Business, Publicity, Finance and Management report

28 April 2009

Warwick Mobile Robotics
Mobile Robotics Laboratory
International Manufacturing Centre
University of Warwick
Coventry
CV4 7AL

THE UNIVERSITY OF WARWICK

Telephone: +44 (0) 2476 574 306
Web: www.mobilerobotics.warwick.ac.uk
email: mobilerobotics@eng.warwick.ac.uk

Table of Contents

Figures, Tables and Equations

1. Introduction

This report describes the Business, Publicity, Finance and Management functions of the 2009 Warwick Mobile Robotics (WMR) team. Aims and objectives were stated at the outset of the project to provide a guide as well as a benchmark for success. These aims and objectives, stated below, were used to guide financial and management operations as well as technical design work.

1.1 Project Aims and Objectives

- Build on the success of 2008
  - Optimise tele-operation
  - Implement mapping and autonomy
  - Investigate further victim identification
  - Achieve Best in Class for Mobility at RoboCup Rescue German Open
  - Qualify for the international final in Austria
- Raise the profile of WMR and sponsors through continually developing marketing strategy
- Increase awareness of Engineering both at the University of Warwick and as a profession
- Showcase Warwick innovation to the world

2. Business

2.1 Introduction

WMR is a research group whose primary interest for the 08/09 academic year is the development of a mobile robotic system for the RoboCup Rescue competition. This competition tests the abilities of robots in simulated disaster environments, while aiming to "increase awareness of the challenges involved in search and rescue applications [and] provide objective evaluation of robotic implementations" (1). Thus the competition can be seen as a testing ground for robotic systems with real world applications.

As the team is a research group the immediate aim is not to develop a commercially viable robotic system, however this can be viewed as the ultimate aim of the research effort. In this section Technology Readiness Levels are used to assess the maturity of the technology being developed, consideration is then given to commercial factors involved in developing the technology into a product. Finally, further developments, both research and commercial, are considered along with potential modes of funding.

2.2 Technology Readiness Levels

Technology Readiness Levels (TRAs) are used by governments and companies to assess the maturity of a technology before it is used in any systems or subsystems. Appendix A Table 8-1 gives the definitions of the 9 TRLs as used by NASA. A mobile robotic system has been built by the 2008 project team and tested with some success in a simulated disaster environment. This project focuses on developing the system to deliver superior performance within this environment. Since the competition environment represents a "relevant", but not "operational", environment the technology currently being developed by WMR can be classified as TRL 6.

This provides a quantitative evaluation of the readiness of this technology for commercial use, as well as a series of stages necessary to pass through in order to verify the readiness of the technology.

2.3 Marketing

2.3.1 Market Position

The Ansoff matrix is a tool used by businesses to decide upon strategies for growth by considering both products and markets. This tool can be applied to WMR to identify the appropriate strategy for developing the research of WMR into a commercial venture.

The product being developed is an Urban Search and Rescue (USAR) robot. This product is currently in the prototype stage, and has been classified as TRL 6 in Section 2.2. Developing this prototype into a marketable product would be considered a new product strategy since the product has not exposed to a commercial audience before.

As a research venture, WMR has no customers and hence no market. While WMR hold no commercial market, it should be noted that an "academic market" exists for the group's research output, for example the RoboCup Rescue competition. While a market may exist for USAR robots, WMR is not currently a supplier and so moving into this market would be considered a new market strategy.

WMR must use a diversification strategy in order to develop from research to commercial operations. Diversification strategies are known for being the most risky strategies dues to two main factors:

- A company must usually develop new competencies in order to produce a new product
- A company may lack credibility in the new market

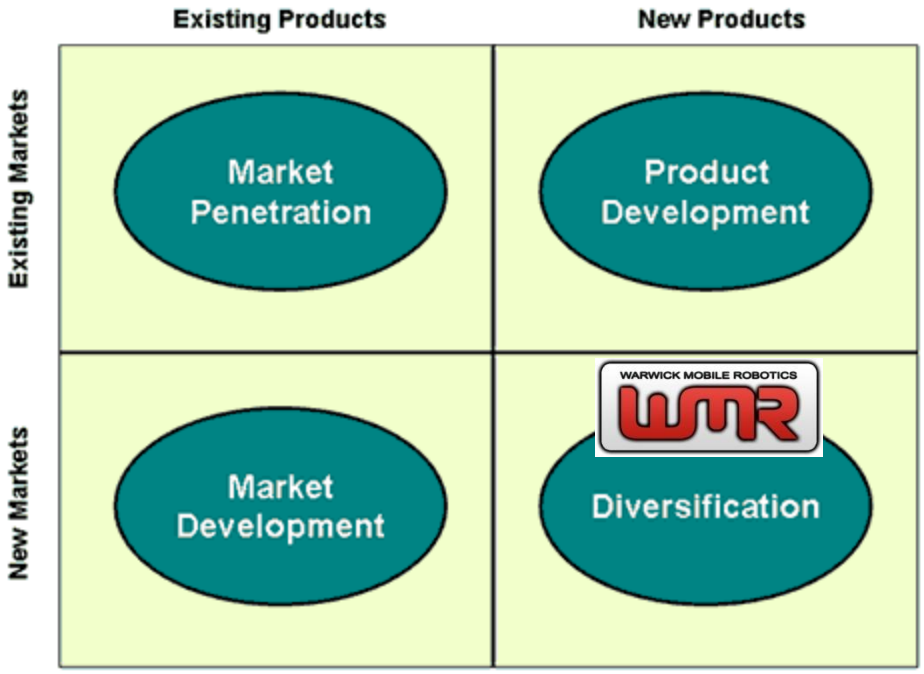

Figure 2-1: Ansoff's matrix (2)

WMR has been involved with robotics research for 13 years, initially developing autonomous robot football teams, and thus already possesses many key competencies necessary for developing robots. These competencies exist in the form of the experience of academics, students and support staff involved in the project as well as physical capabilities such as machining tools. Additionally, WMR is primarily a research group, and thus the development of new competencies is integral to the work.

While WMR has no experience of marketing commercial robotics products, the team has significant technical expertise and understanding of the product that can be used to gain credibility with potential customers. Success within international competitions, such as RoboCup Rescue, may also be leveraged in order to gain credibility.

2.3.2 Marketing Mix

The marketing mix describes the basic components of any marketing plan, the 4 P's: product, price, promotion and place. As part of planning successful commercial operations, an analysis must be conducted of these factors in relation to the activities of WMR.

Product – The product must have the requisite capabilities for the application, categories of capabilities include: mobility, sensory, automation, mapping, power and safety (see the Systems Design Report Section 2 for a full capability analysis). Customisation of the base product must be possible in to deliver products customised to particular customers and applications.

Price – Since no direct competition exists it is difficult determine the market price for our product. Pricing may be accomplished by simply adding a mark-up to costs. Section 4.5 gives a costing for the project – these must be separated into fixed and variable costs to be useful in costing.

Promotion – Since unit volumes are likely to be small and unit costs high, narrowcast (as opposed to broadcast) advertising should be used. This enables detailed understanding of customer needs and appropriate product customisation, additionally this method allows for the building of strong customer relations – necessary for long term success. Demonstrations represent a powerful promotional channel. Competitions such as RoboCup Rescue and the Sellafield Mobile Robotics Open Day generate credibility by demonstration and objective evaluation of product capabilities.

Place – Unit volumes and cost again dictate a personal approach to sales. Distribution channels will be direct to the consumer.

2.3.3 Customers

Two main groups of customers exist for USAR robotics products; these are governments and NGOs (non-governmental organisations).

2.3.3.1 Non-Governmental Organisations

RAPID UK (3) is part of the International Search and Rescue Group (UK-ISARG) which is the official international search and rescue response from the UK. This organisation is an ideal customer for WMR given the nature of their work. Currently RAPID does not use robotic aids but does use some technological aids, including highly sensitive microphones used to detect both sound and vibrations, from tapping for example, emitted by tapped victims. Such devices are deemed superior to heat sensing techniques.

Since RAPID are a charity they may have a limited budget and are likely to require cost - benefit justification in order to justify the spend. Such justification could come in the form of proven performance in representative environments.

2.3.3.2 Governments

In the UK, response to international disasters is coordinated by the Department for International Development (DfID); this body may represent another potential customer. The UK government is unlikely to require robots for domestic use due to the limited frequency and severity of disasters requiring USAR.

Selling to governmental bodies would require a justification of taxpayer expense; this will be difficult given the current record budget deficit of £175 billion (4).

