: November 22, 2012.] http://en.wikipedia.org/wiki/Middle_Ages.

23. The Demise of Heavy Armored Cavalry. *IMH.org.* [Online] [Cited: November 22, 2012.] http://imh.org/history-of-the-horse/legacy-of-the-horse/medieval-horse-476-c.-1450/the-demise-of-heavy-armored-cavalry.html.

24. [Online] [Cited: November 22, 2012.] http://en.wikipedia.org/wiki/Nail_(fastener).

25. Superstition Bash - Horseshoes. *csicop.org.* [Online] [Cited: November 22, 2012.] http://www.csicop.org/superstition/library/horseshoes/.

26. "Horseshoe". *Encyclopedia Brittanica. 15th ed. Vol. 20.* 2005.

## APPENDIX B: TRENDS AND ISSUES OF THE HORSESHOEING INDUSTRY

| Strategic Objectives of CAVALTECH | Related Current-Trends | Related Current -Issues | Current Company Position | Critical Success Factors |
|---|---|---|---|---|
| Build technology that can replace existing horseshoeing methods | Synthetic horseshoes emerging<br>Greater understanding of hoof biomechanics<br>Metal horseshoes reaching end of life cycle | Metal horseshoes red-ocean<br>Synthetic shoes yet to cross chasm and lack of dominant design<br>No methods of improving horseshoeing methods | Technology is 30% built | Apply existing computer vision and automation technology to solve problems<br>Adequate funding available |
| Ensure the technology provides a better solution over current methods | Increase in part time farriers<br>Decrease in farrier quality<br>Metal horseshoes reaching end of life cycle | Low standard of farrier workmanship<br>Farriers very inconsistent<br>Farriers culture of bad attitude and lack of professionalism | | Design technology to be faster, more consistent and more accurate than current methods<br>Design technology to meet the needs of the market |
| Ensure the technology is safe and reliable | Increasing animal rights awareness<br>Increasing legal regulation | Public quick to ridicule any perceived animal abuse<br>Legal risks to expensive horses | None | Design technology to meet industry standards<br>Design technology with fail-safe and emergency mechanisms in place |
| Build a profitable business model to fit the horseshoeing industry | Increasing popularity of horses<br>Increasing cost of land and horse upkeep | High cost of owning and shoeing horses | Completed | Demand for new technology<br>Ability to generate revenue streams |
| Ensure the company can add value to the horseshoeing process | Barefoot movement<br>Increase in owner "knowledge" and expectations<br>Increase in number of horses housed in stables | Decrease in hoof quality due to environment<br>Horseshoeing a nuisance for owners | Completed | Technology solves an industry pain<br>Technology is economically viable for purchaser |
| Set up manufacturing and supply of the new technology | | | None | Technology can be manufactured cost effectively<br>Adequate funding available |
| Sell the technology worldwide | Increasing popularity of horses<br>Increasing cost of land and horse upkeep | Technology resistance culture with regards to metal shoes | None | Product can be supplied worldwide<br>Company builds and maintains solid branding and reputation.<br>First to market<br>Overcome new technology resistance |

## INTRODUCTION

CAVALTECH mission is to be the next innovation in the horseshoeing industry by focusing on the methods of horseshoeing rather than the horseshoes themselves. This is to be achieved by bringing cutting edge computer vision and automation technology over to the horseshoeing industry to streamline the horseshoeing processes.

To achieve this mission, CAVALTECH needs to meet the following objectives:

1. Build technology that will improve horseshoeing methods
2. Ensure the technology provides a better solution over current methods
3. Ensure the company can add value to the horseshoeing process
4. Ensure the technology is safe and reliable
5. Build a profitable business model to fit the horseshoeing industry
6. Set up manufacturing and supply of the new technology
7. Sell the technology worldwide

This paper aims to provide the directors of CAVALTECH with an analysis of the current trends/issues in the industry and analysis of the company's current position and critical success factors so that the directors can formulate solid strategies to achieve the objectives outlined above.

# CURRENT ISSUES/TRENDS IN THE INDUSTRY

## PESTLE ANALYSIS

### Political

Trends:

- Growing trend towards **improving animal rights across the developed world**, including horses.
- Internet provides platform for **fast and crippling animal rights accusations** to spread worldwide.

Issues:

- The **horses hoof is of utmost importance to the overall wellbeing of the horse** (1).
- Public will **be quick to ridicule** any perceived animal abuse.

### Economic

The equestrian industry is worth $1 Billion Dollars to the NZ economy $6.3 Billion to the Australian economy and $102 Billion to the US economy (2) (3) (4).

Trends:

- The equestrian industry is a **very big industry** and is **ever increasing** due to the popularity of sport and leisure horses in developed countries where high disposable incomes are available.
- Rapidly growing industry in fast developing countries like South Korea and UAE due to gambling.
- **Increasing cost of land** in very highly developed areas, like New York State, where land is on high demand (5).

Issues:

- The **cost of owning a horse is very high** (5).
- The cost of horseshoeing is very high - **7% of the total equestrian industry** spending (36).

