

**REPORT ON**

***Remote Rope Deployment System***

By:

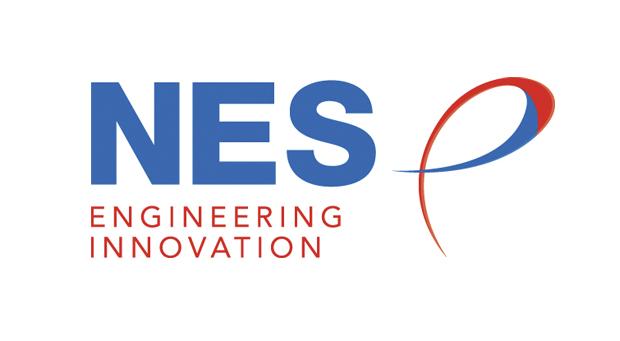
*Ethan Spall*

*Kathryn McGregor*

*Nic Gaskell*

*Jacob Kay*

**SUPPORTED BY**





**EXECUTIVE SUMMARY**

We are a group of 4 lead by Geoff WoodWard From winstanley colleg. We consist of Ethan Spall - Team Leader. Nic Gaskell - Model Engineer, Jabo Kay - Main Electronics engineer And Kathryn McGregor - Lead programmer.

*{Secondly, introduce your project and explain the reason why it is necessary.}*

The project comprised of the research and development of a .......................... in order to solve the problem of............................

*{Thirdly, briefly explain the various options and motivate the chosen one.}*

*{This section sets the tone of your report, where you market your project, explains briefly what the project is all about and makes the reader wanting to read on.}*

The team identified *3* possible solutions. The solution that was found to be the most effective is .............. (outline reasons why.) It is expected that *{Sponsor Company}* will save £*xxx* .........

*{Finally, briefly say what benefit was gained by the EES programme.}*

By participating in the EES, the team members gained general experience and knowledge of communications, problem analysis and solving, solution design, project management and presentation. The team became aware that a relatively expensive solution may be the most economical in the long term because of better quality materials and reliability.

.. ......... 2011

**ACKNOWLEDGEMENTS**

We wish to extend our appreciation and thanks to the following, without whom we would not have had this experience.

* The Engineering Development Trust
* The Engineering Education Scheme
* Nuclear Engineering Services (NES), for their sponsorship
* Project Managers from NES, Mr SanJay Lad and Peter ??
* University of Liverpool, and their staff for the extensive use of their facilities
* Winstanley College, especially Mr Geoff WoodWard

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I. SUMMARY OF KEY COMMUNICATIONS

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**1 INTRODUCTION**

* 1. Background Information

The objective of The Engineering Education Scheme (EES) is to encourage Year 12, Lower 6th Form students, usually taking Mathematics at A level, to consider Science, Engineering and Technology as future career pathways through the application of theoretical learning. Working as a team, linked to a local company, on a six-month real scientific, engineering or technological problem, all key life skills are developed within the context of the world of work. Personal development realised through work related learning is at the core of this high quality educational enrichment scheme. The EES encourages companies to offer real live projects to a team of Year 12 students to work on over a 6-month period.

Nuclear Engineering Services Limited sponsored and mentored a team from Winstanley College, Greater Manchester to partake in the Engineering Education Scheme, an Engineering Development Trust (EDT) programme. Their company profile is enclosed as Appendix A.

* 1. Project Brief - need to explain better (i.e. what is Rope positioning system), merge with section below

NES have asked us to create a rope positioning system that can work remotely and is precise. The rope positioning system must position a rope in the aperture of a silo (filled with radioactive waste) to 12 pre programmed positions within the silo. It has to be operated remotely due to the high levels of radiation in the concrete silo that is to be emptied and decommissioned. The silos are set in the foundations of an old building that needs to be demolished safely to prevent any release of radioactive material. The main restriction is the radiation emitted by the waste within the silo and the shielded box. The radiation emitted is beta radiation. Beta radiation emits electrons,which will destroy any circuitry by disrupting the lattice structures of the metal conductors within the circuitry, rendering any electronics inside the shielded box worthless . This means no electrical components can be put inside the shielded box. NES have tested this, and this also means any system that we design must not compromise the shielding of the box. It also needs to be very durable and reliable as replacing parts will take time due to the need to replace them remotely if they are in the shielded box. It is also stated that the system places the minimum amount of equipment within the shielded box for ease of maintenance and to reduce the extra contaminated waste created by replacing parts that are inside the shielding.