2.3.4 Intellectual Property Rights

Intellectual Property (IP) are legal property rights granting exclusive rights to the creators of artistic or commercial output. Copyright law covers artistic creations such as music, books and paintings, while industrial or commercial IP is covered by patents, trademarks and industrial design rights.

The software written for the project is automatically covered by copyright as the right "arises whenever an individual or company creates a work… [that is] original, and exhibits a degree of labour, skill or judgement" (5). Since the work was created as part of studies at the University of Warwick, the university is the copyright holder. The copyright lasts 70 years from the end of the calendar year in which the last remaining author of the work dies. While patents prevent unauthorised use, "fair dealing" permits use of the software for private, academic or educational purposes (5).

Patents are granted to inventors of products in order to provide a competitive advantage. In order to be granted a patent an idea must be new, non-obvious and useful. It is unlikely that a patent would be granted for the robot developed by WMR due to its similarity to other robots developed for similar purposes. This would not present a major obstacle to commercialisation of the project since significant value would be realised through team expertise and credibility as well as the ability to customise the product to particular applications.

2.3.5 Future Developments

This project offers many avenues for future development. The most obvious is continued focus on the RoboCup Rescue competition – the overall aim being victory in the world finals.

In order to achieve TRL 7, the robot must be tested in an operational environment – such an environment is provided by the NIST Reality Arena (6). This facility allows for the testing of USAR robots in "real-life" environments that may be dusty, wet and contain collapsed debris. As with the RoboCup Rescue competition the objective is to locate simulated victims. Success in such an exercise may be necessary in securing sales of a commercial robot.

Other applications exist for mobile robotics systems of the sort developed by WMR, for example rail companies have signalled interest in using robots for line checking applications. Developing robots for alternative applications represents another possible development.

Future developments of WMR as a research venture are likely to continue to be financed through university research bodies such as WMG and engineering companies interested in exposure to Warwick engineering graduates. Any commercial development of robotics products may require Venture Capital (VC) funding; this is available through Warwick Ventures (7).

3. Publicity

3.1 Introduction

Three of the aims for this project pertain to publicity, specifically:

- Raise the profile of WMR and sponsors through continually developing marketing strategy
- Increase awareness of Engineering both at the University of Warwick and as a profession
- Showcase Warwick innovation to the world

Significant funding was required, as described in section 4, and thus sponsorship capital was crucial to the success of the project. Publicity was used to attract, and maintain positive relationships with, partner organisations. Large amounts of sponsorship capital were obtained through university research bodies. WMR therefore represented the University of Warwick at many events and demonstrations aimed at increasing the profile of engineering.

National and international competition was used as a platform to demonstrate the innovative research conducted at WMR, as well as at the University of Warwick generally.

3.2 Promotional Activities

A press release, including professionally taken photographs, was organised at the outset of the project to raise the profile of WMR. This generated national press coverage in print media including Professional Engineer, the Coventry Telegraph and the Surrey Advertiser, as well as radio including Eagle Radio, Mercia FM and Smooth FM. Such mainstream media exposure was instrumental in securing £1000 of sponsorship from Surrey firm WIS.

In order to showcase Engineering at Warwick, WMR demonstrated their work to a diverse range of audiences. Such demonstrations have included events organised by WMG Centres of Excellence as well as a presentation to the directors of ITCM. These demonstrations have contributed to the positive image of Engineering at Warwick, as well as helping to generate a £2000 annual sponsorship deal with ITCM.

Presenting the robot at the Imagineering Fair provided a chance to engage a younger generation in engineering. Additionally, the team demonstrated at an event organised by WMG Centres of Excellence, aimed at highlighting engineering excellence to a group of Young Apprentices on the Midlands Group Training Service (MGTS) scheme.

WMR were invited to demonstrate at the Sellafield Remote Technology Open Day – an event aimed at bringing together academic and professional groups involved in the development of robotics systems. Demonstrating at this event provided an opportunity to strengthen relations with existing partners Remotec as well as develop new links with Sellafield Sites. Sellafield Sites are interested in sponsoring the development of mobile robotic systems for nuclear decommissioning applications.

The team have presented their work to a variety of audiences in order to raise the profile of the group's research. Notable presentation venues include the Forum of Mobile and Autonomous Robots at the Hannover Messe and the DEC Consultation event in Southend[1]. Project progress was communicated to stakeholders through monthly newsletters; these are given in Appendix D.

Promotional banners and polo shirts containing sponsor logos were used at promotional events to communicate the WMR brand as well as those of project sponsors. In addition WMR and sponsor logos were laser etched onto the robot to further communicate brands.

3.3 Conclusion

The promotional activities have been very successful in achieving the aims stated in section 3.1. A wide range of promotional activities as well as a strong brand image have contributed to raising the profile of WMR. Evidence of this is the widespread national press coverage generated through the project.

A demonstration at the Imagineering Fair as well as articles in non-engineering publications have helped to raise the profile of engineering at the University of Warwick. Competing successfully at the RoboCup rescue competition has provided an international platform from which the team have generated positive publicity for WMR, project sponsors and the University of Warwick.

[1] For more information please contact Stephen Hetherington through WMR

4. Finance

4.1 Introduction

The financial function covers sponsorship, budgeting and financial record keeping. In order to achieve the project aims significant capital inflow was required. This was to be achieved through sponsorship of the project by university research and development bodies and external partners both existing and new.

4.2 Sponsorship

An initial budget, given in Appendix B Table 7-1, was drawn up to guide the sponsorship efforts. A promotional campaign, as described in Section 3.2, was launched to generate sponsorship interest.

Sponsorship deals for £4,700 and £4,500 were secured with WMG and WIMRC respectively. The financing provided by WIMRC was to be used exclusively for publicity activities. WIMRC also pledged to cover the cost of team polo shirts. New sponsorship deals were secured through a highly successful promotional campaign with ITCM and WIS for £2,000 and £1,000 respectively. ITCM have pledged an ongoing contribution of £2,000 per year; providing subsequent project teams with a financial starting point.

Further funding of £3,000 was provided by Sellafield Sites for participation in the Sellafield Remote Technology Open Day. This funding was provided for travel, accommodation and other purchases relating to our demonstration. These costs were budgeted for along with the income, as shown in Appendix B Table 7-2.

Additional funding was provided by the School of Engineering and from the surplus left from the 2008 project. This brings the total capital inflow for the project to £18,036.64 as shown in Appendix C Table 8-2.

4.3 Budgeting

Throughout the project, a budget was maintained to provide financial control and to inform technical decisions. For every purchase many options exist; the budget was used to quantify the impact of selecting more or less expensive products.

A capability and requirements analysis (see Systems Design Report Sections 2.1 – 2.3) was conducted to ascertain the developments and improvements necessary to satisfy the project aims and objectives. These requirements were used to generate an initial budget; for example it was required that the robot be tested on competition standard terrain, therefore £300 was budgeted for wood to be used in the construction of such terrain. This budget, given in Appendix B Table 7-1 was used to guide sponsorship efforts; helping to decide the amounts to ask for as well as helping to communicate and justify our financial requirements.

Flexible budgeting was employed, utilising minimum and maximum costs for items. This was useful at the start of the project, before sponsorship deals were completed. As project financing became clearer, more accurate budgeting was possible. Appendix B Table 7-2 shows the project budget as of 28/01/09, the table shows the total budget at this date was £15,299.50. Total budget was maintained at a level roughly 10% below secured project funds to ensure on budget delivery even in the event of unexpected circumstances.

4.4 Financial Record Keeping

Due to the large budget of the project financial record keeping was crucial to allocating financial resources and avoiding overspend. A record of all capital inflows and outflows for the project was maintained on an ongoing basis. This record allows for timely assessment of account funds, thus helping prevent overspend, as well as providing a record of equipment purchases for subsequent WMR project teams. Appendix C Table 8-1 gives the final project expenses while Appendix C Table 8-2 gives the final project capital inflows.

4.4.1 Multiple Account Management

Numerous accounts were used by the team due to the numerous internal project sponsors, Appendix C Table 8-3 summarises these accounts. The account to which purchases were charged was recorded along with the purchase in the expense records. This allowed for management of multiple accounts, helping to prevent overspend from any account.

4.5 Project Costing

In an industrial setting the cost of the project is determined by equipment purchases, expenses and labour. Estimation of labour as well as expense records allow for costing of the WMR 2009 project. Labour inputs to the project include team members as well as academic consultants and manufacturing time. Unit costs were taken from the ES327 Project Handbook (8). Production costs were generated using the fees charged by WMG to external customers for machining services. Table 4-1 summarises the project costing.