### Social

Trends:

- Horse owners' ability to **freely access information** via the internet about horseshoeing.
- An increase in short courses in farriery available to anyone has resulted in an **increase in part time farriers.** 30 years ago full-time professional farriers comprised 90% of the work force. Now 80% of farriers are part time, with only 20% being full- time professionals (7).
- **Barefoot movement** within the industry where owners are opting to keep their horses unshod in the hope that a more **natural environment will be better for the horse**

Issues:

- Metal horseshoes and nails have been used for over 1500 years and **old habits die slowly.** For this reason there exists a **new technology resistance culture** in the horseshoeing industry.
- Embedded social **belief** in some of the farrier population, generally older, that **metal horseshoes are the only solution** and will always be the only solution.
- **Barefoot methods not a solution** due to reduction in performance and increase in care and maintenance of hooves.
- Overall **standard of workmanship has decreased** due to an increase in part time farriers (7).
- Inconsistencies between different farriers.
- Farriers tend to have a bad attitude and poor professionalism (36).

### Technological

Up until recently horseshoe technology has remained **almost unchanged for hundreds of years**. Horseshoes are still made from steel and have the same general shape as they did 800 years ago. Modern shoes are only slightly better than pre-industrialization times, which have undergone small amounts of incremental tweaking of the material and shape throughout the years.

Trends:

- **Metal horseshoeing** very near the end of its adoption cycle – **will soon become redundant**.
- Latest innovation has been the use **of synthetic shoes and glue.**
- Substantial research going into **the understanding of the hoof biomechanics.**

Issues:

- Metal horseshoe industry is undoubtedly **a Red Ocean** where hundreds of manufacturers around the world compete for the same customer base.
- Synthetic shoes yet to cross the chasm to mainstream market. Currently they are only really used as speciality shoes if the horse is sore or uncomfortable in regular shoes.
- H**undreds of different designs** for plastic horseshoes sold by companies all around the world. The designs vary greatly and there seems to be a lack of a dominant design.
- No current trends towards **improving the methods and systems of attaching and fitting** the horseshoes to the horses' hoof.

### Legal

Trends:

- Increasing legal regulation around the treatment and care of animals.

Issues

- In the UK and Europe laws exist which state a horse must be shod by **a qualified farrier.**
- The **legal impacts of damaging a horse could be very severe** and have a damaging effect to public image. Especially if the horses in question is of very high value.

### Environmental

In Europe, most horses are kept in **stables** which has detrimental effects on their hooves therefore a more likely to require horseshoes (8). In New Zealand, Australia and USA horses are mostly kept outdoors which generally means they have slightly better hoof quality.

Trends:

- The **trend is towards more horses in stables** due to the increasing cost of land.
- Current environmental pressure on farm animals due to greenhouse gas emissions, however horses do not release the greenhouse gas, methane, which is causing the most concern.

Issues:

- More stabled horses means a decrease in hoof quality therefore an increase in horseshoeing importance.

## Market Survey

In order to gain a better understanding of the current issues in the marketplace, a survey of varied types of horse owners was undertaken. The results are summarised below.

- There was a total of 154 horses owned by the 25 people surveyed, an average of 6.16 each.
- 90 of these were kept regularly shod, which is about 58% of them.
- The average cost of shoeing was about $122 (generally higher in the North Island), the highest being $160 and the lowest at $90.
- 64% thought the cost of shoeing was too expensive and the rest considered the price to be fair considering it was such a hard job.
- 20% of participants chose to shoe their own horse's rather than employ a farrier. Reasons for this were; farriers are too expensive and "to keep the wife happy".
- Only 40% of owners thought that horse shoeing was a nuisance but the rest considered it a tough job that had to be done in order for their horses to perform to their potential. A lot of people said that actually finding a decent farrier was a big nuisance but once they had found one it was OK. The reasons that people considered it a nuisance were; it's a time consuming process, hard on the back, hard work, farriers have an unpleasant attitude, are hard to get hold of and sometimes don't do the job properly.
- 55% of respondents had problems with their farriers mostly due to incorrect and inconsistent shoeing. Other problems were, finding a decent farrier, grumpy unskilled farriers and getting them to turn up when you want them to.

## Summary of Section

**Table 1: Summary of Current Trends and Issues**

| Trends | Issues |
|---|---|
| - Increasing animal rights awareness<br>- Increasing popularity of sport horses in developed countries and racehorses in developing countries<br>- Increasing cost of land and horse upkeep<br>- Increase in part time farriers<br>- Decrease in farrier quality<br>- Barefoot movement<br>- Increase in owner "knowledge" and expectations<br>- Metal horseshoes reaching end of life cycle<br>- Synthetic horseshoes emerging<br>- Greater understanding of hoof biomechanics | - Public quick to ridicule any perceived animal abuse<br>- High cost of owning and shoeing horses<br>- Technology resistance culture with regards to metal shoes<br>- Low standard of farrier workmanship<br>- Farriers very inconsistent<br>- Farriers culture of bad attitude and lack of professionalism<br>- Metal horseshoes red-ocean<br>- Synthetic shoes yet to cross chasm and lack of dominant design<br>- No methods of improving horseshoeing methods<br>- Legal risks to expensive horses |

| | |
|---|---|
| - Increasing legal regulation<br>- Increase in number of horses housed in stables | - Decrease in hoof quality due to environment<br>- Horseshoeing a nuisance for owners |

## CURRENT COMPANY POSITION

### BELL-MASON

Figure 6: Current position of CAVALTECH outlined in a Bell-Mason curve (Relative to each other)

Figure 6: Current position of CAVALTECH outlined in a Bell-Mason curve describes the current position of CAVALTECH in the marketplace. As would be expected of a start-up company, the position is very weak and substantial progress is required if CAVALTECH wants to compete in the horseshoeing industry. The strategic objectives of CAVALTECH need to be focused on moving these bars outwards to gain a stronger position in the marketplace.

