REMOTE INFORMATION MANAGEMENT OF AN AUTOMATED MANUFACTURING SYSTEM

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Declaration of Independent Work

I, LINDA PRETORIUS, identity number [redacted] and student number 20477732, do hereby declare that this research project which has been submitted to the Central University of Technology for the Degree MASTER TECHNOLOGIAE: INFORMATION TECHNOLOGY, is my own independent work; and complies with the Code of Academic Integrity, as well as other relevant policies, procedures, rules and regulations of the Central University of Technology; and has not been submitted before by any person in fulfilment (or partial fulfilment) of the requirements for the attainment of any qualification.

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SIGNATURE OF STUDENT DATE

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Summary

With technology advancing, more and more people turn to the World Wide Web to conduct business. This may include buying and selling on the Web, advertising and monitoring of business activities.

There is a big need for software and systems that enable remote monitoring and controlling of business activities. The Mechatronics Research Group of the Faculty of Engineering, Information and Communication Technology at the Central University of Technology, Free State, has identified a similar need. This research group has created an Automated Manufacturing System around which research topics revolve. They want to monitor this Automated Manufacturing System from remote locations like their offices or, if possible, from home.

The Remote Information Management (RIM) System was developed, using the Rapid Application Development (RAD) Methodology. The reasons why this methodology was used, is because it is the best to use in a changing environment, when the system needs to be developed very quickly and when most of the data is already available. This is a good description of the Automated Manufacturing System's environment.

The RAD methodology consists of four stages: Requirements Planning, User Design, Rapid Construction and Transition. Project Management is used throughout these stages to ensure that the project goes according to plan. Development of the RIM system went through all four stages and project management was applied.

The final system consisted of a Web Page with Web Camera views of the Automated Manufacturing System. The application that was developed using National Instruments LabVIEW, Microsoft Visual C++, and Microsoft Excel, is embedded in this Web Page. This application is called a Virtual Instrument (VI). The VI shows real-time data from the Automated Manufacturing System. Control over the VI can be granted and will allow the remote user to create reports on how many different products was produced and system downtimes.

A system like the RIM System has advantages in the business world. It can enable telecommuting and will allow employees and managers to monitor (and even control) manufacturing systems, or any system connected to a PLC, from remote locations.

Uittreksel

Met tegnologie wat vooruitgaan, keer meer en meer mense na die Wêreld Wye Web om besigheid te doen. Hierdie mag die koop en verkoop op die Web, advertering en die monitering van besigheidsaktiwiteite insluit.

Daar is ‘n groot behoefte aan sagteware en stelsels wat afstands monitering en kontrollering van besigheidsaktiwiteite toelaat. Die Megatronika Navorsingsgroep van die Fakulteit van Ingenieurswese, Inligtings- en Kommunikasietegnologie aan die Sentrale Universiteit van Tegnologie, Vrystaat, het ‘n soortgelyke behoefte geïdentifiseer. Hierdie navorsingsgroep het ‘n Geoutomatiseerde Vervaardigingsisteem geskep waarom navorsingstemas draai. Hulle wil hierdie Geoutomatiseerde Vervaardigingsisteem monitor vanaf verwyderde liggings soos hul kantore of, indien moontlik, vanaf hul huise.

Die Afstands Inligtingsbestuurstelsel (RIM stelsel) is ontwikkel deur die Vinnige Toepassings Ontwikkelings (RAD) Metodologie te gebruik. Die redes waarom hierdie metodologie gebruik is, is omdat dit die beste is om te gebruik in ‘n veranderende omgewing, wanneer die stelsel baie vinnig ontwikkel moet word en wanneer die meeste van die data reeds beskikbaar is. Dit is ‘n goeie beskrywing van die Geoutomatiseerde Vervaardigingsisteem se omgewing.

Die RAD metodologie bestaan uit vier fases: Beplanning van Benodigdhede, Gebruikerontwerp, Vinnige Konstruksie en Omskakeling. Projekbestuur word regdeur hierdie fases gebruik om te verseker dat die projek volgens plan verloop. Ontwikkeling van die RIM stelsel het deur al vier fases gegaan en projekbestuur is toegepas.

Die finale stelsel bestaan uit ‘n Webbladsy met Webkamera beelde van die Geoutomatiseerde Vervaardigingsisteem. Die toepassing wat ontwikkel is deur gebruik te maak van National Instruments LabVIEW, Microsoft Visual C++ en Microsoft Excel, is ingebou in hierdie Webbladsy. Hierdie toepassing word ‘n Virtuele Instrument (VI) genoem. Die VI wys intydse data vanaf die Geoutomatiseerde Vervaardigingsisteem. Beheer oor die VI kan toegestaan word en sal die afstandsgebruiker toelaat om verslae te skep oor hoeveel verskillende produkte vervaardig is en tye wat die stelsel af was.

‘n Stelsel soos die RIM stelsel het voordele in die besigheidswêreld. Dit kan dit moontlik maak om van die huis af te werk. Dit kan ook werkers en bestuurders toelaat om vervaardigingsisteme, of enige stelsel gekoppel aan ‘n PLB, vanaf verwyderde liggings te monitor (en selfs te kontrolleer).

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List of Abbreviations

4GL	Fourth Generation Language
AMS	Automated Manufacturing System
ASP	Active Server Pages
CSP	Communicating Sequential Processes
CUT	Central University of Technology
DFD	Data Flow Diagram
DLL	Dynamic Link Library
ERD	Entity Relationship Diagram
GUI	Graphical User Interface
HTML	Hypertext Markup Language
HVAC	Heating, Ventilation and Air Conditioning
IP	Internet Protocol
IT	Information Technology
LabVIEW	Laboratory Virtual Instrument Engineering Workbench
LED	Light Emitting Diode
LPG	Light Petroleum Gas
OLE	Object Linking and Embedding
OPC	Object Process Control
PC	Personal Computer
PLC	Programmable Logic Controller
PM	Project Management
RAD	Rapid Application Development
RIM	Remote Information Management

SDLC	Software Development Life Cycle
SMTP	Simple Mail Transfer Protocol
TCP/IP	Transmission Control Protocol / Internet Protocol
UIMS	User Interface Management Systems
UML	Unified Modelling Language
VI	Virtual Instrument
WWW	World Wide Web

Chapter 1: Introduction to Remote Information Management

1.1 Introduction

Researchers from the Faculty of Engineering, Information and Communication Technology at the Central University of Technology, Free State formed a research group called the Mechatronics Research Group. These researchers were mainly from the School for Electrical Engineering, the School for Mechanical Engineering and the School for Information and Communication Technology.

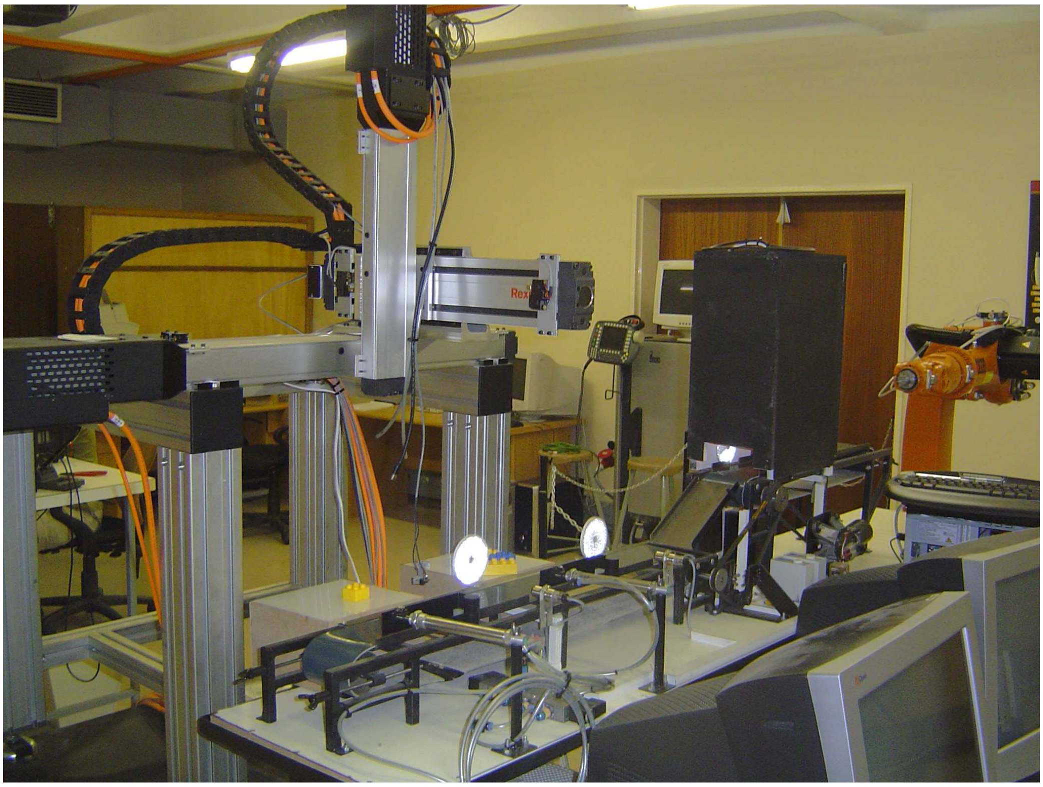

Figure 1-1: The Automated Manufacturing System

Research revolves around an Automated Manufacturing System. A dedicated laboratory is used to create the Automated Manufacturing System in and where researchers can conduct their research (Figure 1-1).

The Automated Manufacturing System consists of two conveyor belts (Conveyor A and Conveyor B) that carry small components of different shapes. A robotic arm (Figure 1-2) picks up the component and places it on Conveyor A. The component moves through an image processing area (Figure 1-3) where the shape of the component is determined. Depending on the shape, the component is classified as either Product A, Product B or a rejected product. From Conveyor A the component moves over a slope where the component will be weighed (Figure 1-3). From there it will move to Conveyor B.

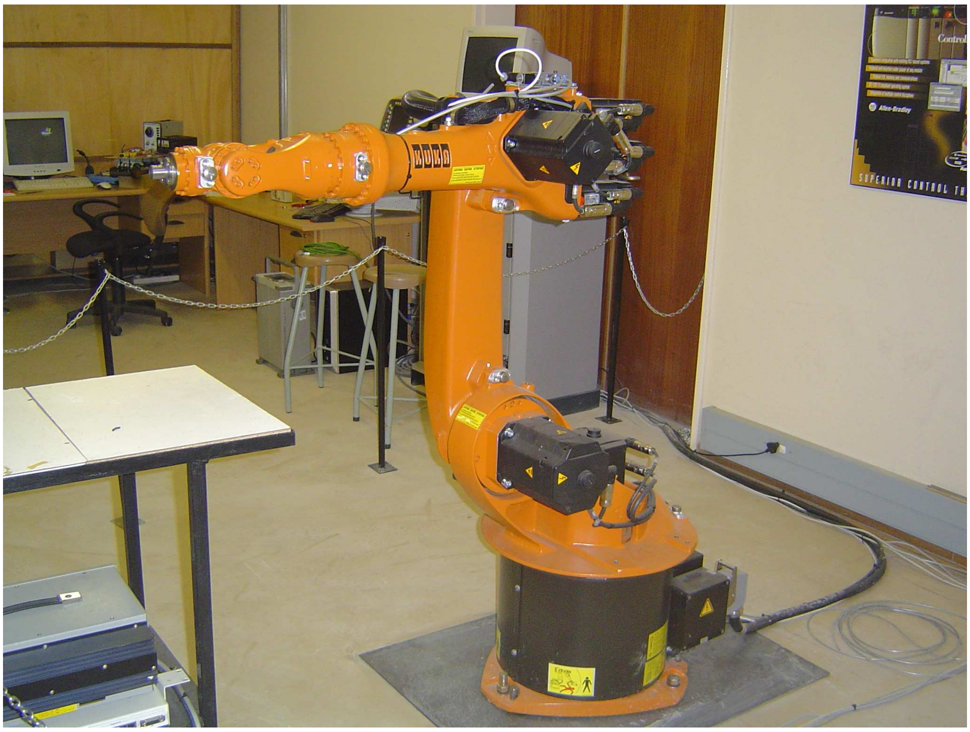

Figure 1-2: Kuka Robot Arm

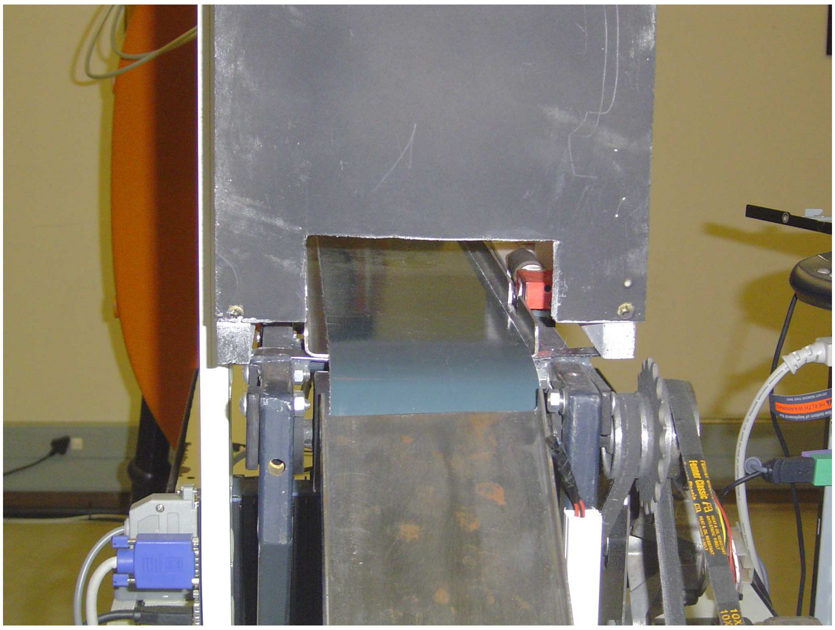

Figure 1-3: Image Processing and Weighing Area

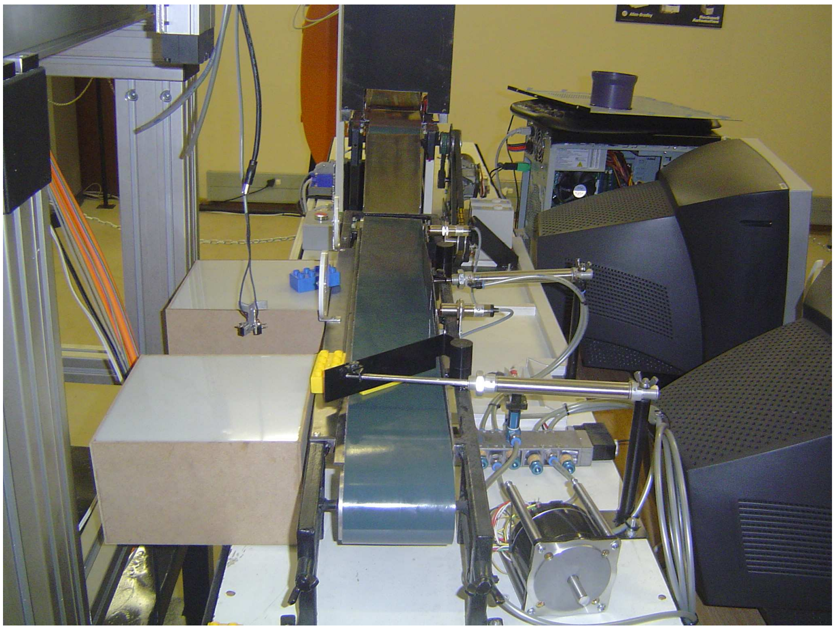

Figure 1-4: Conveyor B with the exits for the different types of products

When on Conveyor B, the product will be directed to the correct exit (Figure 1-4), depending on the type of product as determined at the image processing area. Another mechanical mechanism will pick the product from the exit area and place it on an Automatic Guided

Vehicle using a Cartesian robot for transportation of the component to a permanent storage area.

The conveyor is controlled by an Allen-Bradley programmable logic controller (PLC). Various sensors including speed, pressure and positional sensors provide input signals to the controller (Figure 1-5). Data from the system will be available as outputs from the controller, as well as the values of timers and counters of the controller. The PLC works with RSLinx software and from there the data is made available through the Internet via Allen-Bradley Ethernet Interface. An IP address is assigned to the Ethernet Interface whereby the PLC will be accessed.

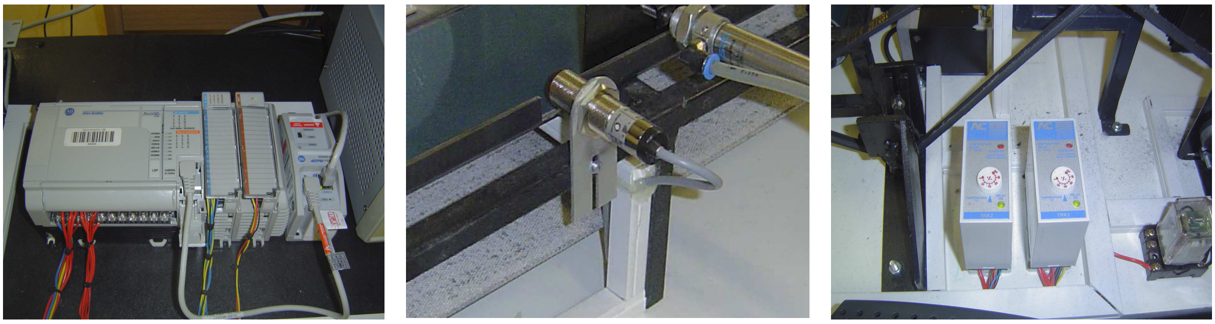

Figure 1-5: The PLC, Positional Sensor and Temperature Control Units

1.2 Purpose of this Study

With technology advancing, more and more people turn to the World Wide Web to conduct business. This may include buying and selling on the Web, advertising, and monitoring of business activities.

The Mechatronics Research Group has identified the need for remote monitoring of the Automated Manufacturing System. They want to be able to monitor the Automated

Manufacturing System from remote locations like their offices or, if possible, from home. They want to access a Web Site and see exactly what is happening at that moment and also get reports of what has happened at certain time periods.

The aim of this research project is to design and develop a Remote Information Management System for the existing Automated Manufacturing System. This system must be available on the Internet. The system will interact with the Automated Manufacturing System by accessing data from the PLC via the Ethernet Interface.

In the business world, a Remote Manufacturing System has advantages. It can enable telecommuting. Telecommuting is when employees can work from home using their computer. It also makes it possible to monitor business activities at weekends or when it is not possible to be at the physical location.

1.3 Hypothesis

The aim of this study is to demonstrate the following:

- LabVIEW can be used to create an Information Management System that will interact with the Automated Manufacturing System via a PLC.
- LabVIEW's Web features can be used to create a Web site that will provide remote access to the Information Management System and thus to the Automated Manufacturing System.

1.4 Satisfying the Hypothesis

The hypothesis will be satisfied if the following criteria are met:

- Real-time data can be captured from the Automated Manufacturing System via LabVIEW and made available for reporting.
- Accurate and timeous reports on the system performance and product manufacturing can be drawn.
- Remote access to the Automated Manufacturing System and Information Management System via the World Wide Web can be established.

1.5 Methodology Used in this Research

The main objective of this Research is to provide remote access to the Automated Manufacturing System. The word ‘remote’, indicates that the Automated Manufacturing System is not close to the site from which access is needed. To provide this remote access, a network system is necessary. The Internet is a world-wide network of computers that makes it easy to communicate remotely. It makes sense to use the Internet, because the infrastructure is already in place.

The first step to create the Remote Information Management (RIM) system, is to attach an Ethernet Interface to the PLC. This Ethernet Interface will provide an IP address to the PLC and make it accessible across the local network. OPC Client/Server Software is needed. The OPC Server Software will be installed on the computer that is directly connected to the PLC (the server) and the OPC Client software will be installed on the computers that need remote access to the PLC. This OPC Client/Server Software will not make the PLC available across the Internet, only within the local network.

The next step is to create the RIM system, using the appropriate development methodology. The RIM system should be created in LabVIEW because LabVIEW is not PLC specific. This means that the PLC can be changed without any effect on the RIM system. The RIM system should provide the following:

- A Virtual Instrument to monitor what is happening at the Automated Manufacturing System. This will be done in LabVIEW. The OPC Client/Server Software will provide the connection between LabVIEW and the PLC's register values.