Table 4-1: Project costing

Expense	Cost per Unit	Number of Units	Total Cost
Equipment, Parts and Consumables			
Rescue robot equipment, parts and consumables			£5,630.51
Other equipment, parts and consumables			£1,573.50
Robocup Rescue Competition Costs			£5,960.18
Man-hours			
Time worked by Alexander Bunn	£15/hour	350	£5,250.00
Time worked by Julian Faulkner	£15/hour	350	£5,250.00
Time worked by Timothy Fletcher	£15/hour	350	£5,250.00
Time worked by Matthew Rooke	£15/hour	350	£5,250.00
Time worked by Oliver Vogel	£15/hour	350	£5,250.00
Time worked by James Williams	£15/hour	350	£5,250.00
Time worked by Rueben Williams	£15/hour	350	£5,250.00
Time worked by Stefan Winkvist	£15/hour	350	£5,250.00
Consultation with Dr. Peter Jones	£50/hour	40	£2,000.00

Consultation with Prof. Ken Young	£50/hour	40	£2,000.00
Consultation with Mr. Michael Tandy	£50/hour	50	£2,500.00
Consultation with Mr. Sadiq Jaffer	£50/hour	25	£1,250.00
Consultation with Mr. Redland Sanders	£50/hour	30	£1,500.00
Consultation with Mr. Adam Land	£20/hour	160	£3,200.00
Consultation with Mr. Ian Griffith	£20/hour	2	£40.00
Consultation with Mr. Jonathan Meadows	£20/hour	1	£20.00
Production Costs			
Machining undertaken by Mr. Adam Land	£140/hour	160	£22,400.00
Laser cutting undertaken by Mr. Neil Timms	£140/hour	35	£4,900.00
PCB population undertaken by Mr. Ian Griffith	£40/hour	3	£120.00
		Total Project Cost	**£67,794.19**

Some costs have not been included in this exercise including laboratory space and equipment and overhead costs such as time spend by WMG financial staff. The laboratory space and equipment was inherited from, and accounted for within, previous projects and was therefore deemed not necessary for inclusion within project costs. Overhead costs should be included for completeness however allocation of WMG group costs to WMR activities was deemed impractical.

4.6 Conclusion

Project budgets and actual spend are summarised in Table 4-3. Mechanical spend was £697.21, or 26%, over budget; this was due primarily to higher than expected materials cost from the chassis redesign.

Electronic spend was £726.70, or 25% under budget. This was due to component integration taking longer than forecast, thus reducing the number of electronic components, such as sensors, purchased.

Miscellaneous expenditure was £894.18, or 13% over budget, this was due to not budgeting for team polo shirts as well as exchange rate fluctuations adversely affecting competition expenses denominated in Euros.

Overall project expenditure was £864.69, or 7%, over budget. This figure satisfactorily low – within the margin of safety built into the budget. This agreement between budget and spend is the result of the budgeting techniques described in Section 4.3 and the financial record keeping described in section 4.4.

Table 4-2: Comparison of budget and actual spend

Category	Initial Estimate	Refined Estimate	Actual Spend
Mechanical	£3,120.00	£2,700.00	£3,397.21
Electronic	£4,260.00	£2,960.00	£2,233.30
Miscellaneous[2]	£7,200.00	£6,639.50	£7,533.68
Total	£14,580.00	£12,299.50	£13,164.19

Further project progress is likely to occur outside of the ES410 Project, specifically entrance into the RoboCup Rescue World Final. The account balances given in Appendix C Table 8-3 are thus likely to change before the start of the 2009/10 academic year due to competition expenses.

[2] Figures do not include budgeted or actual spend on RoboCup Rescue world finals to allow fair comparison between figures

5. Management

5.1 Introduction

Managing a project of this scale requires detailed planning as well as effective team communication. This section describes the tools and techniques used for planning as well as the team organisation and structure.

5.2 Project Planning

To ensure the successful achievement of the project goals a detailed project plan was created in the form of a Gantt chart, a screenshot of which is given in Figure 5-1.

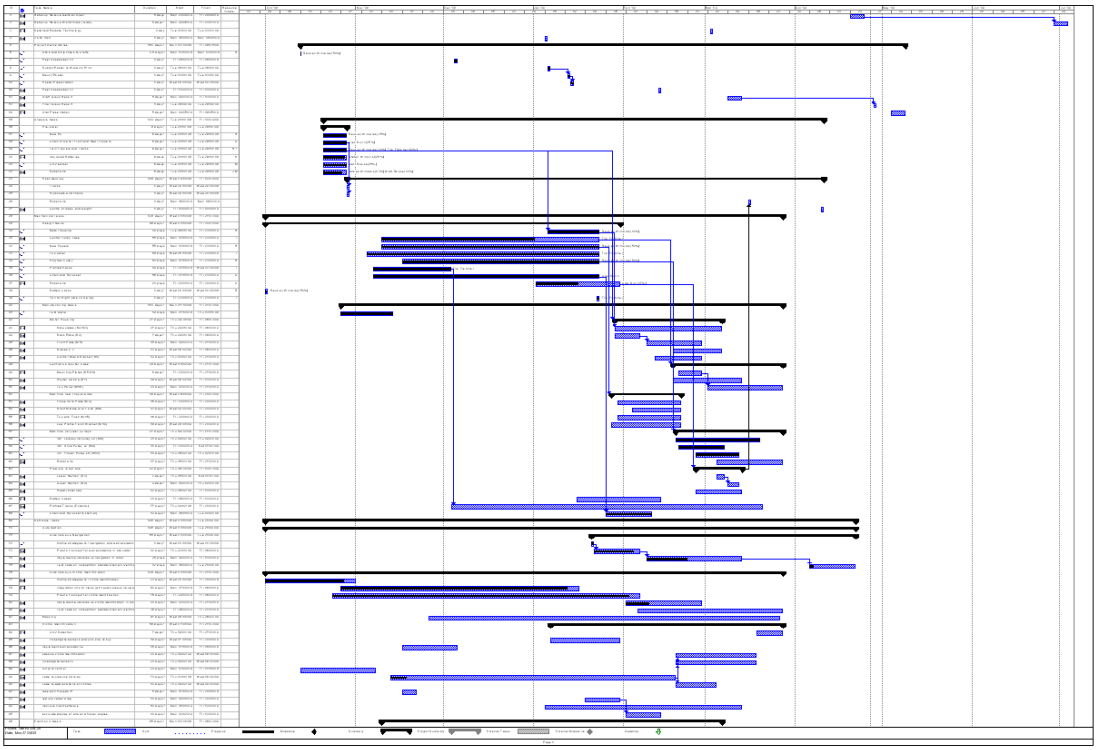

Figure 5-1: Screenshot of MS Project plan

An initial project plan was created from the major project deadlines and milestones such as presentation and competition dates. As subsystem design progressed, design deliverables were added to the plan. Working backward from these deliverables, individual tasks were added to split up large tasks.

Each task in the plan is described by certain activity fields; these are described in Table 5-1. The duration and resource name fields allow for planning work schedules and effective allocation of resources whilst the task status field allows for detailed monitoring of project progress.

The project plan was used to schedule non-design activities such as the promotional schedule. Adding these activities to the plan allows for more integrated planning, for example organising design and build work to ensure an operational robot before promotional demonstrations or presentations.

Viewing all tasks, relative deadlines and criticality allows for the easy identification of risks such as activities extending past their deadline. Where these activities preceded critical activities more time could be allocated to mitigate the risk.

Table 5-2: Activity fields

Activity Field	Description
Task Identity	Name or description of identified activity
Task Number	The task's identification code
Duration	The estimated time required for completion, with start and finish dates
Resource Name	The individual(s) responsible for the task
Percentage Complete	An estimate of the progress achieved to date on that task
Predecessor	A list of linked tasks that require completion before the activity can be completed
Criticality	The team's assessment how important the task was towards achieving various deadlines/objectives
Task Status	An indicator of the current condition of the activity ranging from Blue (completed), Green (on schedule), Yellow (under risk) and Red (Late)

5.2.1 Meetings

Meetings were held throughout the project to facilitate communication within the team as well as between the team and the project supervisors. Two types of meetings were held, both on a weekly basis.

Team meetings provided a forum for communication between all team members. This enabled teams working on different subsystems or capabilities to communicate, thus agreements could be made on subsystem interfaces and integration. Additionally, meetings allowed all team members, from various disciplines, to discuss design issues thus ensuing a range of perspectives in the decision making process.

Director meetings were used to allow the team to benefit from the expertise of the project directors, as well as to communicate project progress and issues to the directors.

Agendas were set for all meetings and minutes were taken by the project secretary in order to record all discussions and decisions. Responsibility for all tasks was allocated during the meetings and progress checked at the following meeting.