There is a shielded box that is there to stop and protect any radioactivity from escaping the box so that it is not at risk to humans or the environment. The shielding is moved above the aperture of the silo and contains all the equipment used to remove and contain waste from the silo. A bucket attached to a rope passes through a small hole in the roof of the shielded box and tools to remove waste are attached to it. The silo is 8m x 8m and 16m deep, the aperture is only 1.5 x 1.5m and is in the centre of the roof of the silo. NES have tools to reach further into the silo than the 1.5 x 1.5m aperture allows, but they require a rope positioning system to move the rope with tools into any position inside the aperture to aid reaching further into the silo.

The rope positioning system is necessary for the nuclear decommissioning work NES have undertaken. The bucket and rope goes down through the centre of the aperture, so the rope positioning system is vital to move the rope into the corners of the aperture to allow NES to clear as much waste as possible. The problem of only being able to clear a 1.5 x 1.5m area using a hydraulic bucket on the end of the rope is already solved by NES, as they have a hydraulic rake attachment that can reach further into the silo and move waste to the directly accessible 1.5 x 1.5m area in the centre. Both the hydraulic bucket and rake would be moved by our rope positioning system to reach as far as possible into the silo.

*Discuss everything you looked up and learnt to do for the project. You will learn a lot of new technology that could solve your problem, so write about that here. You may need to discuss the technology in separate sections ,eg Mechanical, Electrical, Electronics, Software, etc}*

In order for the Report Positioning system to function to the minimum level, that as a group, was collectively decided with all of us.

The rope positioning system will allow NES to safely and efficiently remove as much waste as possible from the silos to allow the building to be decommissioned and then made safe. Without the RPS, NES wouldn’t be able to remove enough waste for the silos and building to be decommissioned

* + 1. Mechanical

The majority of the proposed solution was mechanical, so the mechanical aspects were split up into three main categories; the model, the motors, and spindles/rope related aspects.

There was a need for a scale model of the problem, and any engineered solution. It was decided that no matter which of the three solutions was chosen, there was a need for a scale model. All three solutions would fit in the confines of the scale model. The scale model allows visualisation of the criteria set out by the company. The dimensions of the shielded box were set to 300mm by 300mm by 150mm (WxLxH), and the aperture would be 150mm by 150mm centered in the shielded box. The main criterias for the model were sturdiness, cost, and ease of assembly. The material choice for the shielded box was mainly driven by the need to see the solution working inside, so it could be demonstrated easily. Due to its cost and transparency 5mm clear perspex was used to model the shielded box. The base and ‘legs’ of the model were made out of MDF, because it was cheap, sturdy, and easy to assemble. The MDF base support legs held up the MDF sheet used as the base. The base has the

It was decided to use 5mm thick clear perspex to model the shielded box that sits on top of the silo as it is strong, relatively cheap, and allows the possibility of seeing what is going on in the shielded box and monitoring the solution. We decided we needed a sturdier material to make the base of the model, in order to support the weight of the motors and circuitry, and represent the aperture and silo. We considered using various types of wood, but found it to be too expensive for the budget. We settled on using MDF for the base as it was cheap, readily available, easy to cut to size and strong. The sides of the base were also made from MDF for the same reasons. For the stands holding the motors at the corners of the box, the material we decided to use was cut blocks of pine wood around the corners of the box, as its strong enough to support the motors, easy to drill through, and relatively light, as to not place too much weight/strain on the base of the model. We also used perspex to create the motor holders/brackets, this is because perspex can be easily molded into the desired shape (an “L” bracket) by using heat, which we did at liverpool university.