- Two reports. The first is a report to indicate at what times the system was down and the reason why the system was down during a specified time period. The second report will indicate how many different components were manufactured during a specified time period. Logfiles will be created to monitor what is happening at the Automated Manufacturing System. The information for the two reports will be drawn from the data in these logfiles. The reports will be created in Microsoft Excel, using the LabVIEW Report Generation Toolkit.

- Remote Access to the Automated Manufacturing System. This remote access will be provided using LabVIEW's Web Publishing Tool. This tool will change the computer on which the Virtual Instrument will be installed, into a Web Server. The Web Publishing Tool will also create a Web page that will provide access to the Virtual Instrument. This Web Server and Web Page can then be accessed via the Internet.

1.6 Outline of Thesis

The outline of the thesis will be as follows:

- Chapter 1: Introduction to Remote Information Management

  The introduction will provide a short background on the situation that lead to this research as well as the research hypothesis and methodology.

- Chapter 2: Current Trends

  This chapter will highlight the current trend to also apply information management in the manufacturing sector and listing the advantages associated with it.

- Chapter 3: Development Methodology

  In this chapter three different development methodologies are described:

  - Linear Sequential Model
  - Prototyping Model
  - Rapid Application Development Model

  For each of these three development methodologies the different stages are described in detail. Then a decision is made to which of these methodologies should be used in the development of the Remote Information Management (RIM) system.

- Chapter 4: Rapid Application Development – Requirements Planning and User Design

  Requirements Planning and User Design are the first two stages of the Rapid Application Development (RAD) Methodology. This chapter describes how the development of the RIM system went through these two stages. During the Requirements Planning stage the current situation is researched and all requirements are defined and finalised. A project plan is created and approved. During the User Design data that will be used from the PLC are provided and a system design is created with the help of the end users.

- Chapter 5: Rapid Application Development – Rapid Construction and Transition

  Rapid Construction and Transition are the last two stages of the RAD Methodology. This chapter describes how the development of the RIM system went through these two stages. During the Rapid Construction stage the actual programming of the RIM system takes place. It is an iterative stage consisting of coding, testing and modifying. During the Transition stage the RIM system is implemented, training of users takes place and documentation is finalised.

- Chapter 6: Software Development

  This chapter describes the development of the software in a practical way, referring to critical elements, as well as problems encountered and how they were overcome.

- Chapter 7: Conclusion

  This chapter describes what has been achieved through this research project by looking back at what has been done, what obstacles were encountered and what end result were produced. Possibilities for future studies are also mentioned.

Chapter 2: Current Trends

2.1 Introduction

Competition in the manufacturing sector has lead to challenges to produce and deliver products with improved productivity, quality, service and costs. This requires a tight control and near-zero downtime of the plant floor, equipment and devices. Service and maintenance have become more and more important factors in competitiveness and companies must sustain their manufacturing productivity and customer service at the highest possible level [1].

Companies are changing their focus to machine reliability and high-quality service. The revolution is being driven by Web-enabled remote technology and prognostic methods [1]. The remote technology creates a zero-distance environment that enables users to interact with the system from anywhere in the world. Problems can be attended to even if the specialist is not on site and downtime can be minimised.

Two remote information management trends that are currently quite popular in the manufacturing sector, is the use of virtual plants and messenger systems. Virtual plants and messenger systems can be used separately or in conjunction with each other.

2.2 Virtual Manufacturing Plants

The virtual manufacturing plant is a distributed software architecture that models real industrial plants [2]. A remote and certified user will use the virtual plant to access the real plant for performing command actions and/or monitoring [3].

The virtual plant uses an application server to make the connection between the real plant and the virtual plant. The application server will contain the device object models that will be offered to use remotely. The application server will act as a middleman between application clients and the plant controller (the PLC) [3]. It will read data from the PLC and present it to the application clients via the Internet, using Internet protocols (TCP/IP).

End users will use the application clients (usually a Web-based application embedded within a Web page) to access the real plant. To ensure security, different profiles can be defined which allow users access to certain areas of the virtual plant only.

One advantage of virtual plants is that it has introduced a real-time monitoring option, allowing users to remotely monitor their plants over the Internet from anywhere in the world. If a problem occurs, users can view the real-time conditions of the affected plant area, diagnose the problem remotely and advise the on-site engineers on how to fix it. This will minimise costly plant failures, breakdowns and delays [4].

Ertugrul [5] discussed numerous ways in which virtual plants can be used in education, training and research:

- Virtual plants may be used as a lecturing tool in the classroom environment. The Internet links may bring the hazardous and dangerous laboratory into the classroom or learning environment. In the case of harsh and dangerous environment laboratories the users can access the complex, large or expensive plants remotely, and experience first hand system behavior via the Internet that is not possible or practical in the traditional laboratory practices. However, some legal issues must be solved before sharing sensitive information between the institutions, which can easily be solved by granting a limited access to the external users.

- The technology may also be used to provide hands-on industrial training facilities remotely for the engineering students. The potential employers of engineering graduates may provide a real training environment to prospective employees at the university level.
- Remote experimentation is not limited to education. In research and industry, remote access also represents an opportunity for the scientists and engineers who wish to share unique and expensive equipment. Therefore, it is expected that the collaborations between the higher education institutions and industrial organisations will increase and hence will provide opportunities to share the expensive and the complex experimental setups, training and teaching materials across the organisations.

From interfiews with specialists at Mittal Steel it has become clear that the virtual plant also has limitations. The virtual plant cannot take all external factors that might contribute to a problem into consideration. The person using the virtual plant only see what is presented on his computer screen, which might not always be the only contributing factors to a down-time situation.

2.3 Messenger Systems

Messenger systems make use of cellphone technologies to allow users to monitor and interact with manufacturing systems. These messenger systems are usually connected to a host computer that monitors system changes and archive data [6].

An example of a South African company using a messenger system is Mittal Steel, Vereeniging. When there is a problem causing manufacturing to stop for more than one hour, a message is sent to registered users to notify them of the delay. As soon as manufacturing is back on track, a message is sent to the registered users to notify them that the problem is solved. Registered users will also receive messages notifying them of the daily production statistics.

There are numerous advantages of the messenger system, especially in third-world countries where computers are seen as a luxury item. Even users that don’t own or have access to a computer are able to monitor the status of the manufacturing system.

The messenger system also has limitations. It is not possible to have all the functionality of a virtual plant in a messenger system. Specialists at Mittal Steel feel that the messenger system is primarily a one-way communication system. Even if you are able to send a command to the plant using the messenger system, these commands are fixed and pre-programmed and not always useful. This is the reason why some companies choose to use the messenger system in conjunction with the virtual plant.

2.4 Other Trends

With wireless communications gaining more and more ground, monitoring of manufacturing systems has also gone wireless. Croke, Donohoe and Raleigh [4] have identified manufacturing processes that are already using, or may in future use, wireless technology:

Industry	**Existing and future applications of wireless technology in manufacturing**
Petrochemicals Plants	• Pipeline monitoring system • Controller for pumping station • Intelligent controller for LPG bottling • Terminal automation system
Power Generation Units	• Supervisory system for captive power plants • Control system for switchyard control, substation and distribution automation • Custom solutions, protocol converters and data concentrators • Energy management systems • Data analysis software for sequential event recorders • Automated meter reading systems
Iron and Steel Plants	• Control system for sintering section, soaking section, electric arc furnace • Ladle furnace and continuous casting machine • Subsystem interface development for spectrometers, weighing system and special purpose controllers
Pulp and Paper	• Energy monitoring system using pulse transducers • Implementation of automated energy audit for various plant sections • Supervisory control and monitoring station for digestion station, for the production of chemical pulp, batch process for pulp bleaching and preparing dyes.
HVAC	• Particulate measurement/monitoring systems

	- Control of electrostatic precipitators using automatic voltage controllers - Data acquisition and monitoring systems – remote diagnostics - SO3/water injection control systems

Another new trend is the use of remote support centres. Manufacturing plants outsource their machine diagnosis to these remote support centres in order to reduce the cost of specialised technicians [7]. These support centres access the plant via the Internet. These centres have capabilities to remotely detect faults and reconfigure machine parameters. In such a setting, the majority of the monitoring personnel would be experienced engineers used to handling non-routine situations [4]. As with virtual plants, the limiting factor is that the virtual plant cannot take all external contributing factors into consideration.

2.5 Summary

To stay competitive, manufacturing companies have shifted their focus from business to service, improving manufacturing productivity, creating near-zero downtimes and cutting costs. Remote information systems have helped in achieving this. Popular remote monitoring systems are the virtual plant and messenger systems. Wireless technologies have also become more and more popular as well as the trend to outsource machine diagnosis to remote service centres.

2.6 References

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Chapter 3: Development Methodology

3.1 Introduction

As in any other engineering disciplines, software engineering also has some structured models for software development.

The term ‘methodology’, is one of those terms that can mean different things to many people. In the context of developing software, however, there should be one simple interpretation – ‘A methodology provides a methodical roadmap, framework, or guidance for developing software solutions derived from business needs.’ [1]

3.2 Agile Software Development

Agile Software Development is also called Adaptive Software Development. It promotes iteration throughout the entire duration of the project. Each iteration is an entire software project with planning, requirements gathering, coding, testing and documentation.

According to Cockburn and Highsmith [2] the term ‘agile’ has two distinct connotations. The first is the idea that the business and technology worlds have become turbulent, high speed, and uncertain, requiring a process to both create change and respond rapidly to change. The first connotation implies the second one: An agile process requires responsive people and organizations.

The most popular agile methodologies are:

- Extreme Programming
- Scrum
- Adaptive Software Development
- Crystal Methods
- Feature-Driven Development
- Dynamic Systems Development Methodology

The decision whether to use the traditional methodologies or the agile methodologies will depend on the type of project as well as the company and designers. Boehm and Turner [3, p. 55 – 57] suggested that each one has its own home ground.

Agile home ground:	Traditional home ground:
• Low criticality • Senior developers • Requirements change very often • Small number of developers • Culture that thrives on chaos	• High criticality • Junior developers • Requirements don't change too often • Large number of developers • Culture that demands order

Agile methodologies will not be considered for the purposes of designing the RIM system due to the following reasons:

- The agile method requires senior developers with extensive experience. The researcher does not have the necessary experience.
- The agile method emphasizes face-to-face communication over written documents. It produces very little written documentation. For the purpose of this research documentation is very important.

- The development of the RIM system will be process-centric rather than people-centric thus causing agile principles likely to fail.
- The agile method has a lack of structure and generally no comprehensive support for project management [4].

3.3 Traditional Software Development Methodologies

According to Stylusinc.com [5], the basic popular models used by many software development firms are:

- Linear Sequential Model
- Prototyping Model
- Rapid Application Development Model

3.3.1 Linear Sequential Model

This is also known as System Development Life Cycle Model, or Classic Life Cycle Model, or Waterfall Model. A diagram of the Linear Sequential Model is shown in Figure 3-1.

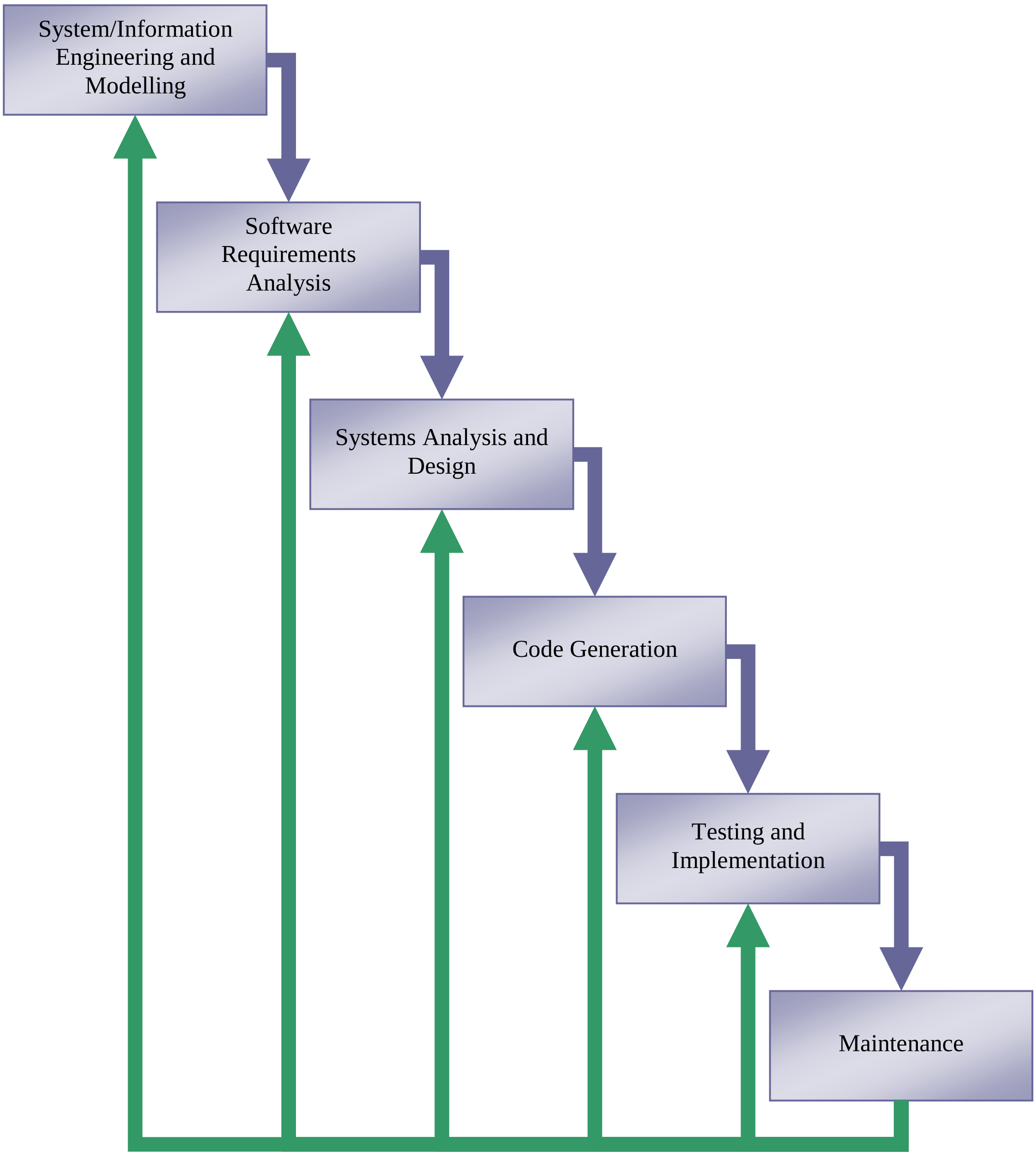
System/Information Engineering and Modelling
Software Requirements Analysis
Systems Analysis and Design
Code Generation
Testing and Implementation
Maintenance

Figure 3-1: Linear Sequential Model

The Linear Sequential Model has the following phases [5]:

1. System/Information Engineering and Modelling

2. Software Requirements Analysis

3. Systems Analysis and Design

4. Code Generation

5. Testing and Implementation
6. Maintenance

Each of these phases will now be discussed in more detail.

3.3.1.1 System/Information Engineering and Modelling

This phase will only be part of the development process if there is no system in place for which the software must be developed, or if the system is not well defined. Software will always be developed for a system. A system can be something like an accounting system, an inventory system or an ordering system. For this research, the system is already in place – the automated manufacturing system.

A system can also have subsystems. For example, the automated manufacturing system will have a subsystem to control the main system and a subsystem to monitor the main system. It is important to know for which system the software will be developed. For this research, software will only be developed for the monitoring subsystem.

This system view is essential when software must interface with other elements such as hardware, people and other resources [5]. If no system exists, then a system must be engineered into place.

A current system might need some re-engineering if it is not defined properly. At first, the monitoring subsystem was not defined well. Users of this system had to think what they wanted to monitor, from where they wanted to monitor it and in what way they would want to monitor it. As soon as they had decided all this, they knew that they needed certain software to help them to obtain this.

The next phase will commence as soon as the system is in place and the scope of the system is understood.

3.3.1.2 Software Requirement Analysis

The essential purpose of this phase is to find the need and to define the problem that needs to be solved [5].

In this phase the development team visit the client to study their current system and to find out what the client really needs. According to Schach [6, p.198 – 199], there are different methods to find out what the requirements are:

- Interviews: This is where you talk to certain members of the client organisation and ask questions regarding how they see the system and use the system and what they would want from the software. This is a very accurate way to define requirements, but can take up a lot of time.
- Questionnaires: This is more useful when you have to reach hundreds of individuals to determine their needs. This can be more accurate than interviews, because the answers might be more carefully thought-out.
- Examine existing information: Documents that is being used currently can also shed some light on what requirements there might be.

- Observation: By making use of video cameras to record the users in their work environment and to see exactly what is being done. Users might feel that this is invading their privacy, or see it as threatening.
- Scenario’s: By sketching the scenario’s in which a certain product might be used, users can understand and define their needs better.

When the requirements have been specified, a document must be set up to state whether it will be feasible and strategic to create the system. Time, budget, and personnel constraints must be taken into consideration. The document must include all the requirements, specific recommendations, personnel assignments, time schedule and costs for the project. This document will be presented to the client organisation and they must give their approval before work will continue. As soon as the document is approved, the next phase will start.

3.3.1.3 System Analysis and Design

During this phase, the specifications of the project will be defined. The specifications will include the following:

- What input data is needed and what is the source of the input data? The source of the input data can be the user that enters data into the system, or it can be a database or file from which data is read.
- What will happen to the data? This will define what processes will take place. Data can be stored in a file or database, or can be used to calculate certain information. Data can also be formatted in certain ways to make it more understandable to the user.

- What output data will be generated? Output data may include information being displayed on the computer screen or a report being printed out to a printer.

The graphical user interface of the software must be planned. The graphical user interface describes what the screen layouts will be and exactly how the user will interact with the software.

If a database will be used, then the database design has to be specified exactly. For example: what tables will you need, what fields should be included in each table, etc. All files that will be used, should also be designed.

All relationships between the data that will be used and the information that will be provided should be specified. Data Flow Analysis and Entity Relationship Diagrams will aid in this.

An important decision to make during this phase, is whether to make use of object oriented design, or structured design. The advantages and disadvantages of each have to be considered. Object oriented design is more popular, because it can lead to reusability.

If a client/server or any network architecture will be used, this also has to be designed. Take into consideration what hardware will be needed and if the current (if any) network structure can be used as is, or if any changes to the network structure might be necessary. Another important factor to consider, is whether middleware will be necessary to let the new software interact with current software.

When the design is finished, the next phase will start.

3.3.1.4 Code Generation

During this phase the design will be used to generate the software code. If the design was done properly and in detail, then this phase shouldn’t take too much time and effort.

Different software programming languages can be used to generate the code. The language that will be used, will depend mainly on what type of software it will be. For example, if the software is a web site, then the programming language must be a web-based programming language.

In some cases more than one programming language might be necessary. This is what happened in this research project. Two programming languages will be used, namely LabVIEW and Microsoft Visual C++. Most dynamic web sites were programmed using more than one language. HTML is used to create the basic structure and then scripting languages like Java or ASP is used to give it dynamic features like online buying and communicating with databases.

When the code generation is done, the next phase will start.

3.3.1.5 Testing and Implementation

The purpose of software testing is reliability, which requires error detection and removal. Software testing cannot turn a poorly designed software program into a good one, but it can help determine the level of reliability before the software is released for use.

Software testing is sometimes done by another company that specialises in software testing.

Test cases have to be prepared and debugging has to take place. Test cases detect errors, while debugging removes bugs and correct errors [1, p.712]. A software bug is a problem that causes a program to produce invalid output, or to crash (lock up). The problem is either insufficient logic, or erroneous logic.

Two types of testing that can be used are white-box testing and black-box testing. With white box testing, the software code is examined to ensure that they are logical. Black box testing is done with test cases to demonstrate that the software functions work, that the right output is being produced and that the database is accessed and updated correctly.

When the testing is done and all the problems and errors are fixed, the product can be delivered to the client organisation. There might be a need to train the users of the software to equip them with the necessary skills to make use of the software.

When the software is implemented successfully and the end users are confident that they can use the software, then the next phase will begin.

3.3.1.6 Maintenance

Software might need some changes after it has been delivered to the client organisation. Reasons for these changes can be a change in the system, a change in the needs of the users or hardware changes. To make changes to the software easier, the software must be developed to accommodate changes.

