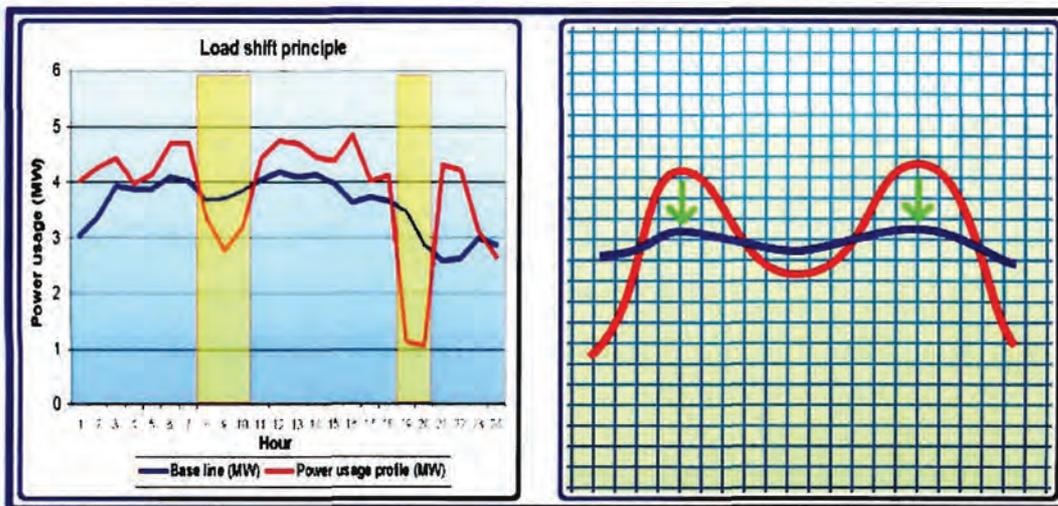

5. Conclusion



This thesis presents the research that lead to the development of a sustainable pump simulation and control system. Case studies prove that the new development was successful.

5.1. Closure

The development of a system capable of shifting load and realising electrical running cost reduction in the South African deep level mine environment was successful. Case studies done on South African deep level mines proved the following:

1. REMS introduced real-time simulation for the purpose of optimisation. The results yielded by the implementation of REMS proved the success of the simulation philosophy. The positive results achieved by REMS were a result of this optimisation.
2. REMS was used to predict and investigate the potential of all the projects mentioned in the case studies prior to implementation. The prediction generated from the investigations proved to be accurate and useful.
3. The results of the case studies clearly show the success achieved in terms of load shift and running cost reductions. These results prove the successful development of REMS. It can therefore be concluded that REMS met the primary requirements set for this research. These requirements are set out in section 1.2.5 of this thesis.
4. By monitoring the operation of the system, it was established that the development of REMS was successful in making it feasible and practical for the South African mining environment. No safety or health regulations were violated by the implementation, and the system was easy and practical enough to be used by the clients.
5. The introduction of automation into the control of the water pumping system was successful and yielded positive results. The automated REMS control yielded more sustainable and reliable results than the control exerted by human operators. REMS 24-hour approach delivered a superior control strategy.
6. As set out in the initial specifications, REMS has to control within a range of system constraints inherent to the physical properties of the intended controlled

system. REMS proved successful in this regard, always meeting these constraints and limits.

7. The integrated REMS tools made reporting and performance monitoring easy and simple. Automated reporting proved successful in presenting overall progress on projects. Automated tools generate reports showing detailed information regarding projects.
8. REMS proved successful in contributing to the maintenance and workload distribution of the pumps. The maintenance of pumps was improved by the work hour counters built into REMS and the introduction of automated workload distribution.
9. The REMS interface proved to be understandable, intuitive and well developed and contributed to the service performed by the control room operators.

5.2. Suggestions for further work

Direct communication to PLC's

REMS has no way to control electrical equipment such as pumps, valves, etc. directly. As described in chapter three of this thesis, REMS communicates with a SCADA, which in turn will control physical equipment in accordance to REMS commands. REMS achieves this communication using the OPC communication protocol.

A problem will arise if REMS is to be installed on a mine or industrial plant where a SCADA system is not present. The problem could be overcome by implementing a SCADA system, but this is not feasible as the cost of SCADA systems is sometimes higher than the electrical savings that could be realised using the REMS system.

Another problem is that the communication chain from REMS to the physical components is dependable on a SCADA system. Eliminating this link in the chain can reduce the risk of losing communication between REMS and the components.

The suggestion is to develop and implement a module into the REMS system that will allow it to connect directly to, and control electrical equipment. This will cut out the need for a SCADA system and increase system reliability.

Incorporating DDE (Direct Data Exchange) into the REMS framework

A standard that was set with the development of SCADA systems was that they are all OPC compatible. OPC is a communication protocol developed to exchange live data in real-time. OPC is used to integrate SCADA packages with one another and third party databases and reporting software.

This standard of inter-compatibility is still upheld, but the OPC protocol is not the only protocol used in inter-SCADA communication. Today, some SCADAs are developed without OPC capabilities, but rather with DDE and other more powerful piping technologies. They can still be made OPC capable with extra add-on packages, but this is a backdoor method that is becoming old and could soon be discontinued.

Most SCADAs developed today are developed with built in DDE communication capabilities. Therefore, a suggestion for further research is to investigate the DDE protocol and to make REMS DDE capable as well as OPC capable. This will ensure that REMS can communicate to a wider range of SCADA packages.

Expanding REMS as a multi terminal application

Most SCADAs found today are developed as multi terminal applications. This means that the heart or engine of the program is situated on a main server, with any number of distributed computers with access to the server's GUI. This has the advantage of having more than one GUI (Graphical User Interface) that can interact with the main server.

A suggestion for further work is to expand REMS as a multi-terminal application so that more than one computer terminal can have access to the system. This will also help if more than one section on a plant needs to have access to the system to monitor its progress.

Better reporting

Much effort has been put into REMS to improve and optimise the way the system presents the results that is achieved. The data presented by REMS also helps engineers to better the REMS control philosophy for each project to find faults in the control set-up.

Although this reporting system is very successful, it is not optimised and completely automated. Further work can be done into developing a more automated system for handling data and reporting on project performance.

Advanced pump monitoring

REMS was developed to control pumps in a pump control system. At this stage REMS focussed on working hours of these pumps and aids in scheduled pump maintenance and pump workload distribution.

REMS could be developed further to monitor not only the working hours of each pump, but also other data regarding the pump, including flow, power usage, operating temperatures etc. This data can then be used to diagnose any problems and/or monitor pump efficiency. This information then can be used to improve on the management and maintenance of these pumps.

Maximum demand control

Mines are billed according to electricity pricing profiles that penalise the user according to a maximum demand value within a given period. This motivates the mine to monitor and manages their maximum power demand.

Since REMS is developed to control the water pumping system of a mine, it also has a profound impact on the electricity usage of that mine and could invariably influence the maximum demand of that mine. A suggestion would be that REMS is developed

to help in maximum demand control by shutting down a pump when a maximum demand target is reached.

Complete water control system

REMS is developed to control and schedule the pumps of a water pumping system to achieve running cost savings and load shifting. The management of the water system of a mine consists of the pump scheduling and include other facets such as:

1. Water balance control,
2. Water purity control,
3. Water distribution to given points etc.

REMS could be engineered to incorporate these functionalities to act as a global water system management system capable of more than just load shifting and running cost reduction.