### MARKET ANALYSIS

CAVALTECH plans to bring horseshoeing into the 21st Century by automating the horseshoeing process. This is something that has never before been attempted which puts them in an uncontested market space illustrated by Figure 7: Horseshoeing Industry Marketplace. AHS = Automated Horseshoeing System.

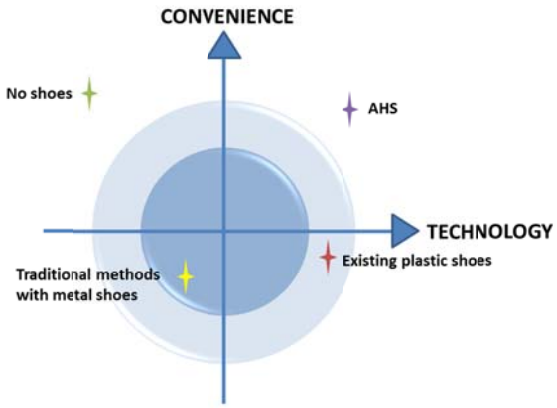


Figure 7: Horseshoeing Industry Marketplace. AHS = Automated Horseshoeing System

## COMPETITORS

Table 2: Summary of CAVALTECH's Potential Competitors identifies the current competing technologies that exist and how they meet the customer needs. All of these needs will be solved by the technology that is currently being developed by CAVALTECH (10).

Table 2: Summary of CAVALTECH's Potential Competitors

| **Product/ Service**<br>**For the Farrier** | **Features** | **Customer outcomes satisfied** | **Customer outcomes not satisfied** |
|---|---|---|---|
| Hand tools, crude measuring devices, forges to shape the metal shoes and personal judgement. | The farrier uses basic hand tools to analyse and trim the hooves. They then often (but not always) shape the metal shoes, using a forge, to fit the foot. The only means they have of determining the alignment and accuracy is their own judgement. The entire process in incredibly time consuming. | | Increase profit<br>Minimise physical effort<br>Minimise time<br>Increase customer satisfaction |
| **Product/ Service**<br>**For Horse Owner/Trainer** | **Features** | **Customer outcomes satisfied** | **Customer outcomes not satisfied** |
| Qualified Farriers | Good experienced farriers are hard to find but will generally provide a quality service. They are usually more expensive and on higher demand. They are still human and make mistakes. | Minimise wear and tear on hoof<br>Improve accuracy<br>Minimise damage | Improve consistency<br>Minimise time<br>Minimise cost |

| | | | |
|---|---|---|---|
| Unqualified/Inexperienced Farriers | Unqualified or inexperienced farriers are usually cheaper but of less quality. A large proportion of the farriers in NZ fall under this category. They are often inconsistent, lazy and unreliable. | Minimise wear and tear on hoof | Minimise damage to hoof<br>Improve accuracy<br>Improve consistency<br>Minimise time |
| DIY | DIY shoeing is when the horse owner chooses to do all or part of the shoeing themselves to save money and hassles. They have varied amounts of experience and generally do not do as good of a job as any type of farrier. | Minimise cost<br>Minimise wear and tear on hoof | Minimise damage to hoof<br>Improve accuracy<br>Improve consistency<br>Minimise time |
| Barefoot | A small minority of horse owners choose to keep their horses unshod. This can only be done with breeds of horses with naturally tough feet. Riders still need to consciously steer clear of damaging terrain like tar seal, gravel and rocky ground. | Minimise cost<br>Minimise time<br>Improve consistency | Minimise wear and tear on hoof<br>Minimise damage to hoof<br>Improve accuracy |

## Market Validation

Unlike farriers, whose shoeing is inconsistent and adversely effected by physical exhaustion, the machine will accurately and consistently trim each hoof to an optimum shape. By eliminating human error, and the potential damage that human mistakes can cause, the horse will be able to perform at its best all the time.

The machine will also drastically decrease the physical effort required by the farrier/operator. This will prevent many of the short and long term injuries farriers experience from the current very labour intensive methods.

The machine will take approximately one third of the time of a conventional farrier to shoe a horse. This means farriers or machine operators will be able to make a greater profit whilst exerting less energy than traditional methods and the monetary benefits will follow.

These factors, which have been backed up by research, confirm the presence of a solid market opportunity for the automated horseshoeing system.

## Critical Success Factors

By analysing the current issues and trends of the horseshoeing industry as well as the current position of the company some critical success factors have been deduced. These CSFs, as the name suggests, are the factors that determine the success or failure of each of the particular objectives.

| Objectives | Critical Success Factors |
|---|---|
| Build technology that can replace existing horseshoeing methods | Apply existing computer vision and automation technology to solve problems<br><br>Adequate funding available |
| Ensure the technology provides a better solution over current methods | Design technology to be faster than current methods<br><br>Design technology to be more consistent than current methods<br><br>Design technology to be more accurate than current methods<br><br>Design technology to meet the needs of the market |
| Ensure the technology is safe and reliable | Design technology to meet industry standards<br><br>Design technology with fail-safe and emergency mechanisms in place |
| Build a profitable business model to fit the horseshoeing industry | Demand for new technology<br><br>Ability to generate revenue streams |
| Ensure the company can add value to the horseshoeing process | Technology solves an industry pain<br><br>Technology is economically viable for purchaser |
| Set up manufacturing and supply of the new technology | Technology can be manufactured cost effectively<br><br>Adequate funding available |
| Sell the technology worldwide | Product can be supplied worldwide<br><br>Company builds and maintains solid branding and reputation.<br><br>First to market<br><br>Overcome new technology resistance |

## BIBLIOGRAPHY

1. **HSU.** Equine Hoof Care. *The Humane Society of Utah.* [Online] 2012. http://www.utahhumane.org/about-us/investigation/public-handouts/equine-hoof-care.