3.3.2 Prototyping Model

The prototyping model is an iterative model that can be used when it is difficult to determine all your requirements up-front. In most cases users don't actually know all of their requirements at the start of the project [7].

The key to prototyping is end user involvement in the development of the prototype [8]. There are also a lot of prototyping tools available to make the development of the prototype easier. With prototyping it is easier to understand the user's needs and the users can be sure that they will receive what they need.

With the linear sequential model, the user will only receive the software once it is finished. With rapid prototyping the user will know from the start what to expect and give their opinions on what they want and don't want.

The prototyping model consists of 5 phases [7] (as shown in Figure 3-2):

- Requirements Gathering
- Design
- Prototype Creation / Modification
- Assessment
- System Implementation

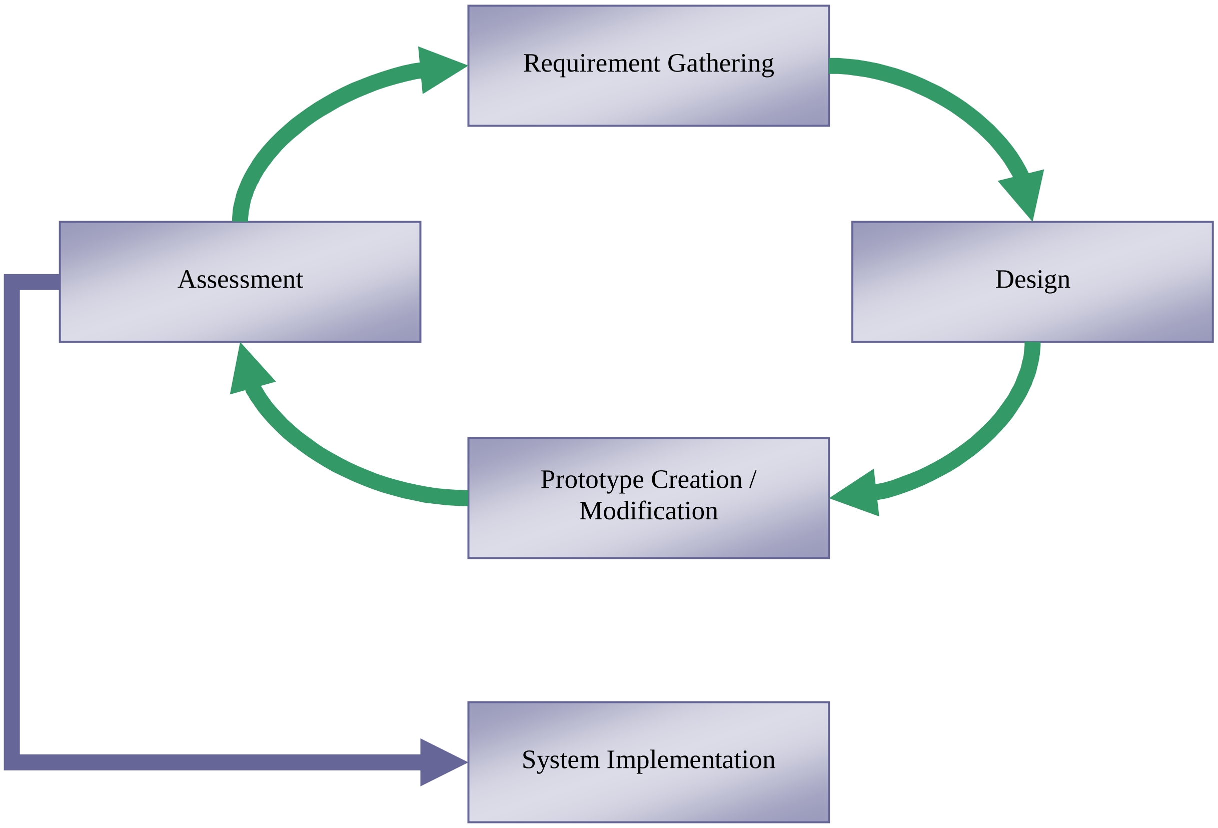

Figure 3-2: Prototyping Model

Each of these phases will now be discussed in more detail.

3.3.2.1 Requirements Gathering

This phase is almost the same as the requirements phase of the linear sequential model, but not in so much detail. The development team will basically just get an overall idea of what the software is supposed to do. The most important requirements will be the system inputs and the system outputs.

3.3.2.2 Design

Once the initial requirements are collected, it is integrated into a new or existing design so that it can be folded into the prototype.

3.3.2.3 Prototype Creation / Modification

The information from the design is used to create the prototype.

There are different ways to construct the prototype:

- Create the user interface of the software, showing the input and output without actually doing any processing. Users will see how the software will look when the development is finished and can give their opinion of what else is needed or should be changed.
- Create a working system that only performs a limited set of processes.
- Create a paper system that will show the screen layouts and output on paper.
- Use an existing system as an example to show some of the functions that will be included in the software.

The prototyping tools that can be used to construct the prototype are:

- Pencil and paper
- Drawing software
- Animation and Slide-show Software such as Microsoft PowerPoint
- "Visual" RAD tools such as Visual Basic.NET and Visual C#
- Fourth Generation Languages (4GLs) – computer languages that is more advanced than traditional high-level programming languages

- User Interface Management Systems (UIMS) – mechanisms for cleanly separating business logic from Graphical user interface (GUI) code in a computer program
- Executable Specification Languages such as CSP, Esterel and Lustre

3.3.2.4 Assessment

The prototype is presented to the user who will review it. If the user is satisfied with the prototype, then phase 5 will follow. If not, then the user will suggest some changes that will initiate phase 1 again. This iteration of phase 1 to 4 will continue until the user is completely satisfied that the development team understand their needs and will implement it correctly.

3.3.2.5 System Implementation

This is where the actual coding, testing and implementation of the software will take place. Sometimes the prototype is discarded completely and the coding starts from scratch. However, some prototyping tools already create a certain portion of the code and can therefore act as a building block for the actual software.

3.3.3 Rapid Application Methodology

The Rapid Application Methodology (RAD) aims to create applications very fast. It is an iterative process that will deliver a workable application very quickly. This methodology holds that a shorter process is preferred to a better system and therefore defers nonessential improvements to the system to a later version [10, p.609].

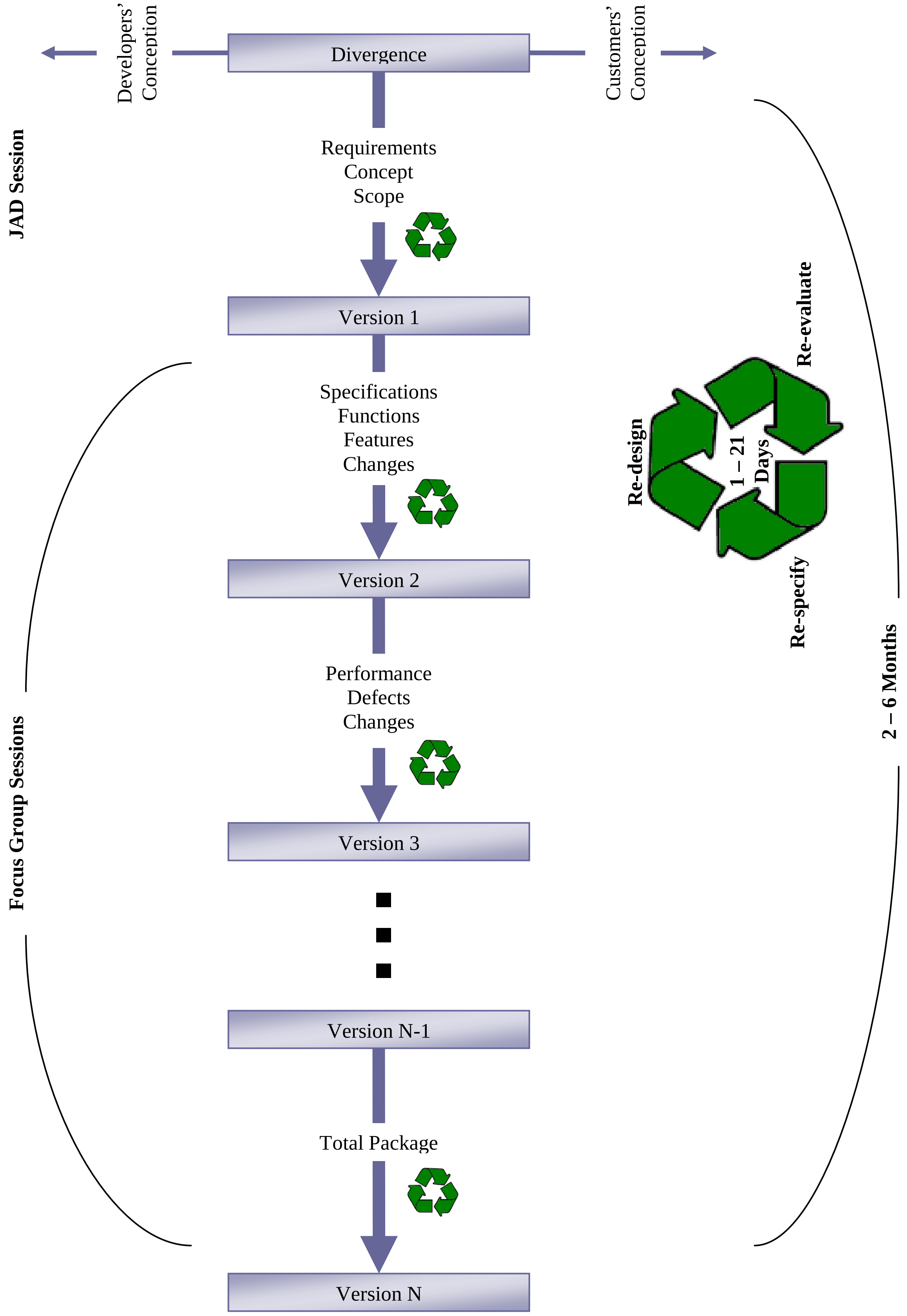

Figure 3-3: Rapid Application Methodology [9]

RAD implements a set of management techniques that are optimised for speed [11]. The three most important are:

- Prototyping: An approach where an incomplete program is created as soon as possible and then enhanced repeatedly according to user feedback.
- Iteration: A management technique where development is incremental and based on enhancement. Iteration and Prototyping goes hand in hand.
- Timeboxing: A management technique that focus on delivery. Under a timebox, scope can change, but delivery cannot.

The RAD software development life-cycle (SDLC) consists of the following four stages:

- Requirements Planning
- User Design
- Rapid Construction
- Transition

Each of these stages will now be discussed in more detail.

3.3.3.1 RAD SDLC Stage 1: Requirements Planning

During the requirements planning stage the current situation has to be researched to establish a general understanding of the business problems. System requirements have to be defined and finalised and approval obtained to proceed with the implementation.

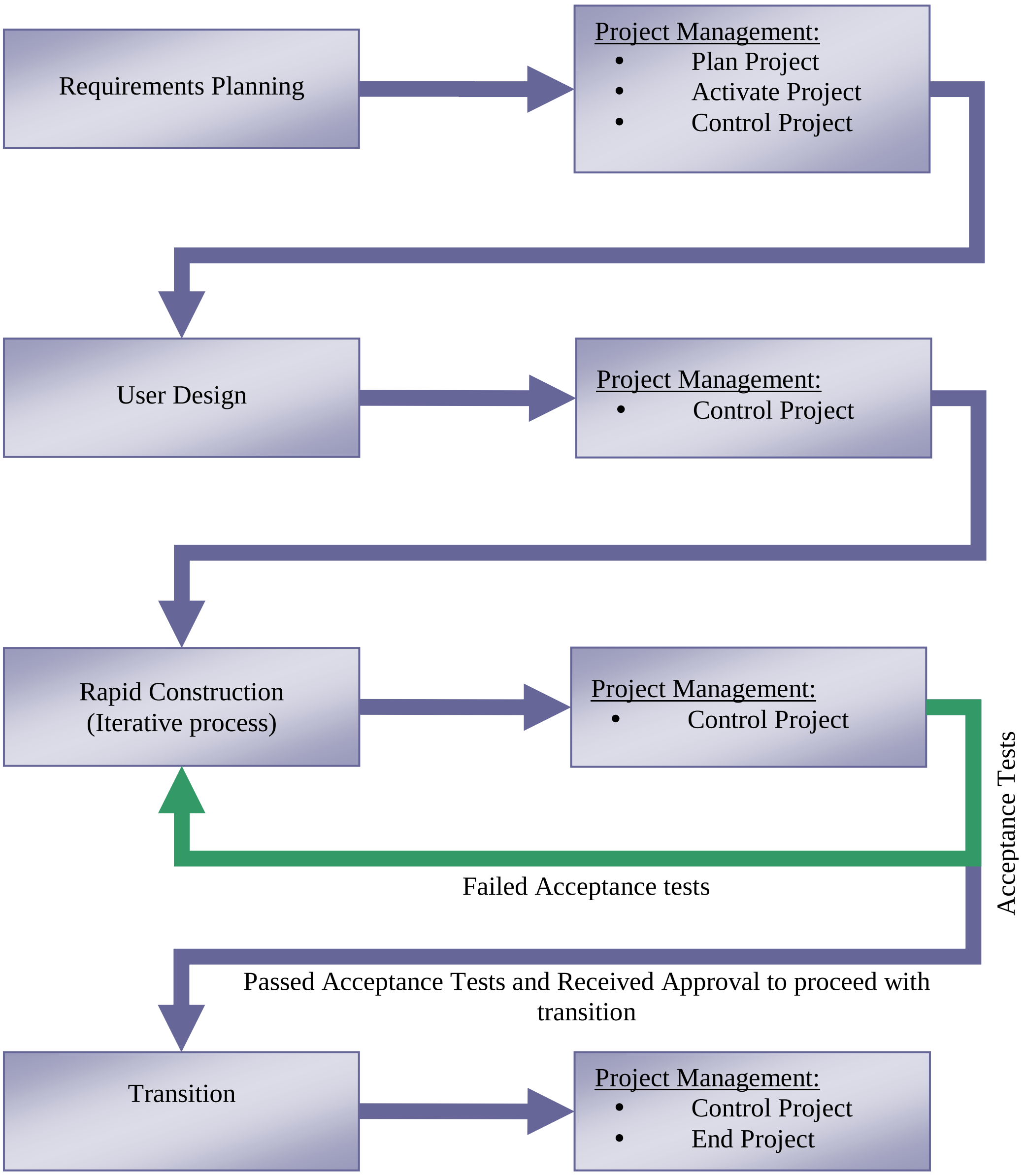

Figure 3-4: RAD Software Development Life-Cycle and Project Management Stages

3.3.3.2 RAD SDLC Stage 2: User Design

The User Design stage produces a detailed system area model. A detailed system area model will show the interactions between entities and processes. An outline system design will be created to define the system procedures. A transition plan will be developed that will indicate the tasks and resources required to implement the application. The user will be involved throughout the entirety of this stage. Approval has to be obtained to proceed with the construction of the system.

3.3.3.3 RAD SDLC Stage 3: Rapid Construction

The Rapid Construction stage is an iterative process in which the design of the proposed system is completed. The application software is created and implemented. Acceptance tests are performed to confirm correct operation. If the software passes the acceptance tests, preparations can be made for transition and approval can be obtained to proceed with the transition. If the software doesn't pass the acceptance tests, the stage has to be repeated until the software passes the acceptance tests.

3.3.3.4 RAD SDLC Stage 4: Transition

Preparations and planning for transition was made during the Rapid Construction stage. Now these plans will be put into action. This will include the training of users, data conversions and the installation of the system.

Four project management (PM) stages go hand in hand with the RAD software development life-cycle stages. They are:

- Plan Project
- Activate Project
- Control Project
- End Project

The first two project management stages (Plan Project and Activate Project) will be present during the first stage of the RAD software development life-cycle stages. The third project management stage (Control Project) will be present during all the RAD software development life-cycle stages. The last project management stage (End Project) will follow the last RAD software development life-cycle stage (Transition). Even if the project plan is not approved and the project doesn’t continue pass the Requirements Planning stage, it is still important to collect and retain project history [11].

Each of these stages will now be discussed in more detail.

3.3.3.5 RAD PM Stage 1: Plan Project

Plan Project defines the project and produces the detailed project plan. It identifies risks and ways to manage them. It also obtains approval to proceed with the project. The project plan includes the budget and schedule and serves as a contract between the client and the software developing company.

3.3.3.6 RAD PM Stage 2: Activate Project

The Activate Project stage launches the project and acquires and develops the project resources. Project resources include people, skills, facilities, equipment, hardware and software.

3.3.3.7 RAD PM Stage 3: Control Project

It is essential to control the project to ensure that everything is going according to the project plan. The project manager will control the project and manage any corrective actions needed. If the corrective actions fall outside the scope of the project plan, the project manager must consult with the client before any changes to the project plan can be made.

3.3.3.8 RAD PM Stage 4: End Project

The End Project stage will be triggered when the system is accepted or the plan is rejected. A completion report has to be created which will document the whole process. The final results have to be turned over to the client company and project resources have to be released.

3.4 Methodology Selection

It is thus clear that there are plenty of software development methodologies available; each being unique in the way it performs the core phases of a software development life cycle. An important factor for selecting a methodology, is whether it supports the type of system you intend to build [12].

The advantages of the different methodologies are:

Linear Sequential Model	Prototyping Model	RAD
It is an enforced discipline approach. It is documentation-driven; however, this can also be a disadvantage when the client	Early visibility. Better assurance that the product will meet the client's real needs. Feedback loops are less	Early visibility. Greater flexibility because developers can redesign almost at will. Can adapt to changing user

doesn’t understand the documentation [6]. Testing proceed continuously throughout the software process. Maintenance is relatively easy.	likely to be needed; therefore development of the product is essentially linear.	requirements. Increased user involvement. Reuse of existing components. Reduced manual coding. Shorter development cycles and therefore reduced cost.

The disadvantages of the different methodologies are:

Linear Sequential Model	Prototyping Model	RAD
There are no feedback mechanisms between phases. There are completion dates imposed on each phase of the software development lifecycle [12]. The duration it takes from inception to final delivery is huge. There is a long delay before the customer gets to see any results. By the time the system is deployed it might not fully meet the needs of its initial customers since: • The customer needs may have changed over time. • The system does not function in a manner that truly represents the real-word flow of business operations [12]. • The system is not intuitive to use, thus facing resistance to its adoption [12].	Difficult to manage. Prototypes tend to be shaped by the tools that are available, rather than by users’ needs [8]. Work on the prototype can take attention away from the problems to be solved. Developers can be trapped in an endless loop of refinement. Prototypes tend to lose the reasoning that went into them, for example, why decisions where made or which requirements led to a set of behaviours or functions [8].	It is harder to measure progress because there are no classic milestones. Reuse of existing components may lead to [9]: • Less efficient software • Reduced features • Unwanted features • Standardised look and feel • Legal problems May accidentally cause a return to the uncontrolled practices of the early days of software development [9]. Requirements may not converge because the interests of customers and developers may diverge from one iteration to the next [9].

Rapid Application Development has been chosen as the best methodology to follow for the development of the Remote Information Management (RIM) System. This is due to the following reasons:

- RAD is the best methodology to use in a changing environment. Because the Automated Manufacturing System is a research area in which different researchers are doing development in different fields, the requirements for the RIM system might change often. The linear sequential model and the prototyping model don’t provide for changes that occur after the coding process has started.

- The RAD methodology was developed to respond to the need to deliver systems very fast [11]. It is essential to create the RIM system to monitor the Automated Manufacturing System as soon as possible, in order to identify and isolate certain problems that might occur.

- It is suitable to use RAD when the project data already exists (completely or in part) and if the project largely comprises analysis, or reporting of the data [11]. With the automated manufacturing system, the data that are needed to create the RIM system is already available through the PLC and just have to be changed into report form by the RIM system.

It is therefore clear that RAD is the best methodology to use for creating the RIM system.

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Chapter 4: Rapid Application Development – Requirements Planning and User Design

4.1 Introduction

The Rapid Application Development (RAD) Methodology is used to develop the Remote Information Management (RIM) System. The RAD Methodology consists of four software-development life-cycle (SDLC) stages, which are supported by four project management (PM) stages.

In this chapter the first two SDLC stages, with their supporting PM stages, will be documented thoroughly, as the RIM System is being developed. The stages will take on the structure provided for Rapid Application Development by gantthead.com [1].