5.2.2 Online Tools

A Google Groups account was created for the team to aid electronic communication, for example of documents, between team members. A central document repository was maintained on the site allowing up to date and remote exchange of project files. Additionally a calendar was maintained on the site to aid human resource allocation.

5.3 Team Organisation

5.3.1 Team Hierarchy and Positions

An organisational structure was created to clarify individual team member's roles and responsibilities within the team. This structure was not used rigidly however, and functional working groups typically formed around particular subsystems or the delivery of a particular capability; see Section 5.3.3 for a full description of the systems approach used for resource management.

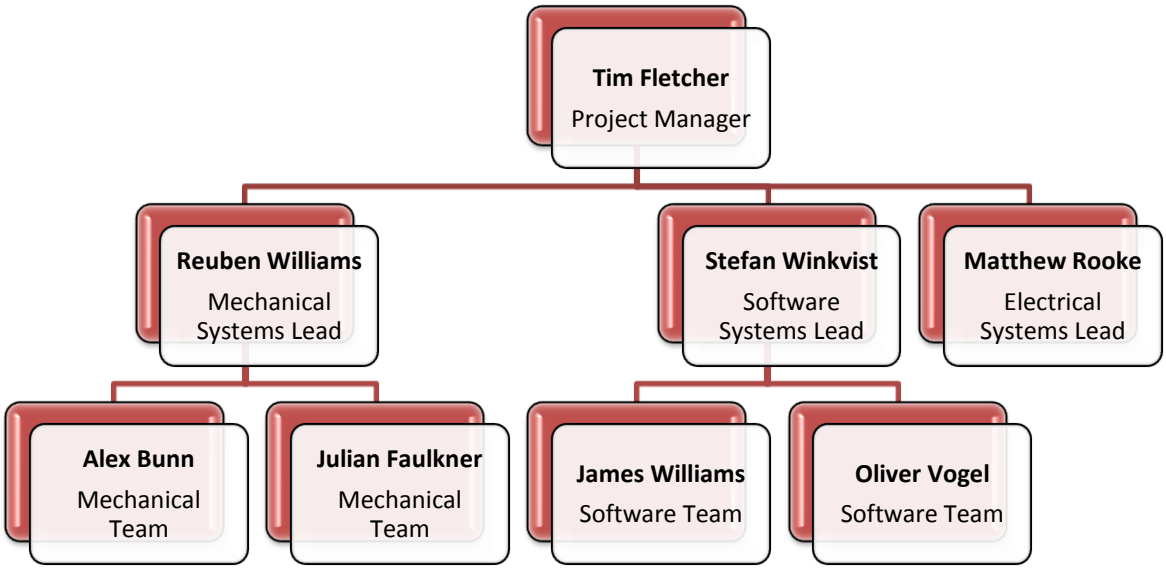

Figure 5-3: Organisational structure of the team

5.3.2 Team Members

Each team member was assigned work according to their individual speciality, competencies and preferences. Team members would be ultimately responsible for all assigned work required from each role and held accountable. The team also took the Belbin Team Role Inventory assessment in order to aid work assignments and hierarchal positions by ascertaining their individual behavioural types.

Alexander Bunn - Mechanical Engineer
Health and Saftey Officer and Mechanical Team
Belbin Role: Plant/Team Worker

Julian Faulkner - Manufacturing Engineer
Financial Officer and Mechanical Team
Belbin Role: Plant/Team Worker

Timothy Fletcher - Mechanical Engineer
Project Manager and Mechanical Team
Belbin Role: Completer/Finisher

Matthew Rooke - Electronic Engineer
Webiste, Publicity and Electrical Lead
Belbin Role: Shaper

Oliver Vogel - Electronic Engineer
Sposorship, Publicity and Software Team
Belbin Role: Resource Investigator

James Williams - Systems Engineer
Competition Manager, Software Team and Systems Integrator
Belbin Role: Monitor Evaluator

Reuben Williams - Manufacturing Engineer
Secretary and Mechanical Lead
Belbin Role: Implementer

Stefan Winkvist - Electronic Engineer
Software Lead
Belbin Role: Specialist

Figure 5-4: Team roles

5.3.3 Systems Approach to Resource Management

Human resources were allocated in a manner in keeping with the systems approach applied to design work (see the Systems Design Report Section 1.4). Functional working groups were formed around the delivery of a particular capability or subsystem. These teams changed during the course of the project and crossed disciplinary borders.

Examples of teams included a team consisting of a mechanical and a systems engineer focused on delivering the central section of the robot (see Systems Design Report Section 4.5). This approach has led to "capability owners" – individuals or teams tasked with delivering a particular capability.

5.3.4 Project Directors

The Warwick Mobile Robotics project is supervised by Prof. Ken Young and Dr. Peter Jones. Their roles are to monitor progress, moderate peer assessment and provide ongoing advice and guidance using their relevant expertise. The two project directors also control the project accounts and therefore must approve all purchases on their cost codes.

5.3.5 External Consultants

Using consultants external to the project provided expertise and insight into specific areas of the project. A list of external project consultants used is given below with areas of their input and expertise.

Table 5-5 External consultants

Consultant	Area of knowledge
Adam Land	Knowledge of manufacturing processes and design for manufacture
Neil Timms	Laser cutting
Ian Grifith	Design, manufacture and population of PCBs
Jonathan Meadows	Design, manufacture and population of PCBs
Michael Tandy	Electronic hardware and software
Redland Sanders	Mechanical deign as well as in depth knowledge of 2008 project
Sadiq Jaffer	Software

5.3.6 Conclusion

Detailed project planning and efficient use of team resources, such as project directors and external consultants, contributed to the overall project success.

6. Appendix A

Table 6-1: Technology Readiness Levels in the National Aeronautics and Space Administration

Technology Readiness Level	Description
1. Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Example might include paper studies of a technology's basic properties.
2. Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. The application is speculative and there is no proof or detailed analysis to support the assumption. Examples are still limited to paper studies.
3. Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that the pieces will work together. This is "low fidelity" compared to the eventual system. Examples include integration of 'ad hoc' hardware in a laboratory.
5. Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so that the technology can be tested in a simulated environment. Examples include 'high fidelity' laboratory integration of components.
6. System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond the breadboard tested for TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment or in simulated operational environment.
7. System prototype demonstration in an	Prototype near or at planned operational system. Represents a major step up from TRL 6, requiring the demonstration of an

operational environment	actual system prototype in an operational environment, such as in an aircraft, vehicle or space. Examples include testing the prototype in a test bed aircraft.
8. Actual system completed and 'flight qualified' through test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system 'flight proven' through successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. In almost all cases, this is the end of the last "bug fixing" aspects of true system development. Examples include using the system under operational mission conditions.

7. Appendix B

Table 7-1: Initial Budget

Category	Expenditure	Expected Spend
Mechanical	Polymer Chassis/Pulleys	£100.00
	Aluminium Arm	£50.00
	Flipper Arms	£50.00
	Flipper Motor	£250.00
	Tracks	£50.00
	Chain/Sprockets	£50.00
	Gripper	£50.00
	Mechanical Miscellaneous	£2,000.00
	Mechanical Subtotal:	**£2,600.00**
Electronic	Batteries	£300.00
	CO_2 Sensor	£200.00
	Microphone	£50.00
	LADAR Upgrade	£1,000.00
	Electronic Miscellaneous	£2,000.00
	Electronic Subtotal:	**£3,550.00**
Miscellaneous	Car Rental	£400.00
	Ferry	£600.00
	Fuel	£1,000.00

	Hotel Costs	£2,000.00
	Competition Entry	£1,000.00
	Office Computer	£700.00
	Wood	£300.00
	Miscellaneous Subtotal:	**£6,000.00**
	Subtotal:	£12,150.00
	20% Safety Margin:	£2,430.00
	Grand Total:	**£14,580.00**

Table 7-2: Budget as of 28/01/09

Category	Expenditure	Minimum Spend	Maximum Spend	Expected Spend
Mechanical	Flipper motor	£300.00	£700.00	£500.00
	Tracks (X 6)	£700.00	£1,400.00	£1,050.00
	Aluminium for flippers (X2)	£150.00	£250.00	£200.00
	Polymer (pulleys & case)	£250.00	£250.00	£250.00
	New transmission	£100.00	£200.00	£150.00
	Aluminium for arm	£40.00	£60.00	£50.00
	Mechanical misc	£400.00	£600.00	£500.00
	Mechanical Subtotal:			**£2,700.00**
Electronic	Batteries	£1,000.00	£1,200.00	£1,100.00