2. *The University of Waikato.* [Online] [Cited: 28 November 2012.] http://www.waikato.ac.nz/news-events/media/2012/11study-finds-sport-horse-industry-worth-$1b.shtml.

3. **Gordon, Jenny.** *The Horse Industry - Contributing to the Australian economy.* s.l. : Centre for International Economics, June 2001. No 01/083.

4. *Casey Horseshoeing.* [Online] [Cited: 28 November 2012.] http://www.caseyhorseshoeing.com/documents/farrier_industry.html.

5. Farrier Industry. *Casey Horseshoeing.* [Online] [Cited: 28 November 2012.] http://www.caseyhorseshoeing.com/documents/farrier_industry.html.

6. **Bloomfield, Chris.** Survey Results. *Equestrian Market Survey.* Christchurch : s.n., 2011.

7. FARRIER INDUSTRY-RELATED PROBLEMS. *Horseshoes.com.* [Online] [Cited: 29 November 2012.] http://www.horseshoes.com/educational-index/articles/business-career-and-health/375-farrier-industry-related-problems.html.

8. The Natural Hoof: A Sign of the Times. *The Horse.* [Online] [Cited: 29 November 2012.] http://www.thehorse.com/articles/10671/the-natural-hoof-a-sign-of-the-times.

9. *Legislation.gov.uk.* [Online] [Cited: 29 November 2012.] http://www.legislation.gov.uk/ukpga/1975/35.