4.2 RAD SDLC Stage 1: Requirements Planning

Figure 4-1 shows the process flow of the Requirements Planning stage. The Requirements Planning stage consists of three processes:

- Research Current Situation
- Define Requirements
- Finalise Requirements

All three processes are applicable to the development of the RIM system and will be documented in detail.

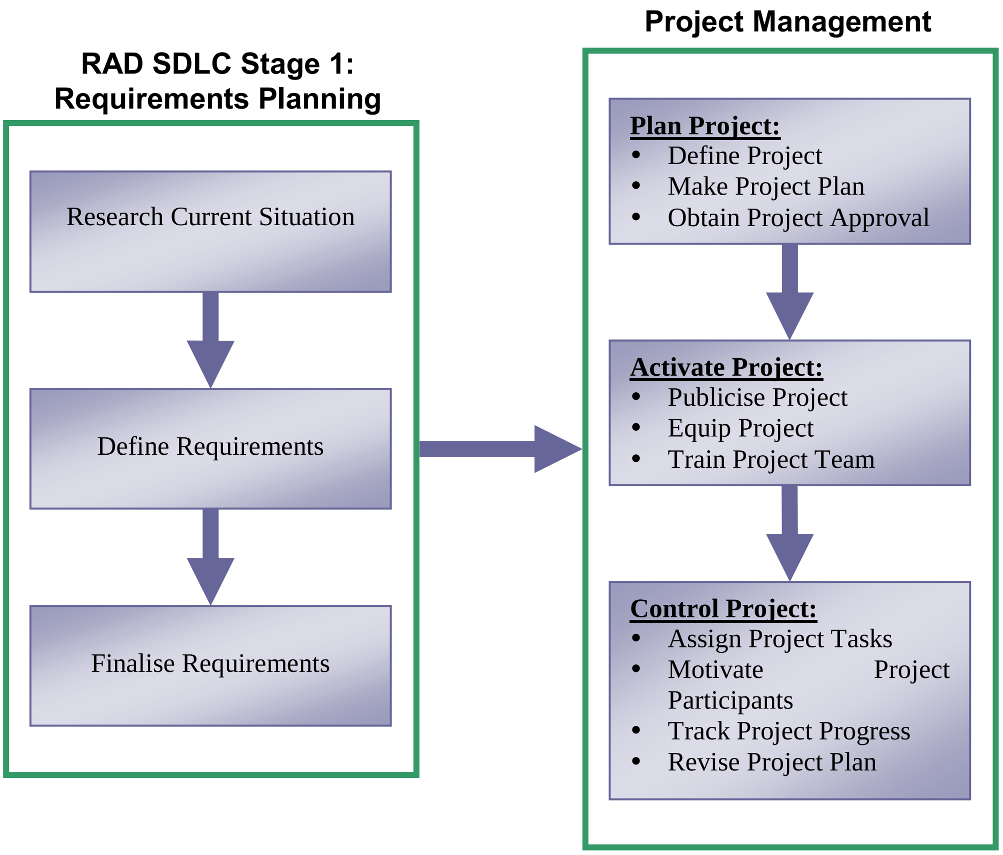

Figure 4-1: Process Flow of the Requirements Planning stage

The Project Management stages that are applicable to this stage, will also be documented in detail. They are:

- Plan Project
- Activate Project
- Control Project

4.2.1 Research Current Situation

The information that is used to create the initial system area model, was developed during formal and informal discussions with various people involved in the development of the

Automated Manufacturing System. This research was conducted in preparation for the requirements definition.

Initial System Area Model

The Automated Manufacturing system is still in a process of development. Currently it consists of a conveyor belt that carries small components of different shapes. The system is designed to transport the small components that are placed on the conveyor, through the different "modules" of the complete system, to:

- do quality assurance on the specific component using image processing,
- weigh the component,
- direct the component to the correct exit,
- pick the component from the exit area and
- place the component on an Automatic Guided Vehicle using a Cartesian robot for transportation of the component to a permanent storage area.

See Figure 4-2 for a photo of the initial Automated Manufacturing system.

The conveyor is controlled by an Allen-Bradley programmable logic controller (PLC). Various sensors including speed, pressure and positional sensors provide input signals to the controller. Data from the system will be available as outputs from the controller, as well as the values of timers and counters of the controller. A Web camera will be connected to the system for even more remote monitoring possibilities.

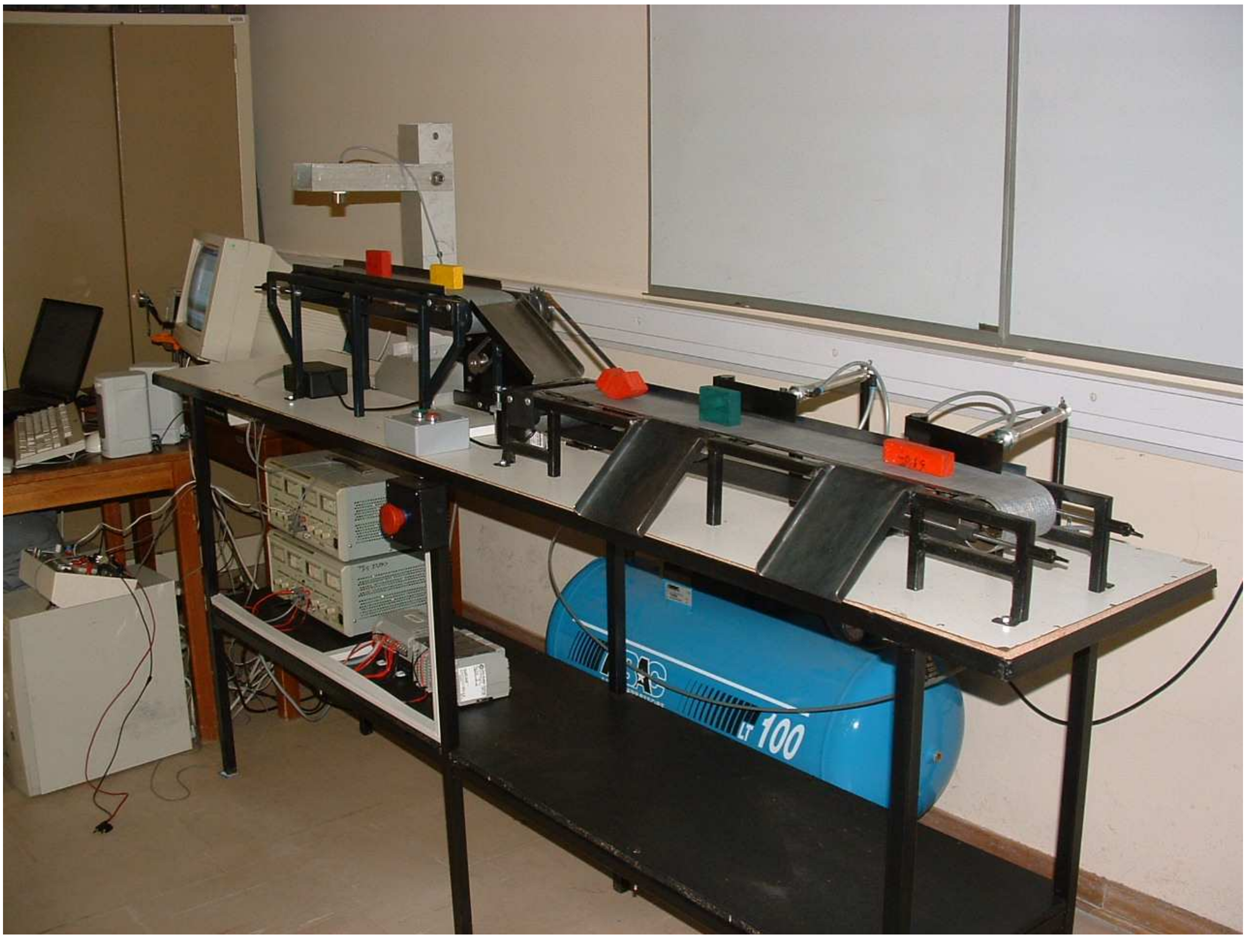

Figure 4-2: The Initial Automated Manufacturing System

The PLC works with Rockwell Automation's RSLinx software and from there the data is made available through the Internet via the Allen-Bradley Ethernet Interface. The Ethernet Network Interface allows you to easily connect non-Ethernet controllers onto new or existing Ethernet networks and upload/download programs, communicate between controllers and generate e-mail messages via SMTP.

In the current manufacturing system, this Ethernet device is used in conjunction with the Object Linking and Embedding (OLE) for Process Control (OPC) Server and OPC Client applications, to make the data available over the Internet (Figure 4-3).

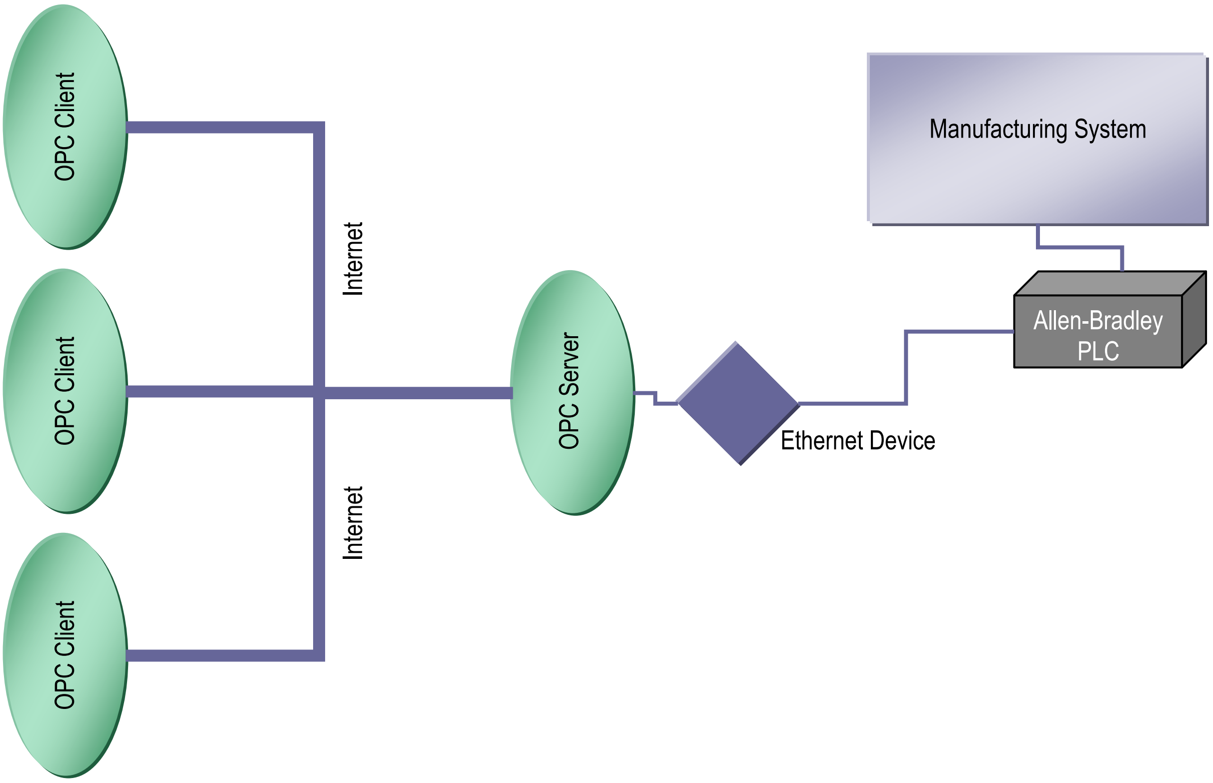

Figure 4-3: The Ethernet Interface

4.2.2 Define Requirements

The requirements were defined during formal and informal discussions with various people involved in the development of the Automated Manufacturing System.

Outline system area model

From the initial system area model, the following business processes can be identified:

- Image processing
- Component direction
- Transportation of components

- Storage of components

From the image processing and component direction processes, the following will be controlled and monitored via the PLC:

- Whether the conveyor belt is on or off.
- Image processing information will identify a component as either component A, component B, or rejected.
- The number of components A and B.
- The number of rejected components.
- The temperature of the conveyor belt motors. If the temperature is too high, the system will stop automatically.
- The skewness of the conveyor belts. If any one of the conveyor belts is skewed left or right, the system will stop automatically.
- A pressure sensor will monitor the pressure. If the pressure is too low, the system will stop automatically.

The transportation and storage of components fall outside the scope of this research project.

The scope of the RIM system

The following will be required from the Remote Information Management (RIM) System:

- Access the data from the PLC through the Internet via the Ethernet Interface.
- Develop a Virtual Instrument (VI) in LabVIEW to view data. The VI has to be developed in LabVIEW because then another manufacturer's PLC can be used with no changes required to the RIM system.

- Display the following information in Excel format:
    - Number of components for a certain time period.
    - Number of different types of components.
    - Number of components not up to standard / rejected.
    - Time that the conveyor belt worked and didn't work in a certain time period.

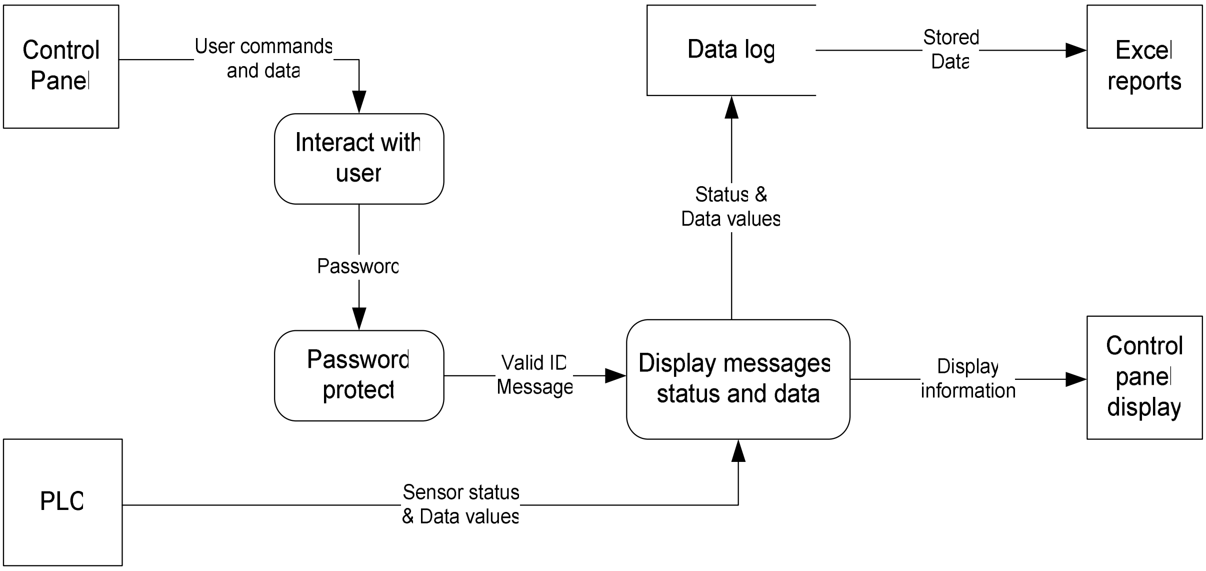

Figure 4-4: Preliminary Data Flow Diagram

The RIM system will only provide monitoring capabilities to remote users. Further enhancements can be made by adding control capabilities to the system. This will fall beyond the scope of this research.

<u>Potential benefits, costs and risks associated with the RIM system</u>

The benefits received from this system are:

- The Automated Manufacturing System can be monitored from a remote location.
- System faults can be isolated and persistent faults can be identified.

The system can prove to be cost saving due to the fact that it will not be necessary for users to physically go to the Automated Manufacturing system to monitor it.

A possible risk can be that hackers can get access to the web server and view confidential information. The importance of this risk will depend on the firewall and network settings of the company. At the CUT, firewall and network settings are set up in a way that will make it impossible for hackers to access the web server.

Constraints, limitations and other business concerns that could affect the development and transition of the proposed system

As mentioned above, the CUT firewall and network settings are very strict. Therefore it might not be possible to access the web server from outside the CUT network unless an additional router and switches are bought and installed to create a safe environment. This is a major development that won’t be approved for this research project. In companies where these resources are already available, this will not be a problem.

4.2.3 Finalise Requirements

Estimate of the resources required to implement the system

The hardware that will be used is:

- The current Automated Manufacturing System
- The PLC connected to the Automated Manufacturing System
- The Ethernet Device

- The Web Cameras
- A PC to use as the Web Server

The software that will be used is:

- Microsoft Windows XP (Operating System)
- National Instruments LabVIEW 7.1
- National Instruments LabVIEW Report Generation Toolkit (has to be installed separately)
- Rockwell Automation RSLinx Software (includes the OPC Client/Server Software)
- Microsoft Visual C++ 6.0
- Microsoft Excel (includes Microsoft Visual Basic to create Macros)
- Microsoft Notepad

The team:

- The RIM system will be developed by only one person.

All the hardware and software necessary to develop the RIM system are already available; therefore no additional hardware and software costs will be encountered.

Estimate of the elapsed time necessary to implement the system

Technology Study: Study the different technologies that make up the Automated Manufacturing System and the technologies (hardware & software) that will be used to create the RIM System.

Time frame: July 2004 – November 2004

System Development: Create and install the application.

Time frame: January 2005 – September 2005

Documentation: Complete documentation of the whole research project.

Time frame: October 2005 – November 2005

The planned time necessary to implement the system will be approximately 17 months.

Obtain approval to proceed with the implementation

The proposal for the project was approved on 27 July 2004.

4.2.4 Project Management

The project management stages are performed in parallel with the three processes of Requirements Planning.

4.2.4.1 Plan Project

The Plan Project stage consists of three processes. They are:

1. Define Project
2. Make Project Plan
3. Obtain Project Approval

The information needed for the first two processes was gathered during the three processes of the Requirements Planning stage.

Define Project

The purpose of the system is to monitor the Automated Manufacturing System and retrieve information across the Internet from the PLC connected to the manufacturing system. See the Requirements Planning Stage for more information about the current situation and the new system requirements.

Make Project Plan

The project plan is the foundation of project management and is the basis for activating the project, controlling it throughout its duration, and ending it in a controlled manner [1].

PROJECT PLAN

1. INTRODUCTION

1.1 Project Overview

The objective of the project is to create a Remote Information Management (RIM) system to enable users to remotely monitor an Automated Manufacturing System. The RIM system must provide remote users with the option to view logged data in the form of Excel reports.

The product to be delivered, will be the installed RIM system with complete documentation for the remote user as well as the local system operator.

Hardware and software resources that will be required during this project are already available. Only one person will make up the development team. The project will start in July 2004 and end in November 2005. No additional costs are expected.

1.2 Project Deliverables

The installed RIM system together with complete documentation for the remote user, as well as the local system operator, will be delivered by the end of September 2005.

1.3 Evolution of the Project Plan

No plan can be cast in concrete. Continual updating of the project plan will be required. All members involved in the development of the RIM system must be aware of any changes in the project plan.

1.4 Reference Materials

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1.5 Definitions and Acronyms

Definitions

Automated: Made or done by a machine.

Dynamic Link Library: A file containing executable code and data bound to a program at load time or run time, rather than during linking. Several applications can share the code and data in a dynamic link library simultaneously.

Excel: A spreadsheet program written and distributed by Microsoft. It features an intuitive interface and capable calculation and graphing tools.

LabVIEW: A graphical programming language that has been widely adopted throughout industry, academia, and government labs as the standard for data acquisition and instrument control software.

Project Management: The discipline of defining and achieving targets, while optimising the use of resources (time, money, people, materials, energy and space).

Acronyms

CUT:	Central University of Technology
DLL:	Dynamic Link Library
LabVIEW:	Laboratory Virtual Instrument Engineering Workbench

PLC:	Programmable Logic Controller
PM:	Project Management
RAD:	Rapid Application Development
RIM:	Remote Information Management
SDLC:	Software Development Life-cycle

2. PROJECT ORGANISATION

2.1 Process Model

The RIM system will be developed, using the Rapid Application Development (RAD) Methodology. This will include thorough testing of the system, to ensure its proper function. Acceptance testing will be done by members of the Mechatronics Research Group, as they will be the users of this system. Project Management will be used throughout development, to ensure the system development goes according to plan.