* + 1. Electronics

For the purpose of our solution, we had to have a circuit that would take a position input from the operator and then step stepper motors the required amount of steps and hence move the rope. We researched a few possibilities for a control system; a raspberry pi (as suggested by our engineers), an Arduino, and a PLC.

We first ruled out using a PLC due to the fact they are very expensive, and no one had any programming experience with it so we felt uncomfortable using it as our control chip. It was then down to the raspberry pi and Arduino. Our engineers were encouraging us to use a raspberry pi since they had experience using it. After researching it though, we found there just weren’t enough outputs for what we needed it to do. We also felt uncomfortable using the raspberry pi due to the fact we didn’t have any programming experience with them.

The Arduino was chosen as our control system due to the fact we all had some degree of experience with programming it, and it was overall cheaper than a raspberry pi or PLC. The fact we could buy the chips in a kit and make our own custom circuit was the final deciding factor because it allowed us to tailor the Arduino circuit for our specific needs to our project.

*These sections may need to be moved down to 2.2*

* + 1. Software

Difference between servos and steppers

Rope positioning systems that exist

Cranes Basically

Controllers

Software

Materials

Circuitry

Circuit diagram

* 1. Research and Fact Finding

*{How you investigated and solved the problem. There may be several sub sections here if you carried out several experiments or investigations in different ways.*

*Describe how you developed your first ideas into a main proposal.*

*Describe any main problems your team had and say how they were dealt with.*

*Describe how you presented your final proposal; maybe how you built a model of, or maybe, a first version of, your final idea.*

*Kaths box*

*Motor*

*Servo Finding*

*Proof of concept*

*Don’t forget to record key sources of information in the reference section – state where you got it from.}*

* + 1. Synchronisation of motors

Programming the Arduinos involved solving the problem of synchronicity of the motor movements, researching which method of Arduino communication was the best to use, and writing test programs to establish all components worked correctly.

Pseudo code helped to model what the code needed to achieve and in which order. A flow chart showed which message was sent by which Arduino and when it was received.

Information on how to communicate between Arduinos was sourced from the Arduino site, the best method found was to use the wire() library as this was similar to other methods previously used by members in the group and was simple to use. However once in Liverpool it was best to change to software.serial() as problems were encountered with the order of communication by running two Arduinos off a central ‘master’ using the wire library . Changing to software.serial() enabled effective communication between the three Arduinos so that messages were sent from the central Arduino to the others at the same time.

Synchronicity of the motor movements was a problem as if they moved out of synch, ropes would slacken in and cause the position and movement to be inaccurate or go too taut and potentially break the system. To solve this problem the motors controlled by one Arduino were sent the message to move the amount of steps calculated by the initial program, then the amount of steps left over for one of the motors.

To test the circuit programs were written to test the digital pins on the Arduino. This cycled through these pins, turning them on so that they user could see they worked, then turning them off again. This was needed to check all components before using the main program, as if one Arduino or motor didn’t work the model wouldn’t work as the movement of the central point is dependent on the individual movements of each motors. A program to test the serial connection with the main Arduino was also needed. This was so that when first tested the system we could establish a connection with the Arduino before sending it information about the number of steps, and fix any complications with sending/receiving data before initializing the main program.

The functioning of the motors also required a test program. This involved turning each motor on for a minimal number of steps. Problems with the motor turning fluidly were common at Liverpool and so a test was needed to check whether the motor was turning the right *way, and at the correct speed the motors so that they would all move in sync.*

* 1. Project Management/Programme

*{Explain your project plan and timetable. Explain how you planned: when you would do what and who would do what. Compile a Gantt Chart and explain if you needed to modify it as you progressed. Say how you would try to make full use of each team member.}*

1. **IMPLEMENTATION OF PROJECT**
   1. Results and Analysis

*{What you found or measured. Say how you tested your final work and judged how successful you thought it was. Show how working through your plan built up your information.*

*Stick to summaries of the data in this section, no massive tables of numbers that are hard to read. Any tables and charts here should be quick and easy for the reader to interpret. Everything else goes in the Appendices.}*