10. **Bloomfield, Chris.** *Entre Venture Summary - CAVALTECH.* 2011

## APPENDIX C: WORK BREAKDOWN STRUCTURE

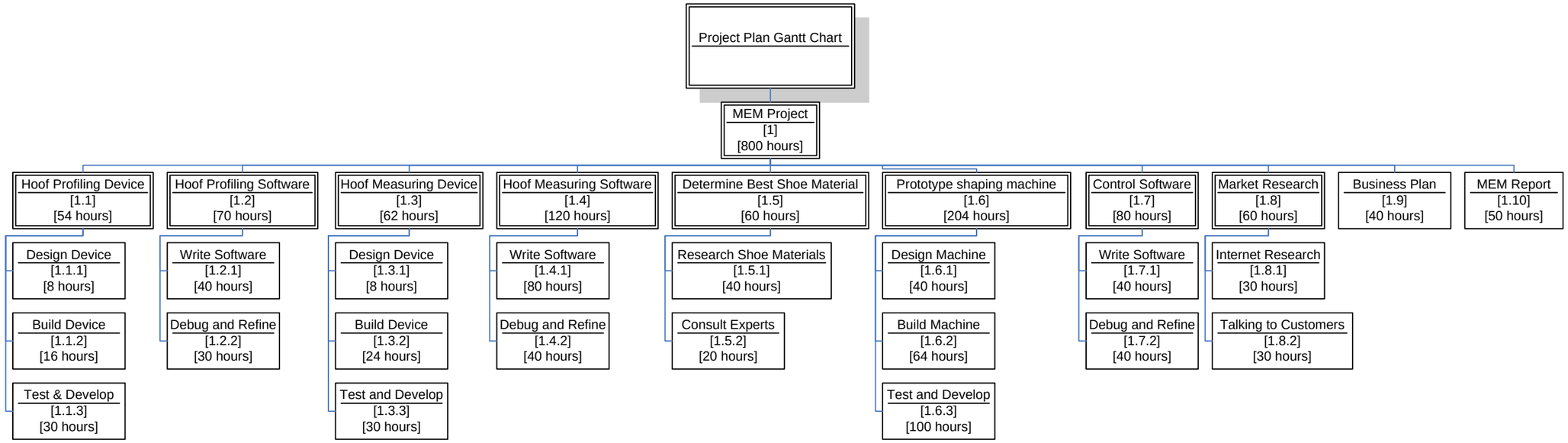


Figure 8: WBS of the project

## PROJECT SCHEDULE

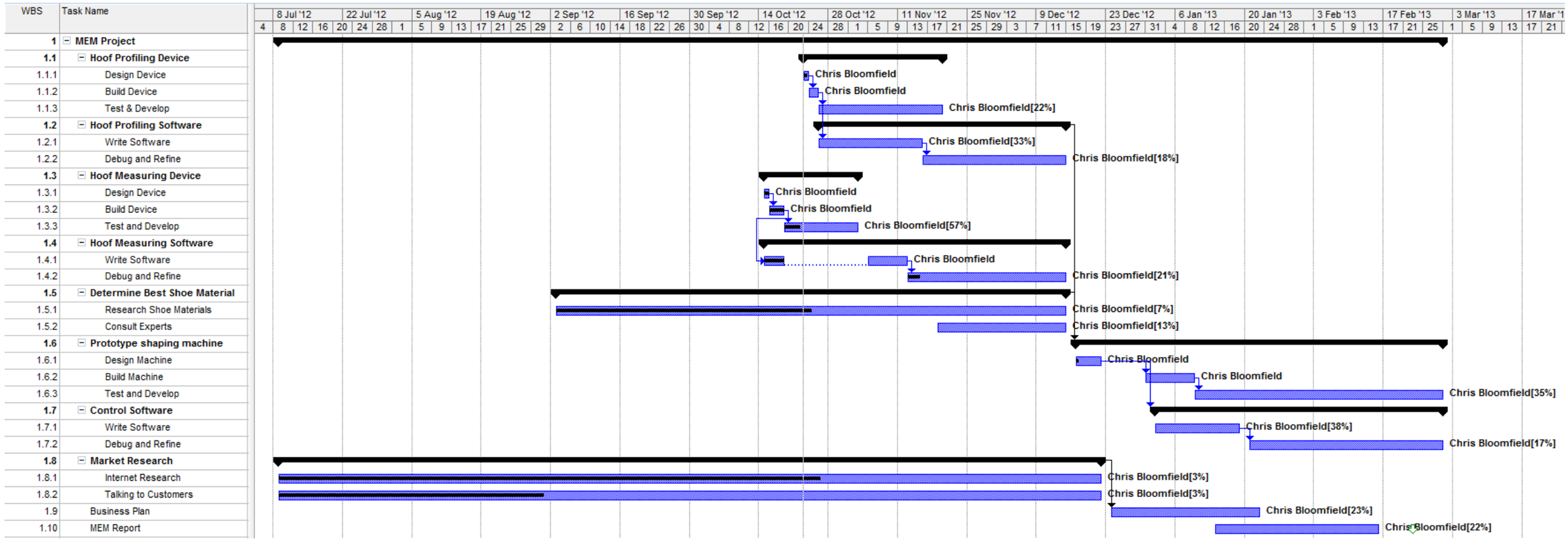


Figure 9: Gantt chart showing the Project Schedule including progress bars as at 20/10/12.

*It must be noted that the MEM Report will be handed in before the completion date of the final shaping machine and control software. This is purely due to time constraints and enables both the requirement of the MEM and MSI funding to be completed in their respective timeframe.

## APPENDIX D: SUMMARY OF PROFILING SOFTWARE

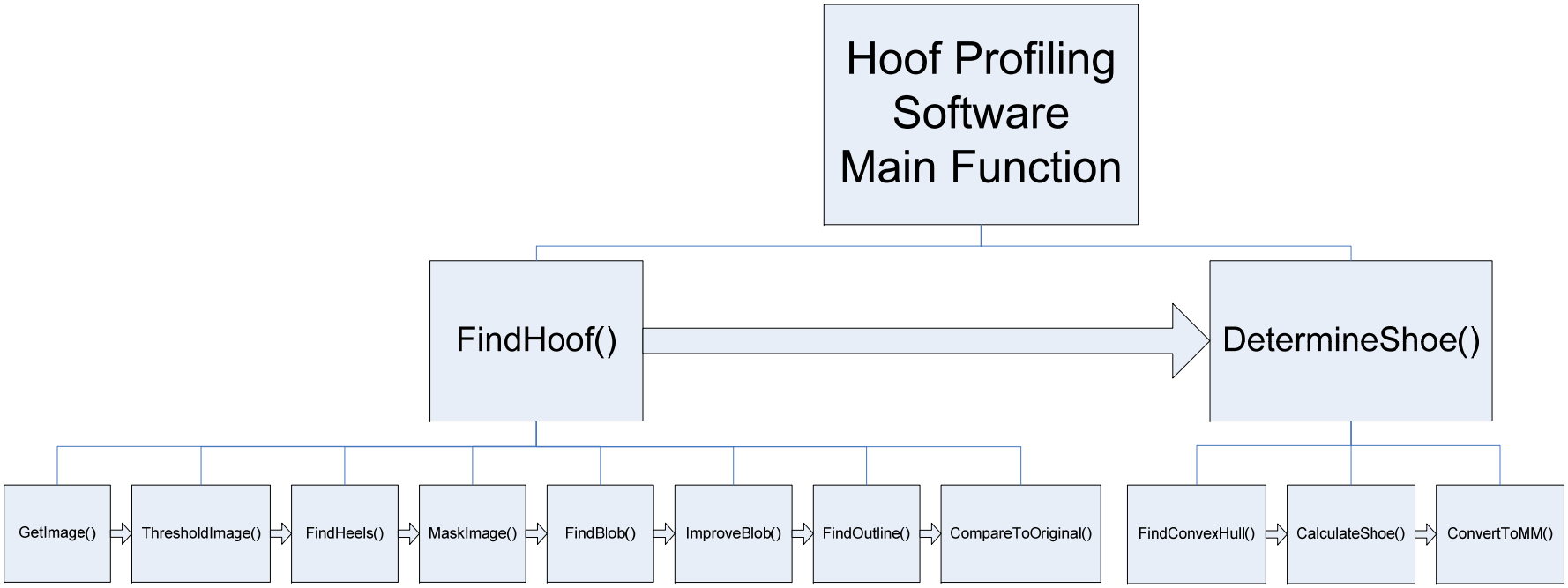


Figure 10: Function Breakdown of the Profiling software

## SOFTWARE FUNCTION DESCRIPTIONS

**FindHoof():**

FindHoof is a high level function called by main() which gets the image of the hoof from the device, finds the hoof in the image and then draws an outline around the hoof.