	CO2 sensors	£40.00	£50.00	£45.00
	Microphone	£0.00	£100.00	£50.00
	Webcam	£160.00	£200.00	£180.00
	PCB Manufacturing	£400.00	£520.00	£460.00
	Servo motors	£500.00	£750.00	£625.00
	Electronic Misc	£400.00	£600.00	£500.00
	Electronic Subtotal:			**£2,960.00**
Miscellaneous				
Competition Funding	Hotel	£2,000.00	£3,000.00	£2,500.00
	Ferry	£520.00	£600.00	£560.00
	Entrance	£1,000.00	£1,000.00	£1,000.00
	Petrol	£800.00	£1,200.00	£1,000.00
	Car hire	£300.00	£400.00	£350.00
	Insurance	£0.00	£0.00	£0.00
	World final funding	£0.00	£6,000.00	£3,000.00
Sellafield	Hotel	£290.00	£310.00	£300.00
	Travel	£50.00	£150.00	£100.00
Other	Wood	£350.00	£450.00	£400.00
	Victim simulation	£40.00	£60.00	£50.00
	Monitor	£129.50	£129.50	£129.50
	Printing	£200.00	£300.00	£250.00
	Miscellaneous Subtotal:			**£9,639.50**

	Grand Total:			**£15,299.50**
	Grand Total (minimum):			£10,259.50
	Grand Total (maximum):			£20,639.50

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9. Appendix C

Table 9-1: Project expenditure

Field Robot

Chassis

Description	Total Exp. (inc. VAT)	Quantity	Expendee	Date	Contractor/Supplier	Part Number/Notes	Account	Delivered?
Taperlock Bush	£8.71	1	J.Faulkner	29.10.2008	RS Online	RS 183-007	Eng	Yes
Black Acetal, 500mm x 125mm	£200.68	2	J.Faulkner	13.01.2009	RS Online	438-6279	WMG	Yes
Black Acetal, 500mm x 100mm	£64.69	1	J.Faulkner	13.01.2009	RS Online	438-6285	WMG	Yes
Black Acetal, 100mm x 125mm dia	£16.22	1	J.Faulkner	20.01.2009	Direct Plastics	Unknown	WMG	Yes
Postage	£6.84	1	J.Faulkner	20.01.2009	Direct Plastics	Postage	WMG	N/A
250 x 250 x 50mm Acetal Sheet	£51.05	1	J.Faulkner	10.02.2009	Direct Plastics	Unknown	WMG	Yes
500 x 500 x 16mm Acetal Sheet	£58.85	1	J.Faulkner	10.02.2009	Direct Plastics	Unknown	WMG	Yes
1/2" 500x500mm Aluminium Plate	£51.18	1	J.Faulkner	10.02.2009	Ravenace Metals	6082 T6	WMG	Yes
3/4" 110mm Aluminium Rod	£18.40	2	J.Faulkner	10.02.2009	Ravenace Metals	6082 T62	WMG	Yes
1/4" 220mm Aluminium Rod	£14.95	2	J.Faulkner	10.02.2009	Ravenace Metals	6082 T61	WMG	Yes

1/4" 290 mm Aluminium Rod	£15.52	2	J.Faulkner	10.02.2009	Ravenace Metals	6082 T61	WMG	Yes
Nylon 66/MoS2 sheet, 500x305x12mm	£34.33	1	J.Faulkner	18.02.2009	RS Online	257-7316	WMG	Yes
RS Online Postage	£6.84	1	J.Faulkner	18.02.2009	RS Online	Postage	WMG	N/A
S-Steel 304 0.9mm 550mmx350mm CUT	£14.38	1	J.Faulkner	27.02.2009	Ravenace Metals	Unknown	WMG	Yes
S-Steel 304 0.9mm 300mmx350mm CUT	£21.85	1	J.Faulkner	27.02.2009	Ravenace Metals	Unknown	WMG	Yes
Hard Anodising of stub shafts	£103.50	1	J.Faulkner	27.02.2009	Aluminium Surface	Unknown	WMG	Yes
S-Steel 304 0.7mm 2500mm x 250mm	£81.65	1	J.Faulkner	18.03.2009	Ravenace Metals	28056	IMRC	Yes
S-Steel 304 0.9mm 2500mm x 2500mm	£89.70	1	J.Faulkner	18.03.2009	Ravenace Metals	28056	IMRC	Yes
M5 x 12mm A2 Stainless Steel	£14.52	1	J.Faulkner	31.03.2009	RS Components	281079	WMG	Yes
28mm bore S/Steel 2 piece collar	£15.49	1	J.Faulkner	31.03.2009	RS Components	3639421	WMG	Yes
M3 x 8mm Blk Steel socket head screw	£8.03	1	J.Faulkner	31.03.2009	RS Components	281186	WMG	Yes
M4 x 8mm A4 S/Steel button head	£7.19	1	J.Faulkner	31.03.2009	RS Components	2328170	WMG	Yes
M4 x 12mm A2 S/Steel Hex socket	£10.01	1	J.Faulkner	31.03.2009	RS Components	171821	WMG	Yes
RS Components Postage	£4.02	1	J.Faulkner	31.03.2009	RS Components	Postage	WMG	N/A
Al plate 1/2inch x 240mm x 180mm	£17.08	1	J.Faulkner	01.04.2009	Ravenace Metals	28056	WMG	Yes
Al plate 1/2inch x 240mm x 120mm	£15.35	1	J.Faulkner	01.04.2009	Ravenace Metals	28056	WMG	Yes
M4 x 4mm Grub screw 50pk	£2.46	1	J.Faulkner	02.04.2009	Farnell ONECALL	FN00230	WMG	Yes
M4 x 6mm Button head 100pk	£11.51	1	J.Faulkner	02.04.2009	Farnell ONECALL	1420686	WMG	Yes

M6 x 16mm Socket cap 100pk	£7.19	1	J.Faulkner	02.04.2009	Farnell ONECALL	1419686	WMG	Yes
M4 x 4mm CSK head 100pk	£6.65	1	J.Faulkner	02.04.2009	Farnell ONECALL	1420614	WMG	Yes
M5 x 8mm Button head 100pk	£11.60	1	J.Faulkner	02.04.2009	Farnell ONECALL	1420693	WMG	Yes
M5 washers 100pk	£0.68	1	J.Faulkner	02.04.2009	Farnell ONECALL	1623992	WMG	Yes
M5 Spring washers 100pk	£0.67	1	J.Faulkner	02.04.2009	Farnell ONECALL	1624028	WMG	Yes
M2.5 x 12mm Bolts Zinc 100pk	£1.29	1	J.Faulkner	02.04.2009	Farnell ONECALL	1419783	WMG	Yes
M2.5 x 20mm Bolts Zinc 100pk	£1.40	1	J.Faulkner	02.04.2009	Farnell ONECALL	8857939	WMG	Yes
Aluminium Plate 1/2" 280x380mm	£51.18	1	J.Faulkner	04.04.2009	Ravenace Metals	6082 T6	WMG	Yes
M2.5 x 6mm cap head zinc plated	£15.08	1	J.Faulkner	08.04.2009	RS Online	4838124	WMG	Yes
M2.5 x 12mm cap head zinc plated	£15.66	1	J.Faulkner	08.04.2009	RS Online	4838130	WMG	Yes
Subtotal:	£1,076.40							

Mechanics

Description	Total Exp. (inc. VAT)	Quantity	Expendee	Date	Contractor/Supplier	Part Number/Notes	Account	Delivered?
Motor RE35	£185.77	1	J.Faulkner	28.11.2008	Maxon Motors	273754	Eng	Yes
Gearbox GP52C	£252.98	1	J.Faulkner	28.11.2008	Maxon Motors	223111	Eng	Yes
Encoder HEDL	£72.38	1	J.Faulkner	28.11.2008	Maxon Motors	110514	Eng	Yes
Postage	£20.56	1	J.Faulkner	28.11.2008	Maxon Motors	Postage	Eng	N/A

Chain 2 lengths 24 links		£24.89	2	J.Faulkner	14.01.2009	HPC Gears	SBR-500	WMG	Yes
Chain links		£3.98	2	J.Faulkner	14.01.2009	HPC Gears	SBR-500/L	WMG	Yes
Sproket-bossed,18mmbore		£95.13	4	J.Faulkner	14.01.2009	HPC Gears	S50-12-S1801	WMG	Yes
Postage		£19.49	1	J.Faulkner	14.01.2009	HPC Gears	Postage	WMG	N/A
New Flipper Belts		£467.36	4	J.Faulkner	07.01.2009	Transdev	75TK10K13C/1410V	WMG	Yes
New Flipper Belts		£552.96	4	J.Faulkner	07.01.2009	Transdev	50TK10K13C/870V	WMG	Yes
Transdev Postage		£11.51	1	J.Faulkner	07.01.2009	Transdev	Postage	WMG	N/A
Dynamixel RX-64 Servo		£606.66	3	J.Faulkner	16.02.2009	Robosavvy	Unknown	WMG	Yes
Robosavvy Postage		£7.14	1	J.Faulkner	16.02.2009	Robosavvy	Postage	WMG	N/A
	Subtotal:	£2,320.81							