*{Analysis of your results. Often the biggest section, unless you had a lot of background work to do. Here you are free to write your thoughts and opinions on your research and results.*

*Try to say how and what you have done relates to the wider world; how some of your ideas might be useful in other situations, like bigger or smaller scale situations or maybe in the third world.*

*It is important to make reference to costs and risks in your analysis.}*

1. **SOLUTION AND EVALUATION**
   1. Solution and Evaluation of Results

*{The solution you would like to propose and any relevant implementation guidelines. This should give the reader the answer to the problem you detailed in the introduction. Explain why the other potential solutions were discarded. One way to evaluate your options is to score them in tabular form on various criteria as per example below and motivate your scoring.}*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CRITERIA** | **OPTION 1** | **OPTION 2** | **OPTION 3** | **OPTION 4** | **OPTION 5** |
| **COST** |  |  |  |  |  |
| **TIME** |  |  |  |  |  |
| **SAFETY** |  |  |  |  |  |
| **SKILL LEVEL** |  |  |  |  |  |
| **MAINTENANCE** |  |  |  |  |  |
| **EFFICIENCY** |  |  |  |  |  |
| **TOTAL SCORE** |  |  |  |  |  |

\*Score each CRITERIA out of 10. Maximum score is best option.

* 1. Future Development

*{Make recommendations for further research/development. If there are none, say so. If further testing or a more rigorous evaluation (including commercial evaluation) is required, indicate what would be envisaged.}*

1. **CONCLUSIONS**

*{This needs to be scientifically based on the facts and results you achieved from Sections 3 and 4 above. Anything that you have successfully proved to either work or not work. You may wish to list them in bullet form}*

* The team addressed the problem of.......... After detailed analysis and testing it was found that the solution is to .......
* The solution needs further refinement *........{state briefly what the reservations are and what needs to be done to resolve them.}*
* It is estimated that *{Sponsor Company}* will benefit financially through ...... *{ it is important to demonstrate the financial benefits.}*

**APPENDICES**

*{Each Appendix to start on a new page}*

1. COMPANY PROFILE
2. OUR TEAM
3. GANTT CHART
4. MINUTES OF MEETINGS
5. CALCULATIONS/TABLES/FIGURES/PHOTOGRAPHS
6. REFERENCES
7. GLOSSARY
8. COMPANY VISIT
9. SUMMARY OF KEY COMMUNICATIONS
10. EES PARTICIPATION EVALUATION

**APPENDIX A**

**COMPANY PROFILE**

*{Sponsor Company to provide a profile of their company and of their mentor}*

**APPENDIX B**

**OUR TEAM**

**OUR TEAM**

Our team consists of four members. We assigned roles to each team member at our first meeting as follows:

*{Examples of roles.}*

Team Leader : ............was appointed chairperson. He/She coordinated the tasks and made sure that everyone was clear about what they needed to do and monitored the progress against the Gantt Chart.

Report writer : .............. co-ordinated and edited the report as work progressed during the project.

Ideas and design : He/She was in charge of this section of the project and contributed many valued opinions and ideas.

Presentation : ...............was in charge of the presentation preparation.

Other roles?: ............

*{Photograph of team? Either a group photograph or individual photographs against each name.}*

**APPENDIX C**

**GANTT CHART**

*{THE PROFORMA EXAMPLE IN THIS FOLDER NEEDS TO BE ADAPTED TO SUIT YOUR OWN REQUIREMENTS}*

**APPENDIX D**

**MINUTES OF MEETING**

*{Insert Minutes of Meetings here}*

**APPENDIX E**

**CALCULATIONS/TABLES/FIGURES/PHOTOGRAPHS**

*{Insert detailed Tables, Figures, Photographs here that are too detailed to include in the main body of the report. These may also include financial cost comparisons etc.}*

**APPENDIX F**

**REFERENCES**

**REFERENCES**

*{Very important to give credit to sources used:*

* + *Books and Publications*
  + *Software data products*
  + *Video information resources*