**DetermineShoe():**

DetermineShoe is also a high level function called by main(). It converts the outline of the hoof into an actual shape for the desired shoe and saves it in a useful format.

**GetImage():**

GetImage is called by FindHoof() and simply finds the current image that it being viewed by the camera in the device and saves it to a memory location.

**ThresholdImage():**

ThresholdImage is called by FindHoof(). It takes the saved image and applies thresholding (1) to the image to help determine the location of the hoof. It can either threshold the hue in the image or the luminance in the image. It will threshold the hue when the red light is being used and will therefore separate the red hue areas from the rest of the image. When the red light is not being used it will simply separate the high luminance areas (ie light – the background) from the low luminance areas (ie dark – the hoof).

**FindHeels():**

FindHeels is an optional function called by FindHoof(). It allows the user to input where the heels of the hoof are if image is not good enough quality. Not always necessary.

**MaskImage():**

MaskImage is called by FindHoof(). It masks the image by removing the parts of the image which will never be required. This helps simplify the later code.

**FindBlob():**

FindBlob is called by FindHoof(). FindBlob determines which of the many blobs left in the image is the horse's hoof. It does this by calculating the properties of each of the blobs, sorting them and then choosing the blob that is most similar to a horse's hoof. It has a 100% hit rate. It will then remove all of the unnecessary blobs.

**ImproveBlob():**

ImproveBlob is called by FindHoof. It takes the hoof blob, fills the holes in the blob and then improves the edges by eroding and dilating the blob using a 5x5 square pixel mask.

**FindOutline():**

FindOutline is called by FindHoof(). FindOutline finds the pixel to pixel outline of the blob using a Canny filter (2).

**CompareToOriginal():**

ComapreToOriginal is called by FindHoof. It draws a red line on the original image around the hoof and displays it to the user to ensure it is correct. Mainly for programming and debugging purposes.

**FindConvexHull():**

FindConvexHull is called by DetermineShoe. It calculates the convex hull (3) of the hoof which is the area encompassed by the very outer points of the blob. Creates a much smoother outline on the blob for fitting the shoe.

**CalculateShoe():**

CalculateShoe is called by DetermineShoe(). It calculates the shape of the final product, the shoe, and also the placement of the nail holes.

**ConvertToMM():**

ConvertToMM is called by DetermineShoe(). It converts the required dimensions of the determined shoe from pixels into millimeters and saves the result into a format required for the CNC machine (G-Code (4)).

(1) http://docs.opencv.org/doc/tutorials/imgproc/threshold/threshold.html
(2) http://docs.opencv.org/doc/tutorials/imgproc/imgtrans/canny_detector/canny_detector.html
(3) http://en.wikipedia.org/wiki/Convex_hull
(4) http://www.cnccookbook.com/CCCNCGCodeCourse.htm

# APPENDIX E: SYNTHETIC HORSESHOE MATERIAL ANALYSIS

## INTRODUCTION

This short document provides a summary of the research into the use of synthetic materials in horseshoes. Its purpose is to identify the best material to use in an automated horseshoe fitting device.

## ANALYSIS

| Company | Product | Material/s |
|---|---|---|
| EponaShoe | | - Three different types of polyurethane<br>- Two small steel stiffeners |
| Ground Control Horseshoes | | - 100% polyurethane |
| Polyflex | | - Polyurethane<br>- Steel wire insert |
| Happy Hoofware | | - Polyurethane |

| | | |
|---|---|---|
| ThoroFlex | | - Resin-based Urethane |
| Nano Flex | | - Unavailable |
| Easywalker | | - Unavailable |
| Equithotics | | - Polyurethane |
| Ollov | | - Rubber<br>- Steel core |

| | | |
|---|---|---|
| Smooth Walker | | - 100% Rubber |
| Remuda Tire Company | | - Polyurethane |

Table 3: Summary of current synthetic shoe materials

## CONCLUSION

Polyurethane appears to be the best choice of material for the automated shaping device. Polyurethane is the most common material used in synthetic horseshoes and is the material of choice for all of the more modern designs of shoes. It is likely that a single type of polyurethane will be preferable for the machine for simplicities sake.

As for the best grade of polyurethane, that will need to be decided with trial and error. None of the companies state their grade of plastic but it likely to be a higher grade like 70 Shore D, therefore harder.

# APPENDIX F: MARKET RESEARCH

## SURVEYS

Refer to Appendix B, Market Survey.

## INTELLECTUAL PROPERTY

Patent and prior-art searches were conducted for both the product being developed in the project and the concept as a whole. The results are summarized below:

### Areas of Investigation

| Process | Description | Potential IP Protection |
|---|---|---|
| 1. Complete Automated Horse Shoeing System (AHSS) | The overall combined system that, scans, trims and shoes a horse's hoof with minimal human input. | Patent<br>Trademark (Name) |
| 2. System to autonomously determine the most appropriate way to trim the hoof | A system that uses 3D cameras or a laser profiler to determine the current shape of the hoof, then, using certain computer algorithms, determines how much of the hoof needs to be trimmed away for the hoof to have an optimum shape to achieve maximum performance from the horse. | Patent |
| 3. System to determine the best fitting shoe for the hoof | A system which photographs the underside of a horses hoof from a standard distance and designs a plastic horse shoe to fit the hoof perfectly. This includes calculating the shape and position of any nail holes if so desired by the user. | Patent |
| 4. System to produce the best fitting plastic shoe for the hoof | A system that can rapidly produce a plastic horseshoe which fits the horses hoof perfectly. This could be done by either adjusting the shape of various sized standard horseshoes or rapidly producing shoes from raw materials | Patent |
| 5. System to trim away the unwanted material on the hoof | A system, which holds the horse hoof in a still position and then trims away the unwanted hoof determined by the scanning system. | Patent |
| 6. System to glue on plastic shoe | A system that glues a shoe on to the hoof in the perfect position mechanically. | Patent |