Batteries and Power

Description	Total Exp. (inc. VAT)	Quantity	Expendee	Date	Contractor/Supplier	Part Number/Notes	Account	Delivered?
Evolite 5350mAf 6s 22.2v	£164.07	1	J.Faulkner	28.11.2008	Heliguy	53506S	Eng	Yes
Heliguy postage	£6.40	1	J.Faulkner	28.11.2008	Heliguy	Postage	Eng	N/A
LiPo battery bags	£23.95	1	J.Faulkner	14.01.2009	Hyperflight	LS2	WMG	Yes
Equalizer Adapter	£3.08	1	J.Faulkner	15.01.2009	Midland Helicopters	RB8215	WMG	Yes
LiPo equalizer 12S	£58.72	1	J.Faulkner	15.01.2009	Midland Helicopters	RB8484	WMG	Yes

Midland Helicopters Postage		£5.38	1	J.Faulkner	15.01.2009	Midland Helicopters	Postage	WMG	N/A
Evolite 5350mAf 6s 22.2v		£449.19	3	J.Faulkner	17.02.2009	Midland Helicopters	53506S	IMRC	Yes
Midland Helicopters Postage		£6.37	1	J.Faulkner	17.02.2009	Midland Helicopters	Postage	IMRC	N/A
DC DC converter 15V		£44.39	1	J.Faulkner	18.02.2009	RS Online	445-028	WMG	Yes
CONVERTER, DC/DC, 30W, 12V/2.5A		£32.84	1	J.Faulkner	18.02.2009	Farnell ONECALL	1007467	WMG	Yes
CONVERTER, DC/DC, 30W, 5.1V/5A		£32.84	1	J.Faulkner	18.02.2009	Farnell ONECALL	1007466	WMG	Yes
Adjustable 1.25 - 18V DC-DC converter		£5.43	1	J.Faulkner	18.02.2009	Farnell ONECALL	9725377	WMG	Yes
Equalizer Adapter		£3.91	1	J.Faulkner	07.04.2009	Model Shop Leeds	1672537	WMG	Yes
Pro-Peak power supply		£39.99	1	J.Faulkner	07.04.2009	Model Shop Leeds	OI-0120	WMG	Yes
Model Shop Leeds Postage		£9.99	1	J.Faulkner	07.04.2009	Model Shop Leeds	Postage	WMG	Yes
	Subtotal:	£886.55							

Sensors

Description	**Total Exp. (inc. VAT)**	**Quantity**	**Expendee**	**Date**	**Contractor/Supplier**	**Part Number/Notes**	**Account**	**Delivered?**
Carbon Dioxide Sensor	£25.89	1	J.Faulkner	29.01.2009	Make My Hobby	AA-26504	WMG	
Postage	£10.58	1	J.Faulkner	29.01.2009	Make My Hobby	Postage	WMG	N/A
Import Tax	not known		J.Faulkner	29.01.2009	Make My Hobby		WMG	N/A
AXIS Network Camera	£201.25	1	J.Faulkner	04.02.2009	Control Z Computers	0199-033	WMG	Yes

Subtotal:	£237.72	

Communications

Description	Total Exp. (inc. VAT)	Quantity	Expendee	Date	Contractor/Supplier	Part Number/Notes	Account	Delivered?
Wireless Adapter	£31.83	1	J.Faulkner	28.11.2008	Amazon	DWL-AG132	Eng	Yes
Amazon Postage	£5.87	1	J.Faulkner	28.11.2008	Amazon	Postage	Eng	N/A
Subtotal:	£37.70							

Additional Electronics

Description	Total Exp. (inc. VAT)	Quantity	Expendee	Date	Contractor/Supplier	Part Number/Notes	Account	Delivered?
Miscellaneous electronics	£2.05	1	M.Rooke	14.11.2008	Farnell ONECALL	Unkown	Eng	Yes
Miscellaneous electronics	£3.12	1	M.Rooke	14.11.2008	Farnell ONECALL	Unkown	Eng	Yes
Miscellaneous electronics	£1.81	1	M.Rooke	14.11.2008	Farnell ONECALL	Unkown	Eng	Yes
Header pin	£0.27	1	M.Rooke	08.12.2008	electronic stores	Unkown	Eng	Yes
75amp powerpole contact 6mm	£13.36	8	J.Faulkner	22.01.2009	Torberry Connectors	5915x2	WMG	Yes
75amp powerpole housing black	£10.48	4	J.Faulkner	22.01.2009	Torberry Connectors	TH-060-BLACK	WMG	Yes
75amp powerpole housing red	£10.48	4	J.Faulkner	22.01.2009	Torberry Connectors	TH-060-RED	WMG	Yes
Postage	£5.17	1	J.Faulkner	22.01.2009	Torberry Connectors	postage	WMG	N/A

Gender changer D Plug 37way	£1.79	1	J.Faulkner	22.01.2009	Farnell ONECALL	4009708	WMG	Yes
USB adaptor A to B	£2.00	1	J.Faulkner	22.01.2009	Farnell ONECALL	CS12016	WMG	Yes
Gender changer male-male 15way	£4.55	2	J.Faulkner	22.01.2009	Farnell ONECALL	1427692	WMG	Yes
Gender changer D 2 Plug 25way	£10.80	2	J.Faulkner	22.01.2009	Farnell ONECALL	1525742	WMG	Yes
Capacitor - 4.7uF	£4.61	5	J.Faulkner	18.02.2009	Farnell ONECALL	1358551	WMG	Yes
Polarized Capacitor - 10uF	£2.90	2	J.Faulkner	18.02.2009	Farnell ONECALL	1562105	WMG	Yes
Capacitor - 220uF	£1.46	10	J.Faulkner	18.02.2009	Farnell ONECALL	9451293	WMG	Yes
Capacitor - 33nF	£0.66	10	J.Faulkner	18.02.2009	Farnell ONECALL	3606170	WMG	Yes
Capacitor - 470nF	£13.11	10	J.Faulkner	18.02.2009	Farnell ONECALL	1657965	WMG	Yes
Capacitor - 100nF	£3.96	5	J.Faulkner	18.02.2009	Farnell ONECALL	1657962	WMG	Yes
Capacitor - 1000uF	£2.42	2	J.Faulkner	18.02.2009	Farnell ONECALL	8126666	WMG	Yes
Capacitor - 100nF	£2.94	15	J.Faulkner	18.02.2009	Farnell ONECALL	1301719	WMG	Yes
3 way 5.08 pitch terminal	£1.49	2	J.Faulkner	18.02.2009	Farnell ONECALL	3041177	WMG	Yes
Dual 12A Diode	£2.30	2	J.Faulkner	18.02.2009	Farnell ONECALL	1440110	WMG	Yes
Schottky Rectifier	£3.24	2	J.Faulkner	18.02.2009	Farnell ONECALL	1463221	WMG	Yes
Diode 1N4001	£0.22	5	J.Faulkner	18.02.2009	Farnell ONECALL	1651089	WMG	Yes
Low current SMT LED - 1.8V, 2mA	£6.54	20	J.Faulkner	18.02.2009	Farnell ONECALL	1685056	WMG	Yes
20mm Fuseholder + Fuse - 1A	£6.49	6	J.Faulkner	18.02.2009	Farnell ONECALL	FF01910	WMG	Yes