*Don’t forget to include author and publisher}*

**APPENDIX G**

**GLOSSARY**

**GLOSSARY**

*{Technical terms: You cannot assume that everyone understands “common expressions”*

*Repeated technical terms can be abbreviated:*

*eg*

* *dvm - digital volt meter*
* *HSE - Health and Safety Executive*
* *RPS – Rope Positioning System*

*Make it easy for the reader - LIST THEM}*

**APPENDIX H**

**COMPANY VISIT**

*{Describe the company visit, what you saw, your experiences, what you learnt, how it helped in undertaking the project.}*

**The company visit took place on Thursday 6th February 2014, and we went down to NES’ Wolverhampton manufacturing facility. We were taken round the whole facility and shown the**

**APPENDIX I**

**SUMMARY OF KEY COMMUNICATIONS**

**{PROJECT TITLE}**

**SUMMARY OF KEY COMMUNICATIONS**

|  |  |  |  |
| --- | --- | --- | --- |
| **DATE** | **TO/FROM** | **TYPE AND PURPOSE** | **OUTCOME/RESULT** |
|  |  |  |  |
|  |  |  |  |

*{Can be phone call, fax, email}*

**APPENDIX J**

**EES PARTICIPATION EVALUATION**

**EES PARTICIPATION EVALUATION**

1 Scheme Launch

The Scheme Launch was held at Liverpool University on Wednesday 16th October 2013. This event was focused on introducing the Engineering Education Scheme, laying out the expectations and rewards gained during the scheme. It summarised the scheme and informed us of all the dates and deadlines. There were two teambuilding tasks that involved thinking outside the box and building up communication skills between the members of the team. We didn’t know each other prior to the scheme. The first task involved building a chair that could support a team member. The only supplies were 18 balloons, sellotape, and 2 pieces of paper. There was a twist; we couldn’t speak. This task built up our team working skills and allowed us to fall into the roles we were naturally good at in this task. The second task involved making a ‘rollercoaster’ track out of 8 sheets of A4 card and sellotape. A marble was used to go down the track. The ‘rollercoaster’ was rated based on how long the marble took to roll to the end, and the overall ‘thrill’ of the coaster. It helped us get to know each other as we worked together well to build a good rollercoaster.

2 Three Day Residential Workshop

The three day workshop was held at the {........} Campus of *{Name}* University, *{City/Town}* between the .. and .. December 2010.

*{Summarise the events and activities and what you learnt for each day. ie DAY 1, DAY 2 and DAY3.}*

3 Team/Engineer Meetings

Eg

Team/Engineer meetings were held on the following dates:

Thursday 24th October 2013

... January 20..

... March 20..

Copies of the Minutes of these meetings are enclosed in Appendix D. We found these meetings beneficial as they not only provided direction and support in our research, but provided the opportunity to experience how meetings are conducted in the real life situation. Compiling the minutes of a meeting taught us the written skill of recording discussions and kept the person accountable for actions that were their responsibility.

The team generally met each Thursday to review progress and to plan the way forward for the following week. Each team member left the meeting with specified tasks set for the following week. These meetings tended to be informal and it wasn’t deemed necessary to keep minutes of these meetings.

4 Skills Experience and Knowledge

Eg

We have all benefitted greatly from this experience in many ways. The most beneficial experience has been that of working as a team. We all have our skills which have complemented each other to form a successful team which have worked together and have brought the project to a successful conclusion. By monitoring our progress on the Gantt Chart ensured that we completed the project on time. By breaking up the project into various stages helped us to undertake the project in bite size chunks and not be overwhelmed at the task at hand. The team’s understanding of the role of engineering in society was increased by .........................

1. Conclusions

*{List in bullet format }*

* The team members gained an understanding of project management, particularly ....
* The importance of good communication skills was ........
* The sharing of work load amongst team members, using member’s specific skills and knowledge, proved to be important to meeting the project’s timetable.
* The team’s understanding of the role of engineering in society was increased ....
* Etc .........