### Patent Search

**1. Complete Automated Horse Shoeing System**

**Keywords:** automated, horse, horseshoe, system, robotic, mechanical, control, computer, controlled, machine

**Findings:** It seems that no patent exists describing an automated horse shoeing system in any of the databases searched. The closest patent that was found was to do with the automated production of metal horseshoes, which is unlikely to have any overlap. Another of interest was to do with wireless sensors that can measure a horses gait whilst it runs but, once again, no overlap.

**2. System to autonomously determine the most appropriate way to trim the hoof**

**Keywords:** scan, 3D, camera, hoof, horse, angles, photograph, optimum, calculate, algorithm

**Findings:** After substantial searching using combinations of the above key words, only one patent was found to have similarities.

This is Patent US7,088,847: Method and system for analysing animal digit conformation.

This patent covers a method of analysing the lower leg of animals from images where certain scale markers exist to calibrate the image. The biomechanical data is measured and can be used to compare between various animals or tracking changes over time. It is filed only in the US.

**3. System to determine the best fitting shoe for the hoof**

**Keywords:** photograph, horse, hoof, shoe, calculate, profile, scan, dimensions, profile

**Findings:** Once again there was one patent which related to the proposed system.

The patent is US5319918: Method for manufacture of a horseshoe

A method for the manufacture of a horseshoe is described, which is characterized in that firstly individual hoof dimensions are directly measured on the hoof and taken into account during manufacture in such a way that by an automatic control system a horseshoe is worked from a solid material and is ready for fitting to the hoof without any reworking or adaptation deformation being necessary. The patent is published in the US, Germany, Denmark, Netherlands and France. It originated from Germany. It was filed in 1992 which means it is very close to its 20 year limit. Further research was undertaken and there was no evidence that this patent has been acted upon – it has never gotten past the concept stage.

**4. System to produce the best fitting plastic shoe for the hoof**

**Keywords:** plastic, horseshoe, rapid prototype, manufacture, mould, automated, control, profile

**Findings:** It could be seen from the patent found during the previous search that there was going to be a problem. Patent US5319918 is almost exactly describing system 3 and 4 combined into a single patent. The patent will be coming to an end very soon however it would mean that these systems could not be protected.

On the bright side no other patents that related to this system were found using the keywords above in the databases provided.

**5. System to trim away the unwanted material on the hoof**

**Keywords:** Trim, horse, hoof, sand, grind, file, shape, stand, clamp, mechanical

**Findings:** The only relevant patents found using the keywords above were a varied assortment of patents describing designs for farrier stands. These stands are used by farriers to keep the horse's hoof still when performing certain acts whilst shoeing a horse. The stands are very basic and crude and it would be unlikely that they would interfere with the proposed design.

**6. System to glue on plastic shoe**

**Keywords:** System, control, automated, plastic, horseshoe, glue, mechanical

**Findings:** No relevant patents were found for this section apart from methods of gluing on plastic horseshoes by hand.

## Prior-Art

| Prior Art | Relevance |
|---|---|
| Patent US6915859 Biomechanically designed horseshoe | This patent and any other similar patents that describe the design of plastic horseshoes are of medium importance. The design of the machine also needs to take into account the type of plastic horseshoe that needs to be used. It is likely that the company will make a strategic partnership with a company that already produces plastic horseshoes therefore it is not a big deal. The company will most likely own its own IP on plastic horseshoes however it is good to make sure that the right protection is in place. Studying the various plastic horseshoe patents will also provide some good ideas into the best methods and what is on the market. |
| Patent US6467548 Multi-sizable horseshoe | This patent is only of minor importance to the project. It will only become important if it is decided that a multi-sizable horseshoe would be the preferred horseshoe style however this is unlikely. It is still useful to know that the patent exists. |
| Patent US6497292 In Situ horseshoeing | Once again this patent is of only minor importance to the project. The patent describes a fast setting glue that self-adheres to the bottom of a hoof and protects the hoof form damage. The protection is not as good as a conventional shoe and the patent only needs to be considered if there are big advances in the technology. |
| Patent US7387171 Upright Stand | This patent describes an stand that can be used to hold a horse foot still whilst a farrier is working on the hoof. It consists of a cradle like sling that provides support for the leg and foot so that the hoof is easily accessed. This patent is |

| | |
|---|---|
| | likely to be of high relevance to systems 5 and 6 as this would be a very effective method of holding the hoof still whilst trimming and gluing. Once again it is dependent of what design decisions are made further down the track. |
| http://www.entre.canterbury.ac.nz/documents/201175kwinners.pdf | The automated horse shoeing idea was entered into an entrepreneurial competition at the UoC in 2011 and won. As a result the idea gained a small amount of publicity. There is a chance that this could be considered prior art due to the fact that the idea is in the public domain. It is unlikely that this will be an issue as the content released to the public was very minimal and un-descriptive. |
| http://www.vettec.com/ | Vettec the website of the company that is developing the glue that self-adheres to the hoof of a horse and protects the hoof for a short period of time. If this is developed further it could be a potentially useful product to use in the machine. |
| http://www.eponatech.com/ | Eponatech is a company which is developing software which helps people determine how a hoof needs to be trimmed. It is not exactly the same as Cavaltechs products; however, there is some overlap. Eponatech needs to be watched to ensure they do not release any prior art, which could be potentially damaging to the companies cause. |

## Farrier Interviews

Four farriers from the Christchurch region have been interviewed with another three planned. The farriers approached are all experienced and well regarded in the industry. The questions that were asked along with the more common answers are summarised below.