The milestones of the project are as follows:

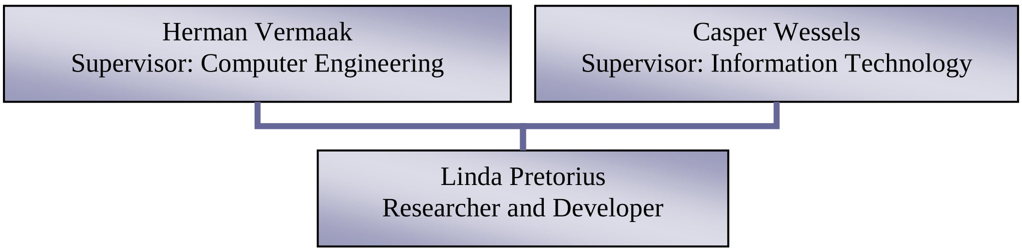
- Technology study: The researcher will study the current system and technologies, the software and hardware needed to create the RIM system. This must be completed by the end of November 2004.
- Development and implementation of the RIM system: The complete RIM system must be developed, tested and implemented by the end of September 2005. All user and operator manuals must be completed by then.
- Finalisation of system documentation: Full documentation on the RAD Software Development Life-cycle must be completed by the end of November 2005.

The deliverables of the project are as follows:

- The complete system including the user and operator manuals.
- Documentation of the entire RAD SDLC.

2.2 Organisational Structure

The RIM system will be developed as a research project with one person doing the researching and developing. There are two supervisors for this research project due to the fact that it crosses the boundaries of Information Technology and Computer Engineering.



2.3 Organisational Boundaries and Interfaces

As mentioned in section 2.2, the RIM system will be developed as a research project. This research project forms part of a bigger research project surrounding the Automated Manufacturing System. Research involves mostly Electrical Engineering and Mechanical Engineering researchers. They have formed a research group called the Mechatronics Research Group. Other research projects will include image recognition, programming of the PLC, controlling robots and creating guided vehicles. There will be interaction between members of the Mechatronics Research Group.

These will take the form of formal meetings. Informal discussions will also take place.

For the RIM system research project, other members of the Mechatronics Research Group will be involved in defining the system requirements. They will also be involved in the acceptance testing of the system, as they will be users of the system.

2.4 Project Responsibilities

The researcher will be responsible for the following:

- System Development, Testing and Implementation
- Project Management
- Documentation

A member of the Mechatronics Research Group will be identified to do the acceptance testing.

3. MANAGERIAL PROCESS

3.1 Management Objectives and Priorities

Frequency and Mechanism of Reporting

Quarterly progress reports will be completed. Any deviations from the planned progress must be noted and reasons for these deviations must be provided.

Priorities Among Requirements

All requirements carry the same priority.

Schedule for the Project

Technology Study: Study the different technologies that make up the Automated Manufacturing System and the technologies (hardware & software) that will be used to create the RIM System.
Time frame: July 2004 – November 2004

System Development: Create and install the application.
Time frame: January 2005 – September 2005

Documentation: Complete documentation of the whole research project.
Time frame: October 2005 – November 2005

The planned time necessary to implement the system will be approximately 17 months.

Budget for the Project

All the hardware and software necessary to develop the RIM system are already available; therefore no additional hardware and software costs will be encountered.

3.2 Assumptions, Dependencies, and Constraints

The development of the RIM system is dependant on the programming of the PLC. The assumption is made that the programming of the PLC will be finished by the end of September 2005.

The CUT’s firewall and network settings are very strict. Therefore it might not be possible to access the web server from outside the CUT network, unless an additional router and switches are bought and installed to create a safe environment. This is a major development that won’t be approved for this research project.

3.3 Risk Management

The biggest risk factor is that the researcher’s workload might interfere with the research and that the project might not be finished on schedule. If this proves to be the case, changes to the schedule have to be made.

3.4 Monitoring and Controlling Mechanisms

The Mechatronics Research Group has formal meetings where progress and problems can be discussed. Quarterly Progress Reports, completed by the researcher and signed by the supervisor, must be completed.

3.5 Staffing Plan

For the entire duration of this project, three persons will be required. They are:

- The researcher and developer – Ms. Linda Pretorius
- Supervisor: Computer Engineering – Dr. Herman Vermaak
- Co-Supervisor: Information Technology – Mr. Casper Wessels

4. TECHNICAL PROCESS

4.1 Methods, Tools, and Techniques

The hardware that will be used for the development of the RIM system are:

- The current Automated Manufacturing System
- The PLC connected to the Automated Manufacturing System
- The Ethernet Device
- The Web Cameras
- A PC to use as the Web Server

The software that will be used for the development of the RIM system are:

- Microsoft Windows XP (Operating System)
- National Instruments LabVIEW 7.1
- National Instruments LabVIEW Report Generation Toolkit (has to be installed separately)
- Rockwell Automation RSLinx Software (includes the OPC Client/Server Software)
- Microsoft Visual C++ 6.0

- Microsoft Excel (includes Microsoft Visual Basic to create Macros)
- Microsoft Notepad

A PLC is connected to the Automated Manufacturing System, which allows the operator to monitor and control the system locally. RSLinx Software will be used to program the PLC. The programming of the PLC falls outside the boundaries of this research project, but this research project is dependant on the programming of the PLC. To enable remote monitoring and controlling, OPC Client/Server software will be used to view the values of the PLC remotely.

The RIM system will be developed in LabVIEW 7.1. This is part of the requirements for the system because then the system will be PLC independent. This means that a PLC from any manufacturer can be used without any changes to the RIM system. LabVIEW will be able to read the values of the PLC registers via the OPC Client software. These will be real-time values. All values will be saved in a Log File. A new Log File will automatically be created daily, but the operator will have an option to create a new Log File at any time.

Because LabVIEW’s file handling is insufficient, Microsoft Visual C++ will be used to create shared library (DLL) files that will be used to do the searching through the Log Files. Any language can be used to write DLLs as long as the DLLs can be called using one of the calling conventions LabVIEW supports. Microsoft Visual C++ is used because it is recommended by National Instruments.

The reports will be created with the use of the LabVIEW Report Generation Toolkit. This toolkit does not come standard with LabVIEW and must be installed separately. The toolkit allows you to create and manipulate HTML, Microsoft Word and Microsoft Excel reports. The requirements specify that the reports should be Microsoft Excel reports. The Report Generation Toolkit will be used to call and run Macros that will be recorded in Excel to create the reports.

The RIM system will be installed on a PC located at the Automated Manufacturing System. LabVIEW will be used to change this PC into a Web Server. A Web Page will be created using LabVIEW and HTML to make the RIM system available to remote users.

The Rapid Application Development (RAD) Methodology will be used to develop the system.

4.2 Software Documentation

User documentation will be created for the remote users as well as the local operator of the RIM system.

The entire progress of project development will be documented.

4.3 Project Support Functions

Quality Assurance

A proposal was submitted to the Research Committee to ensure that the research is up to standard. The supervisors will help to ensure that quality is built into the project.

Test Plans

The software code will be tested by the researcher/developer.

Acceptance testing will be done by a member of the Mechatronics Research Group.

5. WORK PACKAGES, SCHEDULE, AND BUDGET

5.1 Work Packages

Technology Study: Because the developer/researcher has very little knowledge of Electrical & Computer Engineering, these technologies that are involved in the development of the RIM system, have to be studied. This includes the functions of a PLC and the accompanying RSLinx software. LabVIEW and Visual C++ also have to be studied by the developer/researcher.

Development and Implementation: The RIM system has to be developed. The necessary connection with the PLC has to be made and the values read into the LabVIEW Virtual Instrument (VI). The DLLs have to be developed in Visual C++ to search through the Log Files. The Excel Reports have to be created using Microsoft Excel and the LabVIEW Report Generation Toolkit.

Documentation: The whole project development process has to be documented. Remote user and local operator manuals must be created.

Testing: The code has to be tested for errors and acceptance testing has to be done. If the system does not pass the acceptance testing, the code has to be revised.

5.2 Dependencies

The development of the RIM system is dependent on the programming of the PLC.

5.3 Resource Requirements

All the necessary hardware and software are already available. Three staff members are necessary. They are the researcher/developer and the two supervisors. They will all be involved for the entire duration of this project.

5.4 Budget and Resource Allocation

No additional costs are expected.

5.5 Schedule

Technology Study

Study the different technologies that make up the Automated Manufacturing System and the technologies (hardware & software) that will be used to create the RIM System.

Time frame: July 2004 – November 2004

System Development

Create and install the application.

Time frame: January 2005 – September 2005

Documentation

Complete documentation of the whole research project.

Time frame: October 2005 – November 2005

The planned time necessary to implement the system will be approximately 17 months.

Obtain Project Approval

As was stated under the Finalise Requirements process, the proposal for the project was approved on 27 July 2004.

4.2.4.2 Activate Project

Publicise the Project

The need for this project was identified in 2003. The researcher only became involved at the beginning of 2004. When the decision was made to start this project, supervisors for the research project were identified. Future end users were notified to identify the system requirements.

After the approval of the project proposal, quarterly progress reports have to be submitted to monitor the progress of the project. Formal and informal meetings between the members of the Mechatronics Research Group and the researcher and supervisors are held to communicate about the project's progress and activities and to manage expectations about the project results.

Equip Project

All the necessary facilities, hardware, software and people, as stipulated in the Project Plan, were already available even before the project proposal was approved.

The Automated Manufacturing System is situated in a dedicated laboratory and for the time being a temporary PLC is connected to the system. The actual PLC will be connected as soon as programming of the PLC is finished. Web cameras have to be installed. This is the responsibility of another member of the Mechatronics Research Group.

The Allen Bradley Ethernet Interface is connected to the PLC to make it available via the Internet. OPC Server and Client software are installed to access the PLC via the Internet.

LabVIEW, RSLinx and Visual C++ Software are installed on the researcher/developer's computer so that it can be studied.

A computer is available at the Automated Manufacturing System to use as a Web server and to install the RIM system on.

Train Project Team

The RIM System will be developed by only one person. An understanding of how the manufacturing system will operate, is necessary. A basic knowledge of a PLC, is also necessary. LabVIEW, RSLinx and Visual C++ Software will have to be studied. All these skills will be acquired through self-study.

4.2.4.3 Control Project

Assign Project Tasks

The first task that must be performed is the Technology Study. The researcher/developer must study the operation of the Automated Manufacturing System. The researcher/developer must understand how a PLC work and have a basic knowledge of the RSLinx software (this includes OPC client/server software). Most importantly, the researcher/developer has to study LabVIEW and the LabVIEW Report Generation Toolkit and become familiar with its environment.

As been mentioned previously, the development of the RIM system is dependent on the programming of the PLC. At the moment this is not a problem, as code generation will only take place later. The test PLC that is connected to the Automated Manufacturing System will be sufficient.

Motivate Project Participants

Due to the fact that there is only one person involved in the development and the project management of the RIM System, this step doesn't apply.

Track Project Progress

The Requirements Planning stage started as early as April 2004, when the project proposal was created. There were no delays during this stage.

The researcher/developer studied the current environment and became more familiar with the functioning of the PLC during the Requirements Planning stage. LabVIEW and the accompanying Report Generation Toolkit were studied during the last months of 2004.

Revise Project Plan

No changes have been made to the project plan.

4.3 RAD SDLC Stage 2: User Design

Figure 4-5 shows the process flow of the User Design stage. The User Design stage consists of six processes:

- Produce Detailed System Area Model
- Develop Outline System Design
- Refine System Design
- Prepare Implementation Strategies
- Finalise System Design
- Obtain Approval for Construction

All six processes are applicable to the development of the RIM system and will be documented in detail.

The Control Project stage is the only Project Management stage that is applicable to this stage and will also be documented in detail.

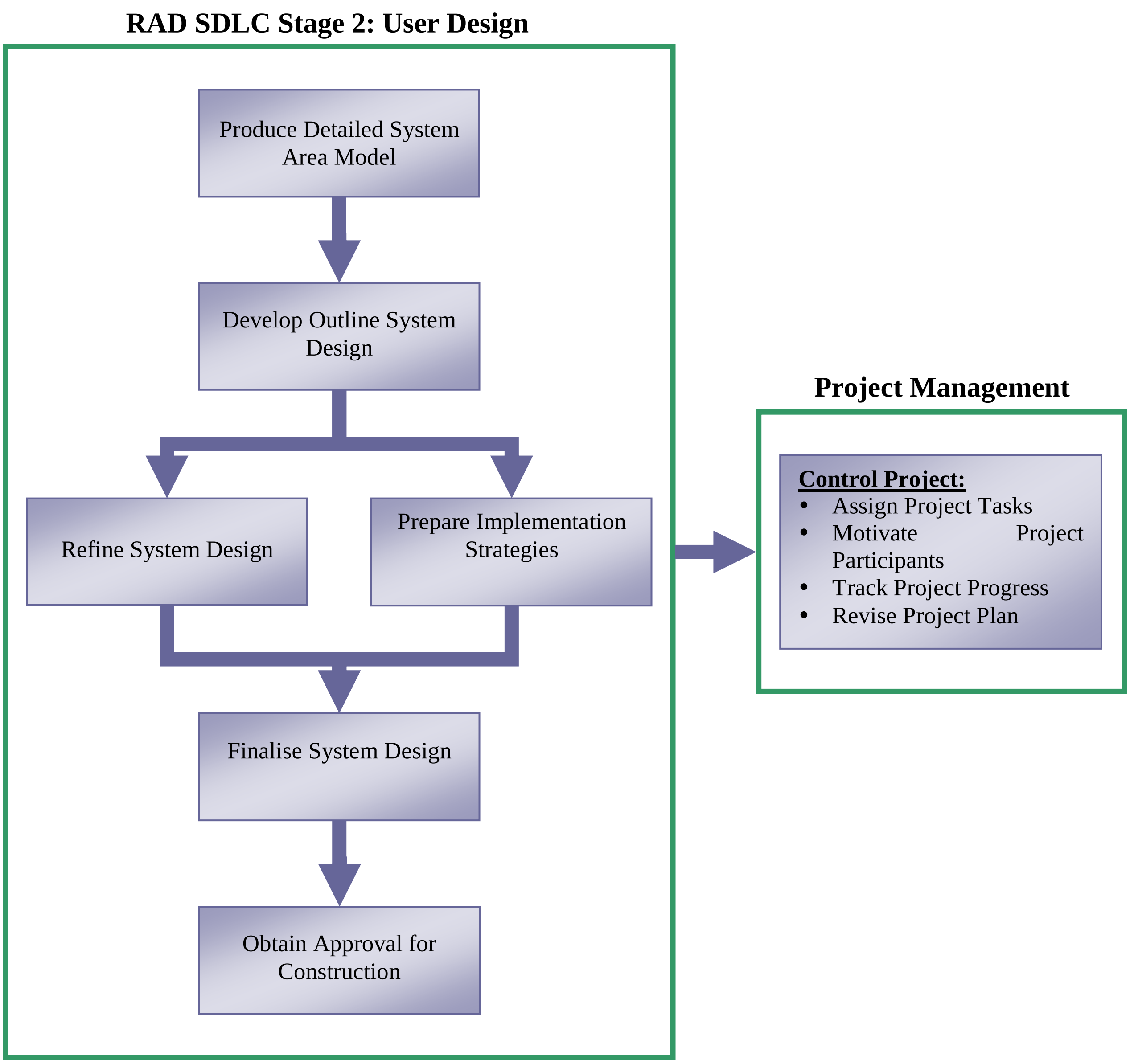

RAD SDLC Stage 2: User Design
Produce Detailed System Area Model
Develop Outline System Design
Refine System Design
Prepare Implementation Strategies
Finalise System Design
Obtain Approval for Construction
Project Management
Control Project:
Assign Project Tasks
Motivate Project Participants
Track Project Progress
Revise Project Plan

Figure 4-5: Process Flow of the User Design stage

4.3.1 Produce Detailed System Area Model

The RIM system will get the following information from the PLC:

Table 4.1: PLC Registers and Values

Information	**PLC Register**	**Data**	**Meaning**
Whether the Automated Manufacturing System is on or off.	O:0.0	Digital	If the value is 0, then the Automated Manufacturing System is off. If the value is 1, the Automated Manufacturing System is on.
The number of components A, B and rejected components.	C5:0.ACC (Component A) C5:1.ACC (Component B) C5:2.ACC (Rejected Components)	Analogue	Actual values will be shown.
The temperature of conveyor belts' motors.	B3:2 (Motor Temperature) B3:4 (Conveyor Drive Temperature)	Analogue	The values will be 10ºC lower than the actual values and must be adjusted in the RIM System.
The temperature of the conveyor belts' motors.	I:1/6 (Motor Temperature) I:1/7 (Conveyor Drive Temperature)	Digital	A value of 0 will indicate that the temperature is too high and a value of 1 will indicate that the temperature is fine.
The skewness of the conveyor belts.	I:1/0 (Conveyor Belt A skewed left) I:1/1 (Conveyor Belt A	Digital	A value of 1 will indicate skewness and a value of 0 will indicate no skewness.

	skewed right) I:1/2 (Conveyor Belt B skewed left) I:1/3 (Conveyor Belt B skewed right)		
The pressure.	I:1/8	Digital	A value of 0 will indicate that the pressure is too low and a value of 1 will indicate that the pressure is fine.

All these values will be shown real-time in the RIM System and have to be saved in log files. Data will be saved in the log file every five seconds. A new log file will be created automatically by the RIM system at 00:00 each day. The log files will be used to create the Excel Reports. Two reports will be sufficient.

The first report will show:

- Number of components for a certain time period.
- Number of different types of components.
- Number of components not up to standard / rejected.

The second report will show:

- Time that the conveyor belt worked and didn’t work in a certain time period.

The user should be able to specify what log file to use and what time periods should apply.

4.3.2 Develop Outline System Design

The RIM System will have to perform the following procedures:

- Retrieve values from the PLC and display all digital values as Boolean values to make the system more user-friendly.
- Add 10ºC to the Temperature analogue values to display the correct temperatures. This is done because the Temperature Control Units' measurements are 10ºC lower than the actual temperature.
- Display the Boolean values, the corrected Temperature values and the number of components real-time.
- Write the current time and the above-mentioned information every five seconds to a log file.
- Create a new log file:
    - when the RIM system is started, or
    - when the Operator request that a new log file is created, or
    - at 00:00 daily.
- Create an Excel report indicating the Automated Manufacturing System status for a certain time period. The user should specify which log file to use and what times should apply. The RIM system should search through the log file for the appropriate times and report on when the Automated Manufacturing System was off and for what reason.
- Create an Excel report indicating the production status for a certain time period. The user should specify which log file to use and what times should apply. The RIM system should search through the log file for the appropriate times and report on how many different components as well as the total number of components that were produced by Automated Manufacturing System during that time.

Tentative Screen and Report Layouts

By considering the procedures mentioned above, the following tentative screen and report layouts were developed.

Figure 4-6 shows the Main Screen where the real-time values from the PLC are shown. Options (in the form of buttons) are available to create reports, a new log file and to exit the program.