20mm Fuseholder + Fuse - 2A	£4.32	4	J.Faulkner	18.02.2009	Farnell ONECALL	FF01911	WMG	Yes
20mm Fuseholder + Fuse - 3A	£2.16	2	J.Faulkner	18.02.2009	Farnell ONECALL	FF01912	WMG	Yes
20mm Fuseholder + Fuse - 5A	£7.57	7	J.Faulkner	18.02.2009	Farnell ONECALL	FF01913	WMG	Yes
Spare Fuse - 1A	£3.16	10	J.Faulkner	18.02.2009	Farnell ONECALL	9922164	WMG	Yes
Spare Fuse - 2A	£3.16	10	J.Faulkner	18.02.2009	Farnell ONECALL	9922172	WMG	Yes
Spare Fuse - 3A	£3.16	10	J.Faulkner	18.02.2009	Farnell ONECALL	9922180	WMG	Yes
Spare Fuse - 5A	£3.16	10	J.Faulkner	18.02.2009	Farnell ONECALL	9922199	WMG	Yes
Inductor - 4.5uH	£6.92	2	J.Faulkner	18.02.2009	Farnell ONECALL	1636223	WMG	Yes
Orange Connectors - Socket	£6.30	25	J.Faulkner	18.02.2009	Farnell ONECALL	1121827	WMG	Yes
Orange Connectors - Plug	£18.12	25	J.Faulkner	18.02.2009	Farnell ONECALL	1121766	WMG	Yes
Header, 10 Pin	£3.22	3	J.Faulkner	18.02.2009	Farnell ONECALL	1298785	WMG	Yes
MOSFET P	£1.64	2	J.Faulkner	18.02.2009	Farnell ONECALL	1611455	WMG	Yes
MOSFET N throttle	£1.58	20	J.Faulkner	18.02.2009	Farnell ONECALL	1299312	WMG	Yes
MOSFET P throttle	£19.62	18	J.Faulkner	18.02.2009	Farnell ONECALL	1463252	WMG	Yes
Resistor - 10KΩ	£2.70	50	J.Faulkner	18.02.2009	Farnell ONECALL	1653282	WMG	Yes
Resistor - 2.7KΩ	£0.60	50	J.Faulkner	18.02.2009	Farnell ONECALL	911902	WMG	Yes
Resistor - 20mΩ	£1.82	5	J.Faulkner	18.02.2009	Farnell ONECALL	1099909	WMG	Yes
Resistor - 130KΩ	£2.05	5	J.Faulkner	18.02.2009	Farnell ONECALL	1670255	WMG	Yes

Resistor - 12KΩ	£1.05	50	J.Faulkner	18.02.2009	Farnell ONECALL	1469865	WMG	Yes
Resistor - 9.1KΩ	£0.27	5	J.Faulkner	18.02.2009	Farnell ONECALL	1653046	WMG	Yes
Resistor - 3.3KΩ	£1.00	50	J.Faulkner	18.02.2009	Farnell ONECALL	1469911	WMG	Yes
Resistor - 6.8KΩ	£1.00	50	J.Faulkner	18.02.2009	Farnell ONECALL	1469949	WMG	Yes
Resistor - 5.4KΩ	£0.27	5	J.Faulkner	18.02.2009	Farnell ONECALL	1653022	WMG	Yes
Resistor - 1.8KΩ	£0.53	10	J.Faulkner	18.02.2009	Farnell ONECALL	1652943	WMG	Yes
Resistor - 5.6KΩ	£1.05	50	J.Faulkner	18.02.2009	Farnell ONECALL	1469941	WMG	Yes
Resistor - 4.7KΩ	£0.27	5	J.Faulkner	18.02.2009	Farnell ONECALL	1653013	WMG	Yes
Resistor - 470Ω	£0.27	5	J.Faulkner	18.02.2009	Farnell ONECALL	1653132	WMG	Yes
Resistor - 27Ω	£0.60	50	J.Faulkner	18.02.2009	Farnell ONECALL	9336290	WMG	Yes
Resistor - 1.5KΩ	£0.27	5	J.Faulkner	18.02.2009	Farnell ONECALL	1653081	WMG	Yes
Resistor - 1MΩ	£0.27	5	J.Faulkner	18.02.2009	Farnell ONECALL	1653085	WMG	Yes
Relay SPCO	£2.97	2	J.Faulkner	18.02.2009	Farnell ONECALL	1094008	WMG	Yes
24V DPCO Relay	£1.34	1	J.Faulkner	18.02.2009	Farnell ONECALL	1175078	WMG	Yes
8-bit Microcontroller, 64K Flash	£23.20	2	J.Faulkner	18.02.2009	Farnell ONECALL	9171355	WMG	Yes
USB to dual serial converter	£5.66	1	J.Faulkner	18.02.2009	Farnell ONECALL	1615843	WMG	Yes
USB connector	£0.62	1	J.Faulkner	18.02.2009	Farnell ONECALL	1321918	WMG	Yes
Resonator 16MHz	£2.41	3	J.Faulkner	18.02.2009	Farnell ONECALL	1218536	WMG	Yes

Resonator 6MHz	£0.91	2	J.Faulkner	18.02.2009	Farnell ONECALL	1170434	WMG	Yes
Harting Female connector plug	£20.91	3	J.Faulkner	23.02.2009	Farnell ONECALL	3454034	WMG	Yes
Earthing wrist band	£3.84	1	J.Faulkner	23.02.2009	Farnell ONECALL	1503191	WMG	Yes
Earth bonding plug	£1.97	1	J.Faulkner	23.02.2009	Farnell ONECALL	SA01327	WMG	Yes
Weidmuller SL5.08/2/180 2way sockets	£5.12	25	J.Faulkner	23.02.2009	Farnell ONECALL	1121826	WMG	Yes
USB-4 port RS232	£29.95	1	J.Faulkner	24.02.2009	USBNow	1437	WMG	Yes
PCB FR-4 two layer with tool cost	£141.53	2	J.Faulkner	11.03.2009	PCB Cart	Unkown	WMG	Yes
Inline Coupler	£5.49	1	J.Faulkner	27.03.2009	Maplin	A14CF	WMG	Yes
RJ 45 Con	£5.18	2	J.Faulkner	27.03.2009	Maplin	JT49D	WMG	Yes
Socket D ICD 15way	£13.84	4	J.Faulkner	03.04.2009	Farnell ONECALL	154854	WMG	Yes
socket D ICD 25way	£16.23	4	J.Faulkner	03.04.2009	Farnell ONECALL	154866	WMG	Yes
Cable, antenna extension 1.8m	£4.72	1	J.Faulkner	03.04.2009	Farnell ONECALL	CS15139	WMG	Yes
Cable coax RG58BU 1m	£0.62	1	J.Faulkner	03.04.2009	Farnell ONECALL	1440543	WMG	Yes
Plug SMA reverse RG58	£2.35	1	J.Faulkner	03.04.2009	Farnell ONECALL	1327442	WMG	Yes
Jack SMA bulkhead rev/pol RG58	£2.75	1	J.Faulkner	03.04.2009	Farnell ONECALL	1327447	WMG	Yes
Ribbon cable 15way 5m	£4.31	5	J.Faulkner	03.04.2009	Farnell ONECALL	1207438	WMG	Yes
Ribbon cable 25way 5m	£9.37	5	J.Faulkner	03.04.2009	Farnell ONECALL	1207443	WMG	Yes
Travel adapter	£2.55	3	J.Faulkner	03.04.2009	Farnell ONECALL	1367058	WMG	Yes

Screw socket cap BZP Mx12	£6.97	1	J.Faulkner	03.04.2009	Farnell ONECALL	1419941	WMG	Yes
Spacer MF 16mm 25pk	£7.89	2	J.Faulkner	03.04.2009	Farnell ONECALL	517665	WMG	Yes
ZN3819 FET's	£3.60	20	M.Rooke	06.04.2009	electronic stores	ZN3819	WMG	Yes
BS170	£1.05	7	M.Rooke	06.04.2009	electronic stores	BS170	WMG	Yes
WEIDMULLER SL5.08/2/180 2way	£5.12	25	J.Faulkner	06.04.2009	Farnell ONECALL	1121826	WMG	Yes
VERMASON J6301NR Earth Plug	£5.21	1	J.Faulkner	06.04.2009	Farnell ONECALL	936868	WMG	Yes
MULTICOMP DY7010 Wrist strap 6ft	£3.23	1	J.Faulkner	06.04.2009	Farnell ONECALL	1521281	WMG	Yes
WUERTH ELEKTRONIK Inductor	£6.92	2	J.Faulkner	06.04.2009	Farnell ONECALL	1636223	WMG	Yes
ELECTROLUBE SMF12P Flux Pen	£4.00	1	J.Faulkner	06.04.2009	Farnell ONECALL	891186	WMG	Yes
Desoldering Braid, PB-free	£1.01	1	J.Faulkner	06.04.2009	Farnell ONECALL	1182012	WMG	Yes
WELLER LT1S round tip stepped 0.25mm	£3.44	1	J.Faulkner	06.04.2009	Farnell ONECALL	971030	WMG	Yes
ULTRICORE (solder) TTC-1 multicore	£3.68	1	J.Faulkner	06.04.2009	Farnell ONECALL	SA01714	WMG	Yes
Multicore solder lead free 0.7mm	£11.96	1	J.Faulkner	06.04.2009	Farnell ONECALL	5091032	WMG	Yes
75 amp Powerpole Contact 6mm	£13.34	8	J.Faulkner	07.04.2009	Torberry Connectors	5915x2	WMG	Yes
75 amp Powerpole Housings BLUE 2pk	£5.24	2	J.Faulkner	07.04.2009	Torberry Connectors	TH-060-BLUE	WMG	Yes
75 amp Powerpole Housings GREEN 2pk	£5.24	2	J.Faulkner	07.04.2009	Torberry Connectors	TH-060-GREEN	WMG	Yes
75 amp Powerpole Housings BLACK 2pk	£5.24	2	J.Faulkner	07.04.2009	Torberry Connectors	TH-060-BLACK	WMG	Yes
75 amp Powerpole Housings RED 2pk	£5.24	2	J.Faulkner	07.04.2009	Torberry Connectors	TH-060-RED	WMG	Yes