### Questions

**How many years have you been shoeing horses for?**

Average: 19

**What do you like about being a farrier?**

Doing things with hands

Seeing the results of work done and made a difference

Being around horses

**What do you dislike about being a farrier?**

Shitty horses

Owners sometimes hard to deal with

Hard work

**What issues do you think the industry currently has?**

Inconsistency and accuracy are a big one

Big egos – every farrier is doing it right – farriers arrogant

Apprentices hard work and make no money

**What do you consider to be the hardest part of your job as a whole?**

Saying no to customers (these were top-end farriers)

**What is the hardest part of the actual horseshoeing process? Physically and mentally?**

Trimming is the most important part of the job mentally

Physically it's the repetitive bending over

**Can you see any trends emerging in the near future within the industry?**

Not in NZ

Plastic shoes appearing

Better imaging and x-ray analysis

**What about long term?**

Can't see anything.

Something that makes the job easier physically would be a lifesaver

**Do you use plastic horseshoes? Why? Why not?**

Yes, absorb concussion

Owners request

Problem horses

**Do you have a formula/measuring techniques for getting the shape and angles of the hoof right or do you use judgement?**

**Would a machine that could measure a hoof from a photograph very accurately and quickly and provide information on the hoof like COB or break over point or angle?**

**What about something that could automatically shape a shoe to fit the hoof?**

**Do you have any means of keeping track of horses progress or is it just by memory?**

**Would a computer database which collects data over time be useful?**

**In the future maybe a machine that can help with trimming and physical processes?**

## NETWORKING

Extensive market research was conducted throughout the year via networking. This was done by attending equestrian shows and events during the weekend and some weekdays. Both horse owners and farriers were spoken to and asked various general and leading questions during casual conversations. This provided a lot of opinionated but uncensored information into the industry and the results are summarized below.

# APPENDIX G: COMMERCIALISATION STRATEGY OF HORSESHOE SHAPING DEVICE

## INTRODUCTION

This document summarises the strategic plan for CAVALTECH to commercialise a plastic horseshoe shaping device. The device is a portable machine which can rapidly scan a horse's hoof then shape a plastic shoe to perfectly fit the hoof within minutes. It is written as a simple guideline rather than a detailed analysis.

## BACKGROUND

Horse shoeing is one of the only industries that has remained mostly unchanged for the past few hundred years. Currently horse shoeing is a very labour intensive, costly, and time-consuming job. It is a job that is completed by "farriers" who are often inconsistent and unskilled.

Horse shoeing involves three main steps; analysing the hoof, trimming the hoof and attaching the shoe. Analysing involves deciding on the best means of trimming and shoeing the horse so that the horse's natural balance and posture is maintained. The hoof is trimmed with a pair of very sharp nippers and then the appropriately shaped shoe is nailed on.

## PROBLEM

Shaping the metal horseshoes is the most time consuming part of the horseshoeing process because the metal horseshoes must be heated to red hot temperature and shaped by the farrier using hammer and anvil. At the same time the farrier runs back and forward between anvil and horse to ensure the shoe will be a perfect fit.

Plastic horseshoes are an emerging new technology with the potential to replace the traditional metal horseshoes. Currently many types of plastic horseshoes exist but they have yet to cross the chasm into the mainstream market. They tend to be over designed and time consuming to fit properly. Fitting is done by using a shoe that is slightly too big and then trimming and filling away the unwanted material.

Another problem with the plastic horseshoes is the nail holes. The holes are generally made in the factory and are therefore in a set position only. The nail holes are best positioned along the white line of the hoof, which follows the outline of the exterior hoof wall. All horses hooves are a different shape therefore holes in the plastic shoes are almost always guaranteed to be in the wrong place. This is not a problem with metal shoes as the entire shoe is heated and bent to fit the hoof

## SOLUTION

The horseshoe shaping machine solves both of the current issues with plastic horseshoes.

- It will swiftly analyse the horses hoof from a photograph and then mechanically trim a plastic shoe to perfectly fit the hoof reducing time and effort greatly.
- It will place the nail holes in exactly the right positions specific for each horse for a better fit.

## STRATEGY

It has been decided that the best method of making a profit off the device is to borrow the printer and ink model where the machine is sold for only a small profit and most of the money is made from

the sale of consumables. In this case the consumables will be the plastic shoes which will be specifically designed to work only with the device.

Implementing this plan involves several steps:

1. Developing the current prototype to a sellable product by designing as a complete, simple and user friendly device.
2. Developing a plastic horseshoe and the device so that the device will only work with horseshoes made by CAVALTECH
3. Setting up production of both the device and the horseshoes, ideally in New Zealand
4. Marketing the product in New Zealand to start with followed by Australia then the rest of the world. Specific strategies will need to be put in place in order to cross the chasm into the mainstream market once the early adopter market begins to dry up. Also strategies will need to be aimed at addressing the adversity to change that currently exists in the farrier industry