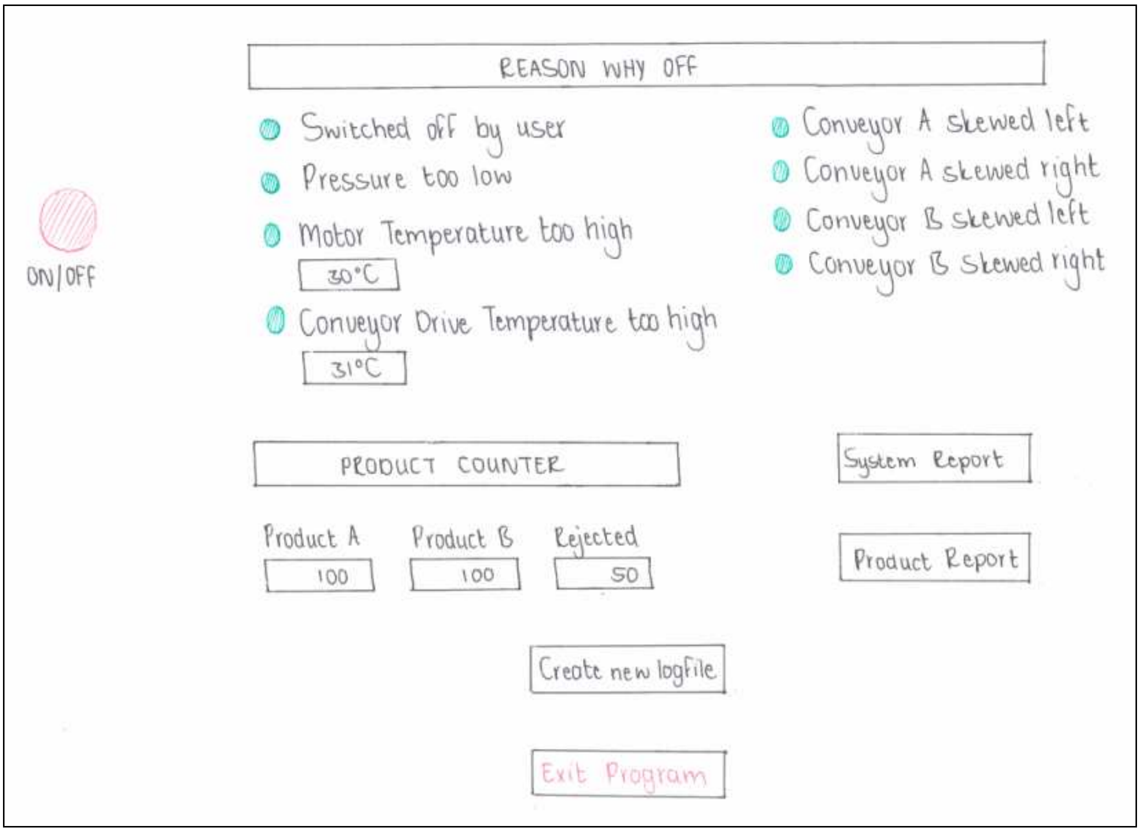


Figure 4-6: Tentative Main Screen Layout

Figure 4-7 shows the screen where the user can specify the log file and time period to use to create either a System report, or a Product report. This screen will appear when the user clicks on either the System Report or the Product Report button in the Main Screen.

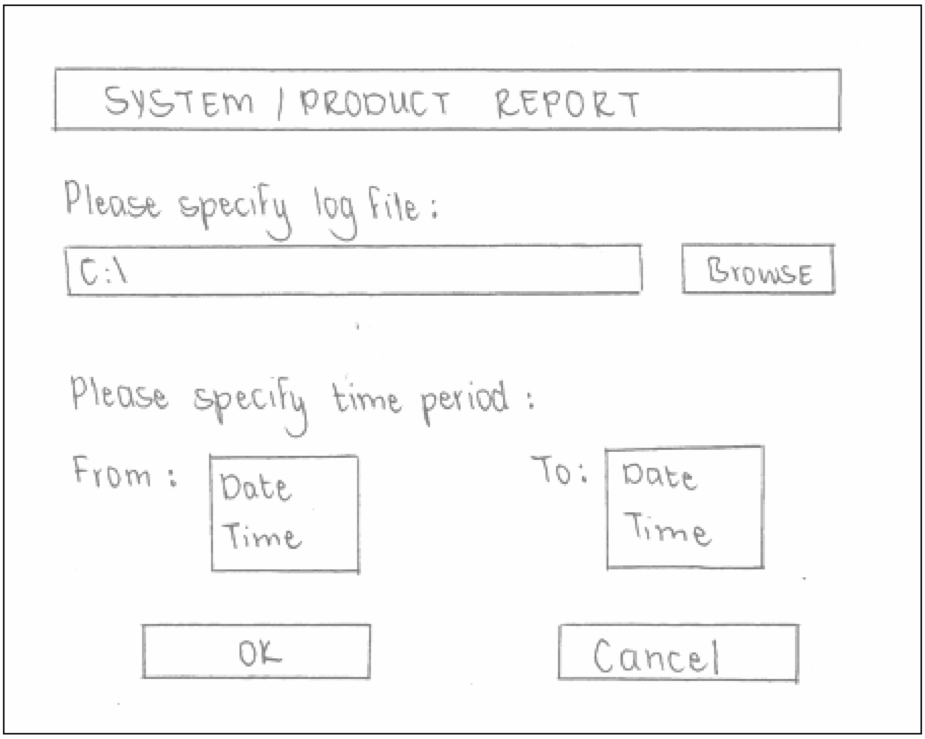
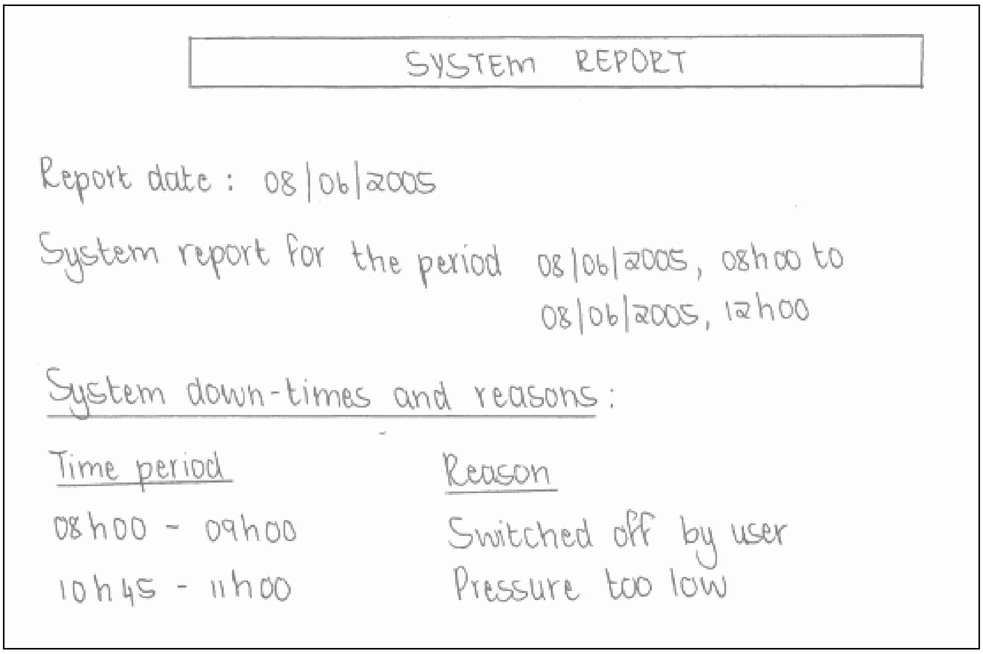


Figure 4-7: Tentative System/Product Report Dialogue Screen Layout

Figure 4-8 shows the System Report that will be created in Microsoft Excel.



SYSTEM REPORT

Report date : 08/06/2005

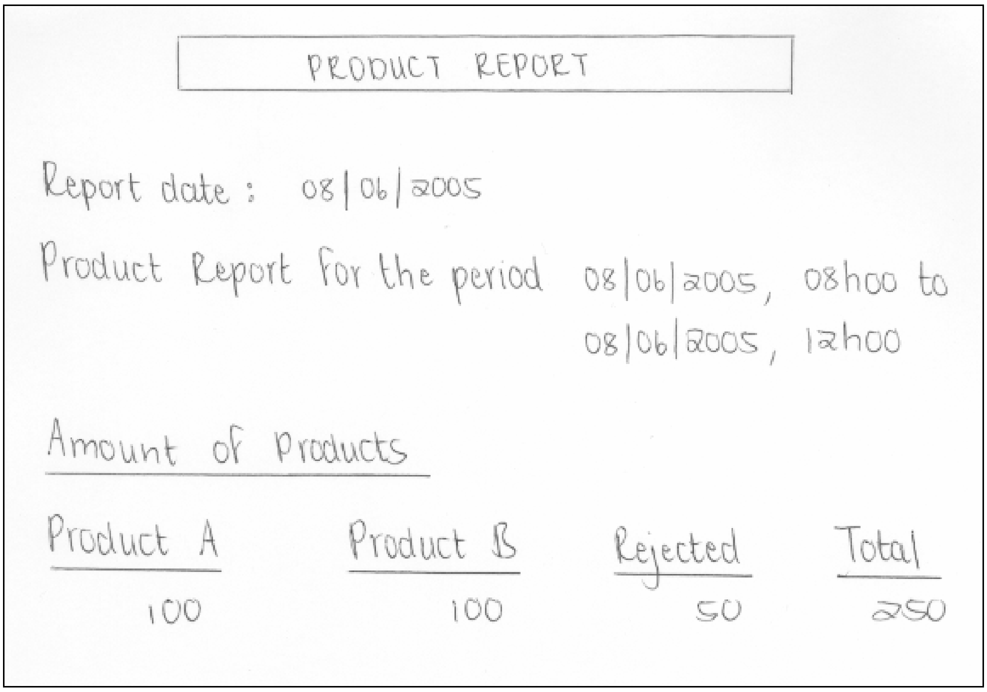
System report for the period 08/06/2005, 08h00 to
08/06/2005, 12h00

System down-times and reasons :

Time period	Reason
08h00 - 09h00	Switched off by user
10h45 - 11h00	Pressure too low

Figure 4-8: Tentative Excel System Report Layout

Figure 4-9 shows the Product Report that will be created in Microsoft Excel.



PRODUCT REPORT

Report date : 08/06/2005

Product Report for the period 08/06/2005, 08h00 to
08/06/2005, 12h00

Amount of Products

Product A	Product B	Rejected	Total
100	100	50	250

Figure 4-9: Tentative Excel Product Report Layout

These tentative layouts will be used in the next process to create the prototypes.

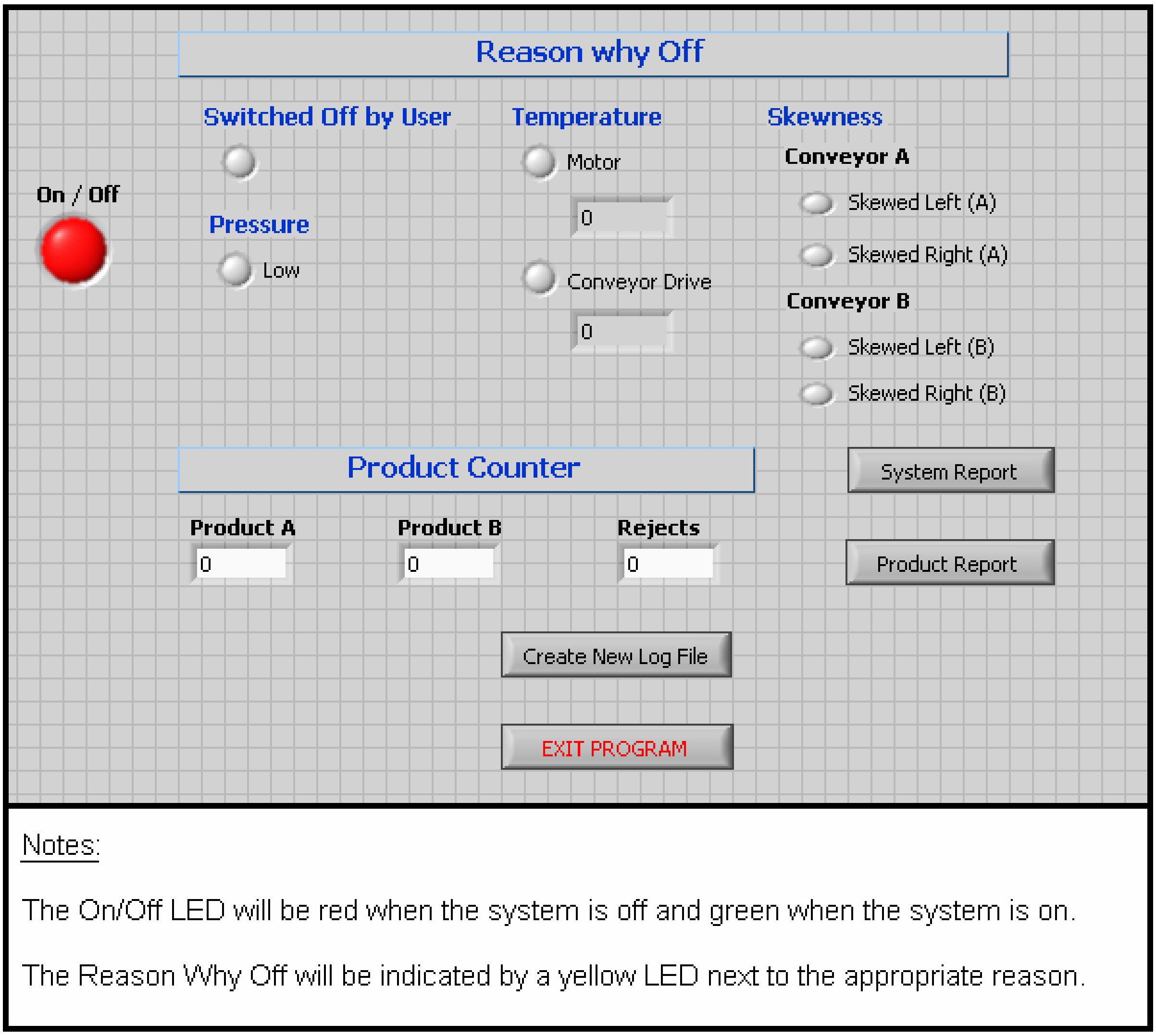
4.3.3 Refine System Design

The detailed system area model and outline system design is complete. The system design needs to be expanded by constructing prototypes of selected screens and dialog flows. Users will evaluate their usability and develop suggestions for improvements.

Prototypes

All screen layouts were designed in LabVIEW. The report layouts were designed in Microsoft Excel. The users know that what they see is what they will receive in the end and they can immediately respond to it.

The Main Screen is shown in Figure 4-10.



Notes:

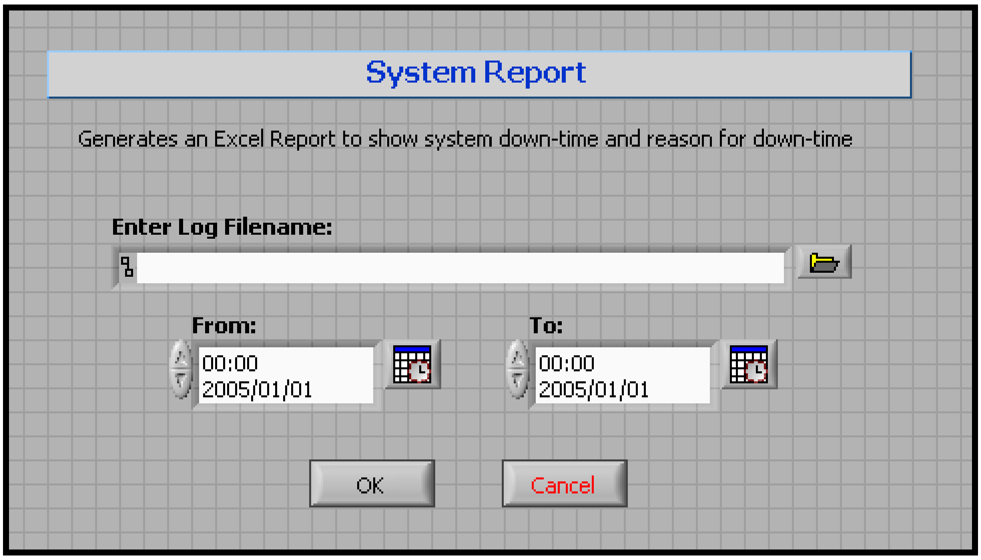
The On/Off LED will be red when the system is off and green when the system is on.

The Reason Why Off will be indicated by a yellow LED next to the appropriate reason.

Figure 4-10: Main Screen Prototype

By clicking on Create New Log File, a new log file will automatically be created. The user cannot choose a file name for the log file. The file will automatically be named with the current date and time.

By clicking on System Report, the screen shown in Figure 4-11 will appear. The user should specify the log file and the time period. When finished and the OK button is clicked, the report as shown in Figure 4-12 will appear. Clicking on Cancel will return to the Main Screen.



System Report

Generates an Excel Report to show system down-time and reason for down-time

Enter Log Filename:

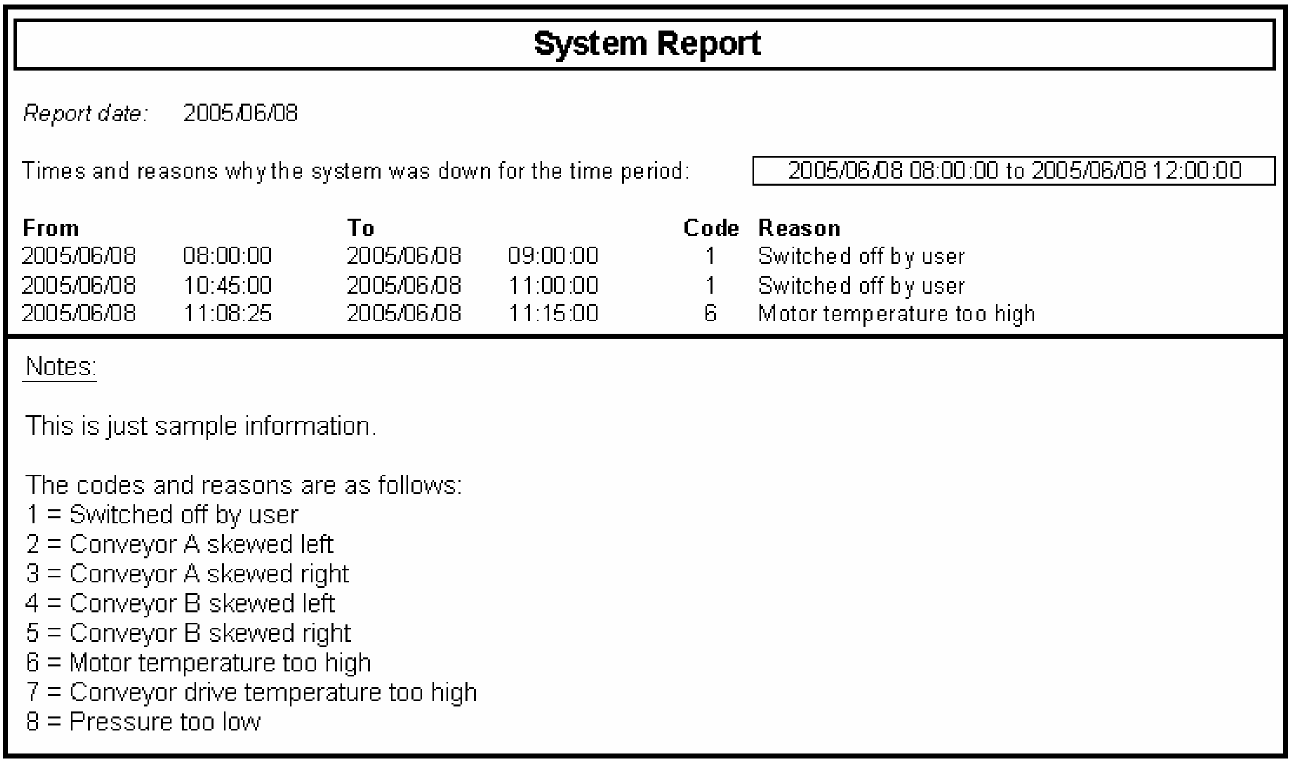
From:

00:00
2005/01/01

To:

00:00
2005/01/01

Figure 4-11: System Report Dialogue Prototype



System Report

Report date: 2005/06/08

Times and reasons why the system was down for the time period: 2005/06/08 08:00:00 to 2005/06/08 12:00:00

From		To		Code	Reason
2005/06/08	08:00:00	2005/06/08	09:00:00	1	Switched off by user
2005/06/08	10:45:00	2005/06/08	11:00:00	1	Switched off by user
2005/06/08	11:08:25	2005/06/08	11:15:00	6	Motor temperature too high

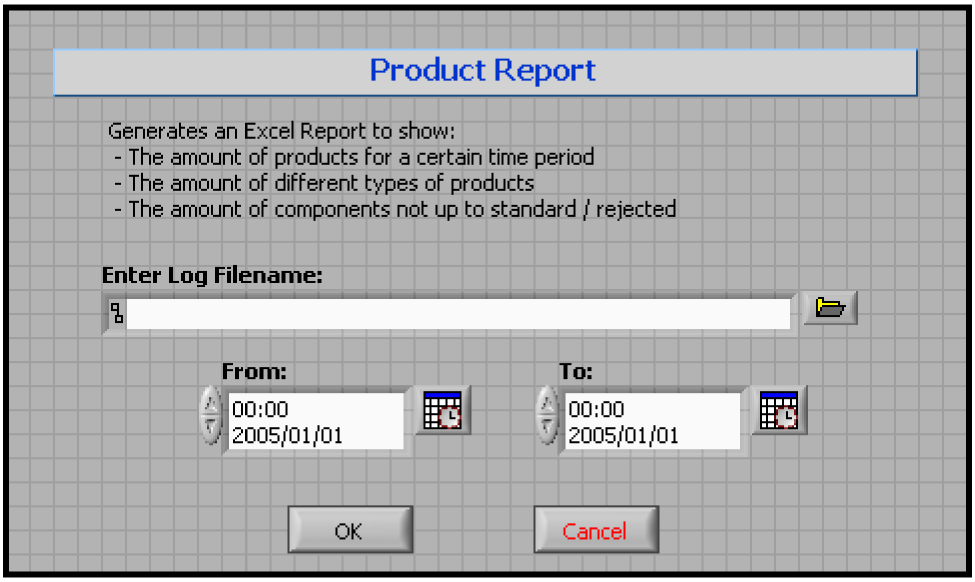
Notes:

This is just sample information.