Torberry Connecters Postage		£4.50	1	J.Faulkner	07.04.2009	Torberry Connectors	postage	WMG	N/A
Akasa 40mm Fan		£8.70	4	J.Faulkner	08.04.2009	2 Source Ltd.	116214	WMG	Yes
Akasa 80mm Crystal Red Fan		£9.07	2	J.Faulkner	08.04.2009	2 Source Ltd.	124016	WMG	Yes
2 Source Ltd. Postage		£6.72	1	J.Faulkner	08.04.2009	2 Source Ltd.	postage	WMG	N/A
Digital Speed Controller 2 channel		£376.84	1	J.Faulkner	08.04.2009	Active Robots	AX3500	WMG	Yes
Active Robots Postage		£22.00	1	J.Faulkner	08.04.2009	Active Robots	postage	WMG	N/A
60A 32V Fuse		£9.66	1	J.Faulkner	08.04.2009	RS Online	4937108	WMG	Yes
LED 4mm 70deg white		£9.68	20	J.Faulkner	15.04.2009	Farnell ONECALL	8577153	WMG	Yes
MOSFET N60 V to-92		£1.61	20	J.Faulkner	15.04.2009	Farnell ONECALL	1299312	WMG	Yes
	Subtotal:	£1,071.33							

Promotional Items and Open Days

Description	Total Exp. (inc. VAT)	Quantity	Expendee	Date	Contractor/Supplier	Part Number/Notes	Account	Delivered?
Posters	£58.00	3	O.Vogel	06.01.2009		100880	IMRC	Yes
Team Polo Shirts	£489.00	1	O.Vogel	12.02.2009		100966	IMRC	Yes
Single room, Sellafield	£99.00	2	O.Vogel	27.01.2009	Stanley Arms	N/A	IMRC	N/A
Twin Room, Sellafield	£187.50	2	O.Vogel	27.01.2009	Stanley Arms	N/A	IMRC	N/A
Sellafield Car Hire	£59.50	1	J.Faulkner	27.01.2009	Zodiac Rent A Car		IMRC	Yes

Fuel for Sellafield		£89.92	1	M.Rooke	04.03.2009		N/A	IMRC	N/A
M6 Toll		£9.40	1	M.Rooke	04.03.2009		N/A	IMRC	N/A
	Subtotal:	£992.32							

RoboCup Rescue Competition

Description	Total Exp. (inc. VAT)	Quantity	Expendee	Date	Contractor/Supplier	Part Number/Notes	Account	Delivered?
Hotel Deposit	£651.12	1	J.Williams	15.12.2008		N/A	IMRC	N/A
Car Hire for Hannover	£180.25	1	J.Williams	26.02.2009	Budget Car Rental		IMRC	N/A
33% daily surcharge	£66.99	1	J.Williams	26.02.2009	Budget Car Rental		IMRC	N/A
Arrangement fee	£15.00	1	J.Williams	26.02.2009	Budget Car Rental		IMRC	N/A
5* European Breakdown cover	£56.00	1	J.Williams	27.02.2009	The AA		IMRC	N/A
Ferry Tickets to RoboCup Rescue	£616.00	2	J.Williams	02.04.2009			WMG	Yes
Newlink Cable lock key type	£10.37	2	J.Faulkner	15.04.2009	Farnell ONECALL	CS15271	WMG	Yes
GB Sticker	£1.56	2	J.Faulkner	15.04.2009	Farnell ONECALL	CP04354	WMG	Yes
RBK HiVis W/Coat 2x1 Banf YLM M	£20.53	7	J.Faulkner	15.04.2009	Farnell ONECALL	322651	WMG	Yes
Extinguisher Car 950g	£10.52	1	J.Faulkner	15.04.2009	Farnell ONECALL	CP0436010	WMG	Yes
AA Car First Aid Kit Soft Pouch	£15.08	2	J.Faulkner	15.04.2009	Farnell ONECALL	CP04347	WMG	Yes
Entry to RoboCup Rescue	£1,178.59	10	J.Williams	16.04.2009	RoboCup Rescue	N/A	WMG	N/A

Remaining Hotel Cost	£2,186.10	1	J.Williams	21.04.2009		N/A	IMRC	N/A	
Parking Costs at RobobCup Rescue	£59.26	N/A	Various	23.04.2009	Hannover Messe	Paid by credit card	WMG	N/A	
Fuel Costs for RoboCup Rescue	£267.11	N/A	Various	23.04.2009		Paid by credit card	WMG	N/A	
Team Meals at RoboCup Rescue	£574.17	N/A	J.Williams	23.04.2009		Paid by credit card	WMG	N/A	
Emergency Parts order	£51.53	1	J.Williams	23.04.2009		Paid by credit card	WMG	Yes	
Subtotal:	£5,960.18								

Unknown Miscellaneous

Description	Total Exp. (inc. VAT)	Quantity	Expendee	Date	Contractor/Supplier	Part Number/Notes	Account	Delivered?
Vehicle hire of transport	£30.00	Unknown	Unknown	Unknown	Unknown	07/08 Misc expeniture	WMG	N/A
Consumables electrical	£34.99	Unknown	Unknown	Unknown	Unknown	07/08 Misc expeniture	WMG	Unknown
Subtotal:	£64.99							
Total Field Robot Outgoing:	**£12,648.00**							

Office Equipment

Description	Total Exp. (inc. VAT)	Quantity	Expendee	Date	Contractor/Supplier	Part Number/Notes	Account	Delivered?
Wood for test Arena	£313.49	1	J.Faulkner	21.20.2008	Avon Timber	N/A	ENG	Yes
Acer 22" monitor x222W	£125.99	1	J.Faulkner	28.11.2008	Amazon	Unkown	ENG	Yes
Amazon postage	£10.36	1	J.Faulkner	28.11.2008	Amazon	Postage	ENG	N/A
Black Ink Cartridge	£9.98	1	J.Faulkner	15.01.2009	Cartridge People	C6656ae	WMG	Yes
Colour Ink Cartridge	£17.98	1	J.Faulkner	15.01.2009	Cartridge People	C6657ae	WMG	Yes
Sawn Pine Timber 4" x 4" x 2.4m	£9.20	1	J.Faulkner	10.02.2009	Avon Timber	N/A	WMG	Yes
8' x 4' x 18mm Strand Board	£13.57	1	J.Faulkner	10.02.2009	Avon Timber	N/A	WMG	Yes
8' x 4' x 11mm Strand Board	£10.44	1	J.Faulkner	10.02.2009	Avon Timber	N/A	WMG	Yes
Cuts	£5.18	1	J.Faulkner	10.02.2009	Avon Timber	N/A	WMG	N/A
Total Office Equipment Outgoing:	**£516.19**							

Total Project Outgoing: **£13,164.19**

Table 9-2: Project income

Source	Amount	Date	Notes	Account	Received?
Carried over from previous project	£1,147.64	28.09.2008		WMG	Yes
Meng project fund	£1,200.00	29.09.2008	£150 per student	Eng	Yes
WMG sponsorship	£4,700.00	12.10.2008	£3500 + £150 p/s	WMG	Yes
WIMRC sponsorship	£4,989.00	14.10.2008	For publicity use	WIMRC	Yes
ITCM sponsorship	£2,000.00	08.11.2008		WMG	Yes
WIS sponsorship	£1,000.00	03.12.2008		WMG	Yes
Sellafield grant	£3,000.00	28.04.2009		WMG	Yes
Total Project Incoming:	£18,036.64				

Table 9-3: Overview of project accounts

Account	Pledged Income	Current Income	Current Expenditure	Current Balance
ENG	£1,200.00	£1,200.00	£1,205.66	-£5.66
WMG	£11,847.64	£11,847.64	£7,183.84	£4,663.80
WIMRC	£4,989.00	£4,989.00	£4,774.69	£214.31
Totals:	**£18,036.64**	**£18,036.64**	**£13,164.19**	**£4,872.45**

10. Appendix D