The codes and reasons are as follows:
1 = Switched off by user
2 = Conveyor A skewed left
3 = Conveyor A skewed right
4 = Conveyor B skewed left
5 = Conveyor B skewed right
6 = Motor temperature too high
7 = Conveyor drive temperature too high
8 = Pressure too low

Figure 4-12: System Report Prototype

By clicking on Product Report, the screen shown in Figure 4-13 will appear. The user should specify the log file and the time period. When finished and the OK button is clicked, the report as shown in Figure 4-14 will appear. Clicking on Cancel will return to the Main Screen.



Product Report

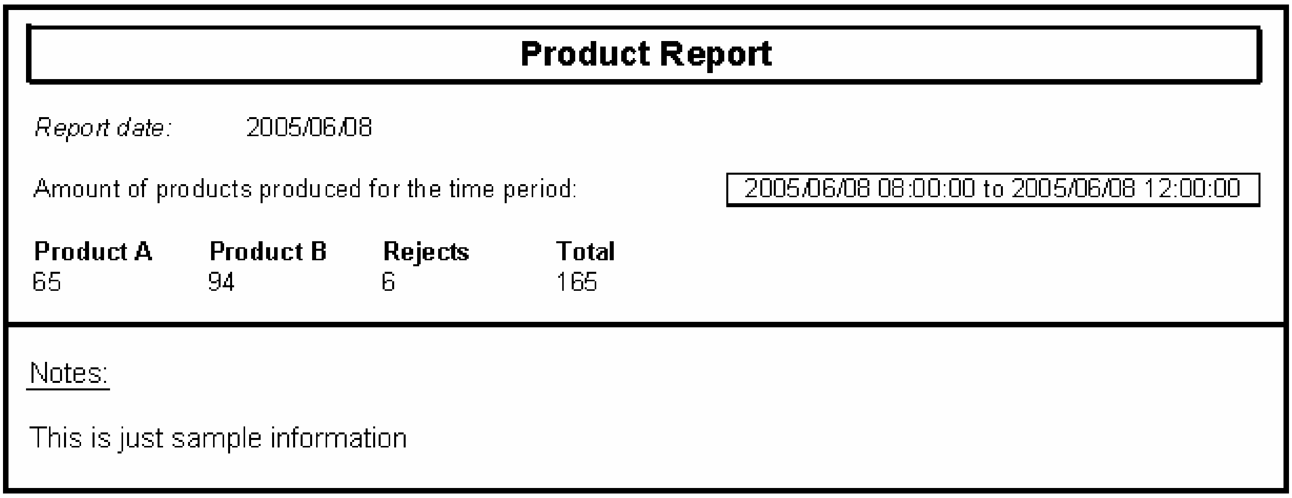
Generates an Excel Report to show:
- The amount of products for a certain time period
- The amount of different types of products
- The amount of components not up to standard / rejected

Enter Log Filename:

From: 00:00 2005/01/01

To: 00:00 2005/01/01

Figure 4-13: Product Report Dialogue Prototype



Product Report

Report date: 2005/06/08

Amount of products produced for the time period: 2005/06/08 08:00:00 to 2005/06/08 12:00:00

Product A	Product B	Rejects	Total
65	94	6	165

Notes:

This is just sample information

Figure 4-14: Product Report Prototype

Suggestions

None at the moment.

4.3.4 Prepare Implementation Strategies

A parallel implementation strategy will be followed. This means that some of the tasks will be performed at the same time.

Tasks

The following tasks must be performed to develop the system and convert it into operational use:

- The RIM system has to be developed in LabVIEW. This task will take up almost all the implementation time.
- The DLLs have to be created in Visual C++. This task will run in parallel with the development of the RIM system in LabVIEW. The LabVIEW application cannot be completed without the DLLs.
- The Excel Reports have to be created and Macros recorded. This task will also run in parallel with the development of the RIM system in LabVIEW. The LabVIEW application cannot be completed without the report templates with recorded Macros.
- User and Operator manuals have to be created. This will be created as the system evolves. The documentation will only be finalised once the RIM system implementation is complete.

Testing strategy

The code will be tested by the researcher/developer to ensure that it is error-free. The code will also be checked by the IT Supervisor. Acceptance testing will be done by an appointed member of the Mechatronics Research Group.

Resources

The estimated time duration for the implementation of the RIM system will be 4 months. Only one person will be responsible for the implementation. No costs are expected.

Schedule for implementation

The RIM system will be implemented from July 2005 to October 2005. This schedule is dependent on the programming of the PLC.

4.3.5 Finalise System Design

The only suggested change to the outline system design, is to change the colour of the Reason Why Off LEDs. The colour should be changed from yellow to green to make it more visible to the operator, who will not always be right in front of the computer.

The transition plan for the system is as follows:

- The following software need to be installed on the computer situated at the Automated Manufacturing System.

  - LabVIEW
  - OPC Client/Server software
- Using the OPC Client/Server software, the connection to the PLC via the Ethernet Interface needs to be made.
- The RIM System has to be installed on the computer.
- The computer has to be converted into a Web Server using LabVIEW's Web Tools.
- The RIM System has to be linked to a Web Page using LabVIEW's Web Tools.
- A folder has to be created on the Web Server to save the Log Files to.
- The user and operator manuals have to be distributed to the appropriate people.

4.3.6 Obtain Approval for Construction

The approved proposal serves as approval for construction.

4.3.7 Project Management

4.3.7.1 Control Project

<u>Assign Project Tasks</u>

Since the Technology Study task is now completed, the next task is the construction of the RIM system. In this task the researcher/developer will make the link between the PLC and LabVIEW, using the OPC Client/Server software and the Ethernet Interface.

The Virtual Instruments (VIs) need to be developed in LabVIEW. The DLLs that will perform the searching through files will be created, using Microsoft Visual C++. The report templates will be created in Microsoft Excel and the necessary Macros will be recorded. The following Macros are needed for both reports:

- A Macro to do the initial formatting of the Excel Report.
- A Macro to read data from the temporary file created by the DLL into the Excel Report.
- A Macro to do the final formatting of the Excel Report.

The programming of the PLC is completed and construction can take place without any further delays.

Motivate Project Participants

Due to the fact that there is only one person involved in the development and the project management of the RIM System, this step doesn’t apply.

Track Project Progress

The user design of the RIM system should have started during January 2005, but due to the high workload of the researcher/developer, the user design was postponed until June 2005. The user design was finished at the end of July 2005.

Construction of the RIM system will start during August 2005.

Revise Project Plan

The only changes to the project plan are the time schedule changes.

Technology Study: Study the different technologies that make up the Automated Manufacturing System and the technologies (hardware & software) that will be used to create the RIM System.
Time frame: July 2004 – November 2004

System Development: Create and install the application.
Time frame: June 2005 – October 2005

Documentation: Complete documentation of the whole research project.
Time frame: November 2005 – December 2005

The project duration is extended by one month.

4.4 References

1. GANTTHEAD.COM. RAD – Rapid Application Development Process. Available on the Internet from: http://www.gantthead.com/process/processMain.cfm?ID=2-19516-2. Accessed: 14 June 2005.

Chapter 5: Rapid Application Development – Rapid Construction and Transition

5.1 Introduction

In this chapter the last two SDLC stages with their supporting PM stages will be documented thoroughly, as the RIM System is being developed. The stages will take on the structure provided for Rapid Application Development by gantthead.com [1].

5.2 RAD SDLC Stage 3: Rapid Construction

Figure 5-1 shows the process flow of the Rapid Construction stage. The Rapid Construction stage consists of five processes:

- Prepare for Rapid Construction
- Construct System
- Generate Test Data and Systems Documents
- Prepare for Transition
- Verify System Construction

All five processes are applicable to the development of the RIM system and will be documented in detail.

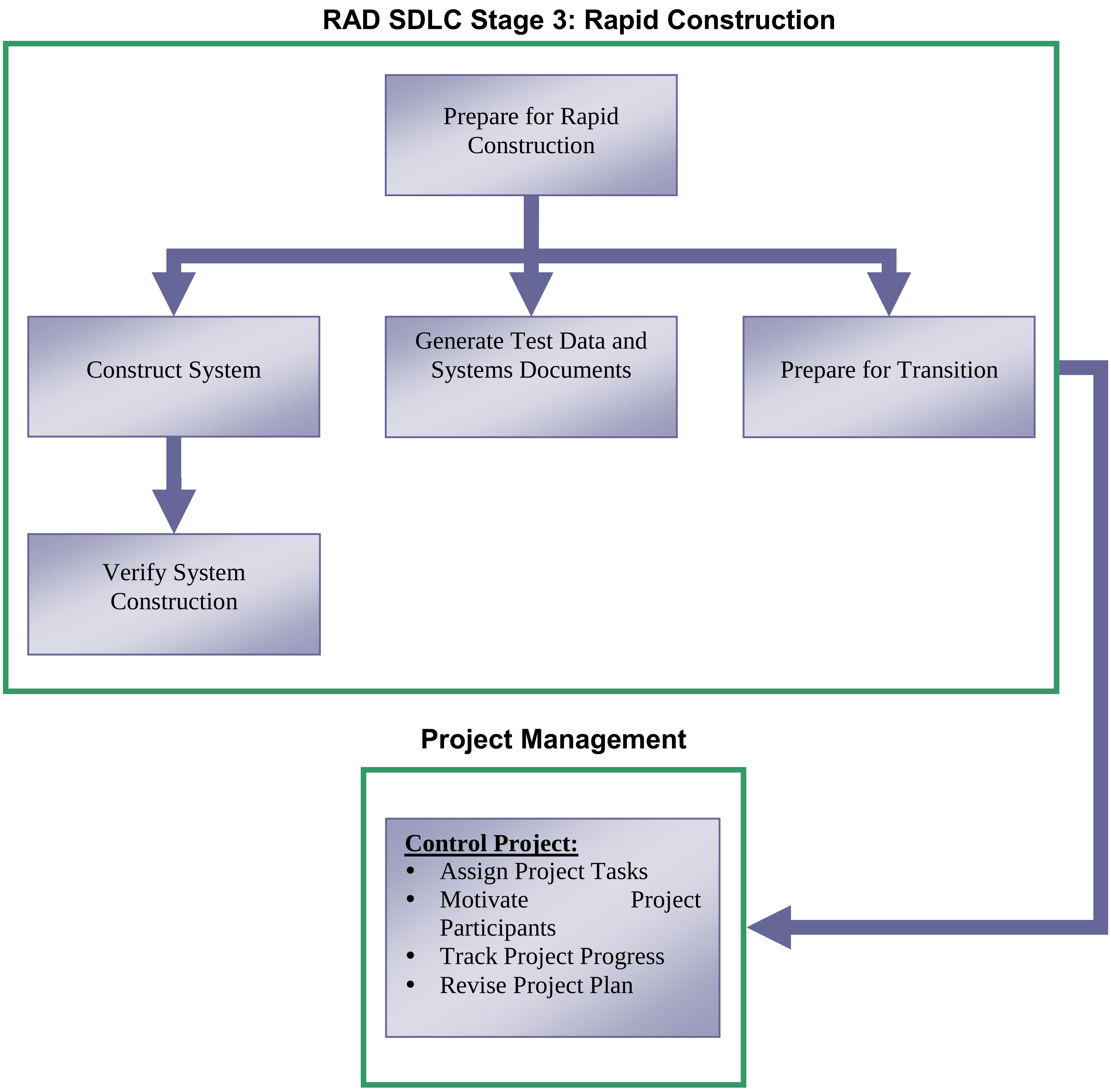

RAD SDLC Stage 3: Rapid Construction
Prepare for Rapid Construction
Construct System
Generate Test Data and Systems Documents
Prepare for Transition
Verify System Construction
Project Management
Control Project:
• Assign Project Tasks
• Motivate Project Participants
• Track Project Progress
• Revise Project Plan

Figure 5-1: Process flow of the Rapid Construction stage

The Control Project stage is the only Project Management stage that is applicable to this stage and will also be documented in detail.

As mentioned in Chapter 3, the Rapid Construction stage is an iterative stage where the application software will be created and implemented. The iterative nature of the Rapid Construction stage is shown in Figure 5-2. Acceptance tests will be performed to confirm correct operation. If the software passes the acceptance tests, preparations can be made for transition and approval can be obtained to proceed with the transition. If the software doesn't pass the acceptance tests, the stage has to be repeated until the software passes the acceptance tests.

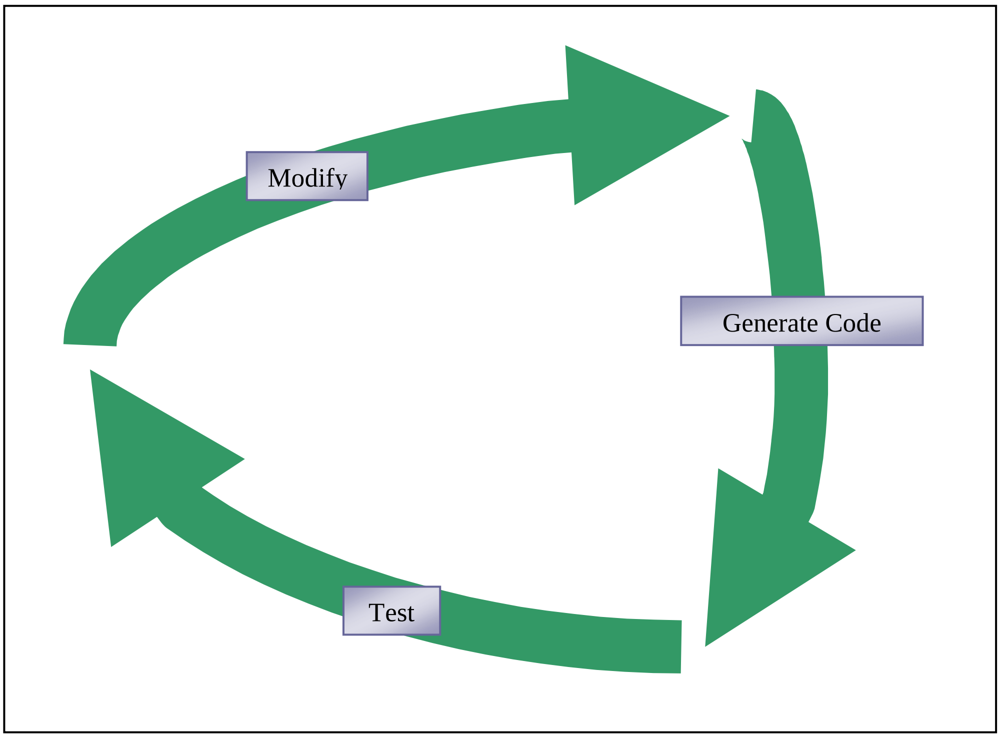


Figure 5-2: The iterative nature of the Rapid Construction stage

Prepare for Rapid Construction

The developer's office will be used as the development environment. A computer is already installed there and connected to the network. The following software is installed on the computer:

- National Instruments LabVIEW 7.1
- National Instruments LabVIEW Report Generation Toolkit

- Rockwell Automation RSLinx Software
- Microsoft Visual C++ 6.0

By using the OPC Test Client Software, which is part of the RSLinx Software, a connection is made to the PLC via the Allen Bradley Ethernet Interface. This will make it possible for LabVIEW to connect to the PLC and view the register values.

In the laboratory where the Automated Manufacturing System is situated, another computer is installed to make integration testing of the LabVIEW VIs easier. Integration tests verify that a VI or group of related VIs operate according to the requirements defined by the users. When development and testing are done, the RIM system will be installed on this computer. The following software is installed on this computer:

- National Instruments LabVIEW 7.1
- National Instruments LabVIEW Report Generation Toolkit
- Rockwell Automation RSLinx Software

From this computer a connection to the PLC is made using the OPC Test Client Software. It is necessary to make the connection to the PLC from this computer, because this computer will be used to install the RIM system on.

The following testing strategy will be followed during the Rapid Construction Stage:

- Unit testing will be done on each VI and DLL to ensure that they work properly and that no programming errors exist. The developer will perform unit testing.
- Integration testing will be done on groups of related VIs and DLLs once they are completed, to ensure that they operate according to the requirements defined by the

users. The developer will perform integration testing. As VIs and DLLs are constructed and unit tested, they are integration tested along with groups of related VIs and DLLs. In this way, prototypes of parts of the system (and ultimately the entire system) are developed and reviewed. It is very likely that any requirements changes or enhancements are made during this stage.

- System testing evolves from the many integration testing cycles and is performed by the developer. System tests verify that the system performs according to the specified user requirements. The test should include usability of the system, security, performance requirements, reliability, error recovery, and manual procedures. Additionally, the system tests address volume and stress testing, configuration testing, and documentation testing.
- Acceptance tests verify that the system is ready for full production mode. The tests are performed by a member of the Mechatronics Research Group, and should be a mirror image of production activities. The user and operator manuals are used to run the tests.

5.2.1 Construct System

Data Flow Diagrams (DFDs) is used as the primary specification technique. Only a few Unified Modelling Language (UML) diagrams are used due to the following reasons:

- UML is a standardized specification language for object modelling. Since LabVIEW is a fourth generation language with a standard set of objects, no new objects will be developed in LabVIEW.
- With LabVIEW there are a flow of data to pre-coded objects, therefore DFDs are the best technique to use.

The following UML diagrams are used:

- Two Use Case Diagrams to show the relationship between the end users and use cases. For the RIM system there will be two types of end users; the operator and the remote user. The operator use case diagram is shown in Figure 5-3 and the remote user use case diagram is shown in Figure 5-4.
- The Physical Deployment Diagram (Figure 5-5), which resembles the diagram used in Figure 4-3 to demonstrate the Ethernet Environment.

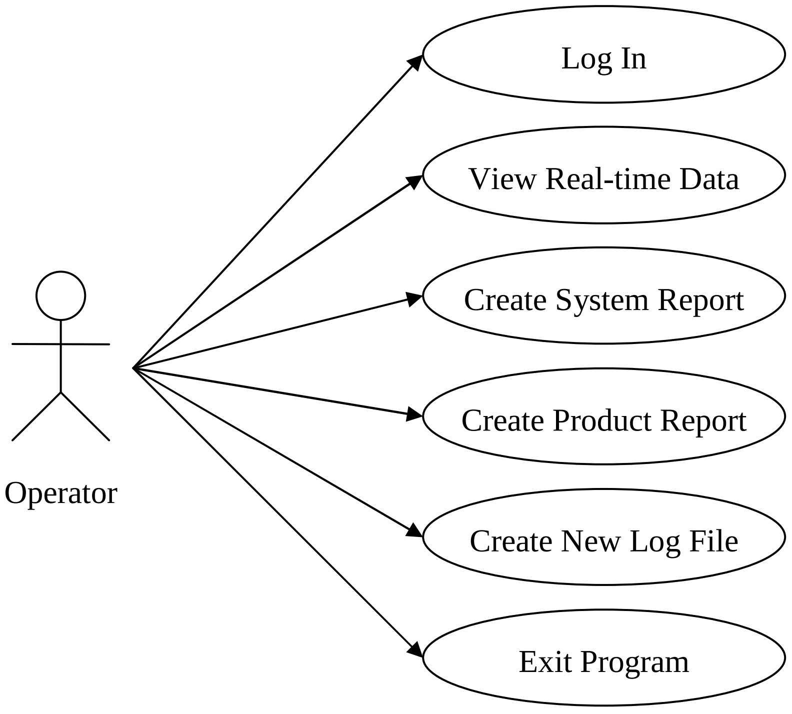


Figure 5-3: UML Operator Use Case Diagram

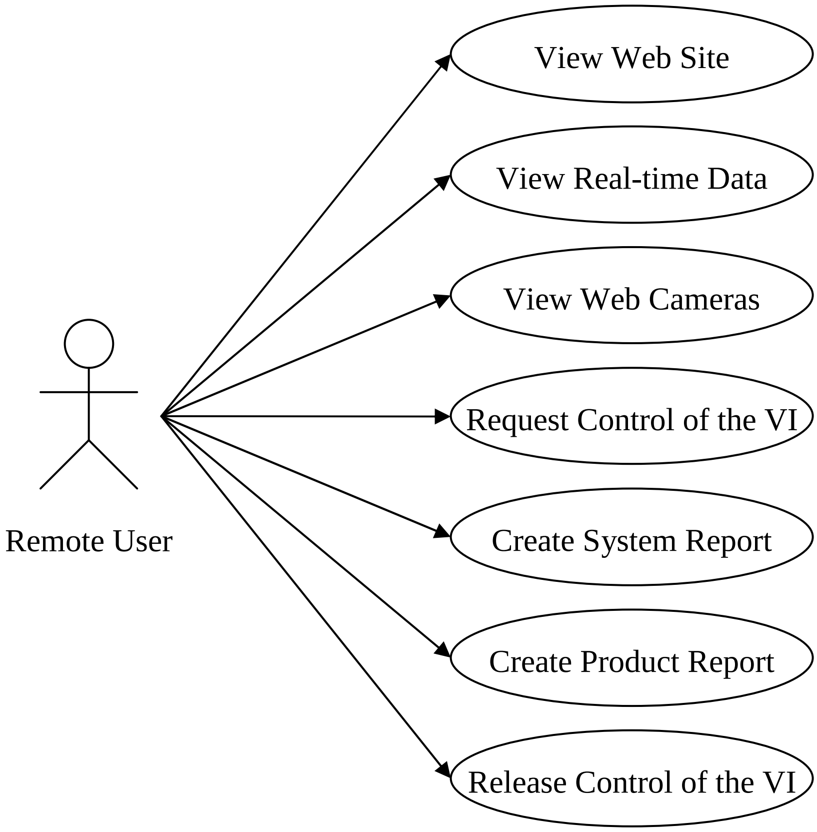


Figure 5-4: UML Remote User Use Case Diagram

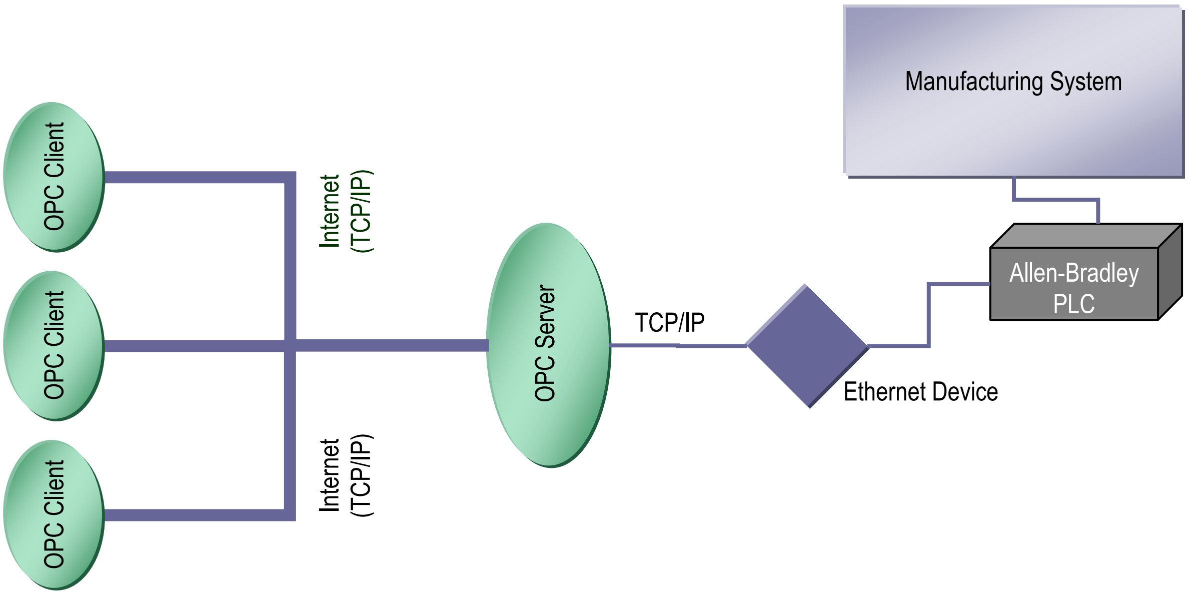


Figure 5-5: UML Physical Deployment Diagram

The first refinement DFD is shown in Figure 5-6. This DFD demonstrates the data flow of the Display VI, which will be the main VI of the RIM system.

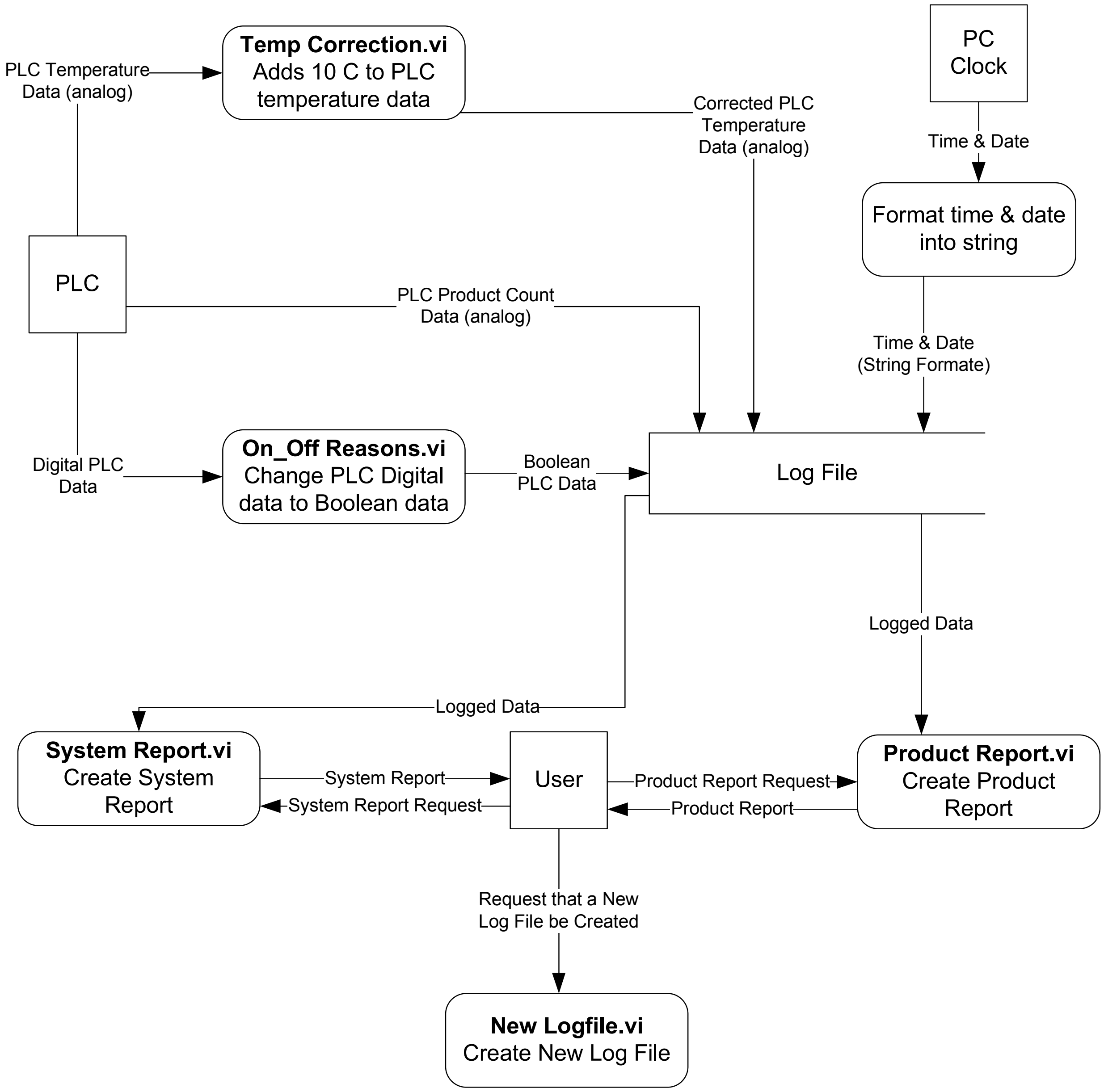


Figure 5-6: Data Flow Diagram of the Display VI (First Refinement DFD)

Further DFD refinements can be done to demonstrate the data flow of the System Report VI and the Product Report VI. These refinements are shown in Figure 5-7 and Figure 5-8 respectively.

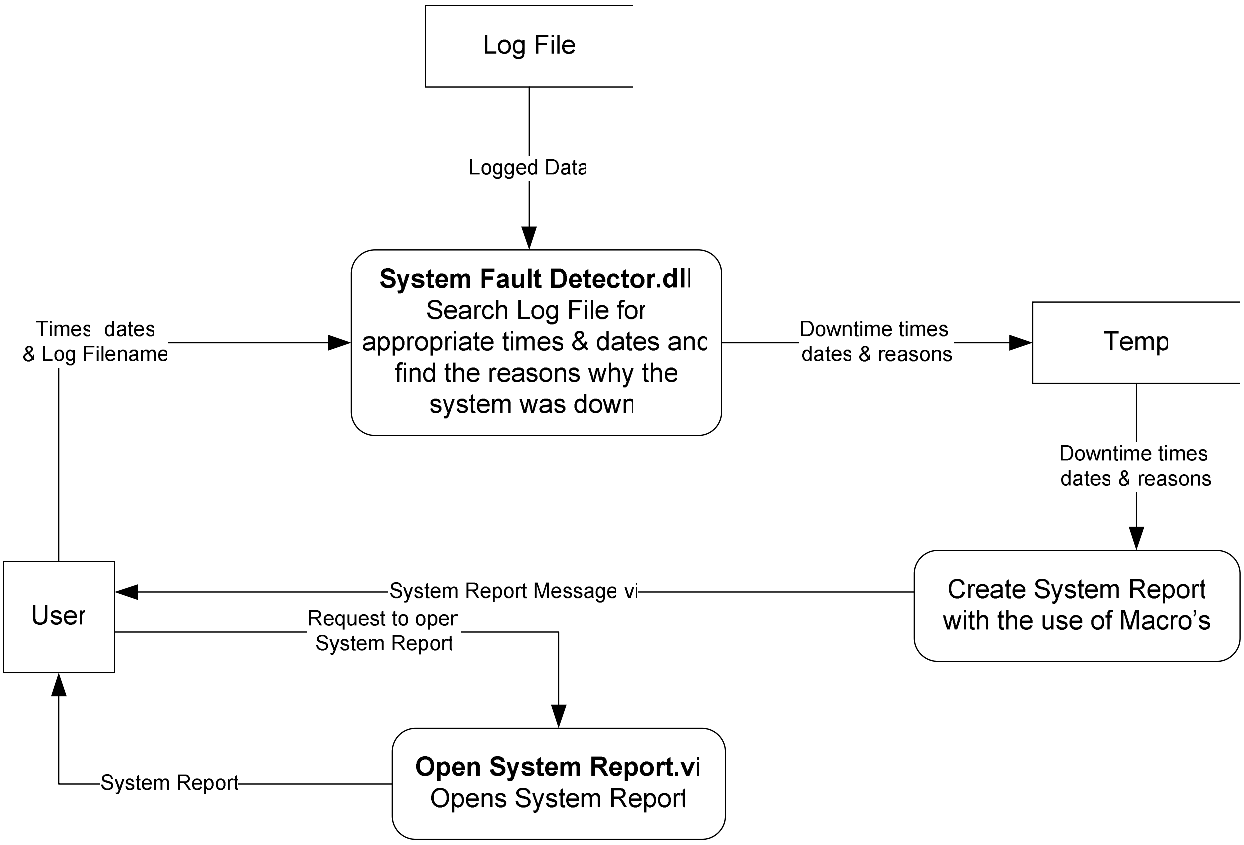

Log File
Logged Data
System Fault Detector.dll
Search Log File for appropriate times & dates and find the reasons why the system was down
Times dates & Log Filename
Downtime times dates & reasons
Temp
Downtime times dates & reasons
Create System Report with the use of Macro's
System Report Message vi
User
Request to open System Report
Open System Report.vi
Opens System Report
System Report

Figure 5-7: Data Flow Diagram of the System Report VI (Second Refinement DFD)

From these DFDs the following VIs and DLLs are created:

- On_Off Reasons.vi
- Temp Correction.vi
- Display.vi
- New Logfile.vi
- System Report.vi
- System Fault Detector.dll
- System Report Message.vi
- Open System Report.vi

- Product Report.vi
- Product Counter.dll
- Product Report Message.vi
- Open Product Report.vi

A detailed description of these VIs and DLLs are given in Table 5.1.

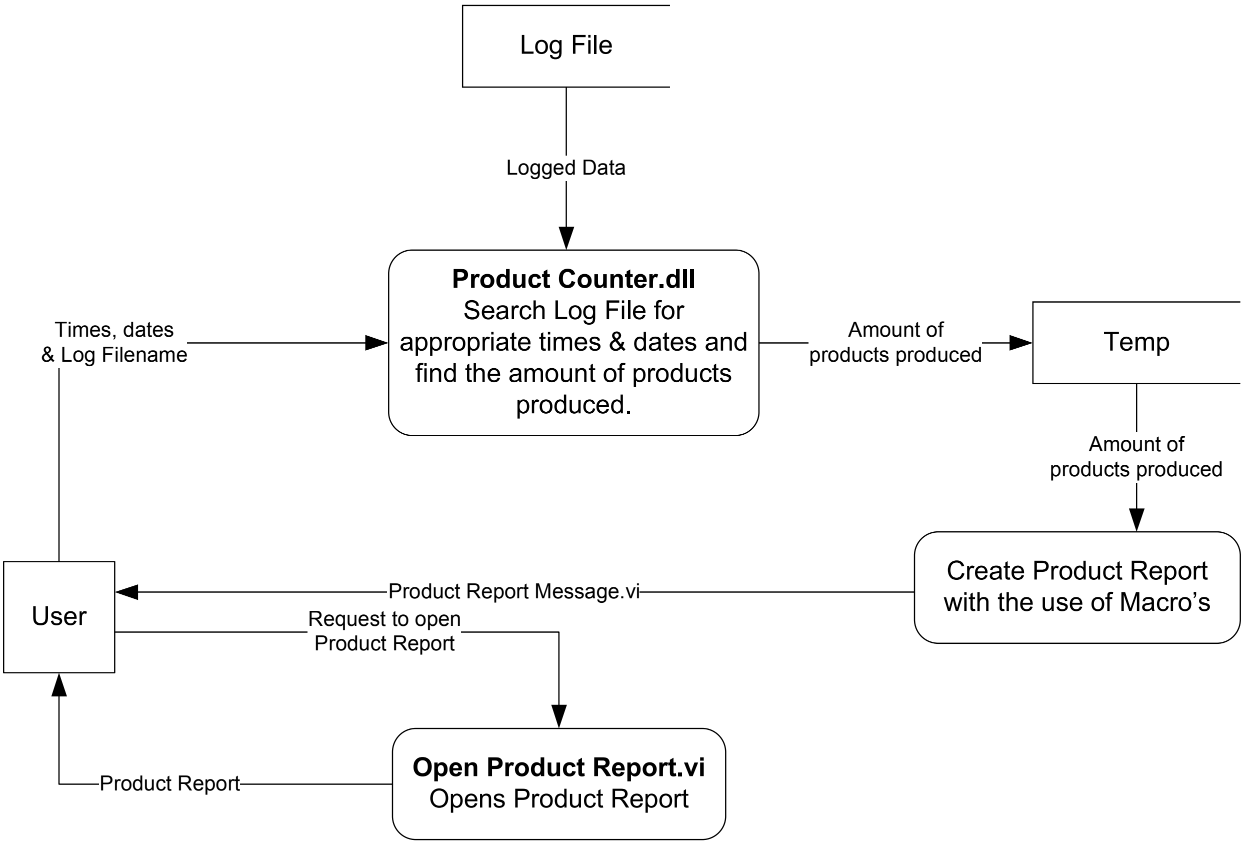

Log File
Logged Data
Product Counter.dll
Search Log File for appropriate times & dates and find the amount of products produced.
Times, dates & Log Filename
Amount of products produced
Temp
Amount of products produced
Create Product Report with the use of Macro’s
User
Product Report Message.vi
Request to open Product Report
Open Product Report.vi
Opens Product Report
Product Report

Figure 5-8: Data Flow Diagram of the Product Report VI (Second Refinement DFD)

Table 5.1: Description of the VIs and DLLs used in the RIM System

VI / DLL Name	**Description**
On_Off Reasons.vi	This VI is not a visible VI. The purpose of this VI is to change certain digital values from the PLC into Boolean values. The on/off status of the Automated Manufacturing system is indicated in the PLC as a digital value. In order for the Display VI to show the on/off status as a LED, this digital value has to be converted to a Boolean value. If the Automated Manufacturing system is off, the PLC register value will be 0. If the value is 0, the Boolean value will be FALSE. If the value is 1, the Boolean value is TRUE. There are eight reasons why the system can be down. Seven of these reasons will be read from the PLC. These seven reasons are indicated by digital values in the PLC. In order for them to be shown as LEDs, they have to be converted to Boolean values. The seven reasons are: • Motor temperature too high. If the motor temperature is too high, the PLC register value will be 1. If the value is 1, the Boolean value will be TRUE. If the value is 0, the Boolean value will be FALSE. • Conveyor drive temperature too high. If the conveyor drive temperature is too high, the PLC

	register value will be 1. If the value is 1, the Boolean value will be TRUE. If the value is 0, the Boolean value will be FALSE. • Conveyor Belt A skewed left. If Conveyor Belt A is skewed to the left, the PLC register value will be 0. If the value is 0, the Boolean value will be TRUE. If the value is 1, the Boolean value will be FALSE. • Conveyor Belt A skewed right. If Conveyor Belt A is skewed to the right, the PLC register value will be 0. If the value is 0, the Boolean value will be TRUE. If the value is 1, the Boolean value will be FALSE. • Conveyor Belt B skewed left If Conveyor Belt B is skewed to the left, the PLC register value will be 0. If the value is 0, the Boolean value will be TRUE. If the value is 1, the Boolean value will be FALSE. • Conveyor Belt B skewed right If Conveyor Belt B is skewed to the right, the PLC register value will be 0. If the value is 0, the Boolean value will be TRUE. If the value is 1, the Boolean value will be FALSE.

	• Pressure too low If the pressure is too low, the PLC register value will be 1. If the value is 1, the Boolean value will be TRUE. If the value is 0, the Boolean value will be FALSE. The eighth reason why the system can be down is when the user switches off the system. If the system is down and the above-mentioned seven reasons are all FALSE, then the system was switched off by the user.
Temp Correction.vi	This VI is not a visible VI. The analogue values of Motor Temperature and Conveyor Drive Temperature as read from the PLC are 10ºC lower than what they should be. This VI adds 10ºC to each of these two analogue values.
Display.vi	This is the main VI of the RIM system. When the RIM system is started, a new logfile will automatically be created. The name of the logfile will be the time and date when the RIM system was started. A new logfile will be created when the Create New Logfile command button is clicked, or at 00:00 each day for as long as the RIM system runs. The Display VI will display the following: • An LED indicating whether the Automated Manufacturing system is on or off. The Boolean value for this LED is an output value of the On_Off

	Reasons.vi. • LEDs to indicate the reason why the RIM system is off. The Boolean values for these LEDs are output values of the On_Off Reasons.vi. • The Motor temperature and Conveyor Drive temperature in degrees centigrade. These values are the output values of the Temp Correction.vi. • The number of components. The number of product A, product B and rejected products are read from the PLC. The following commands are displayed in the form of buttons: • System Report. If this button is clicked, the System Report.vi will run. • Product Report. If this button is clicked, the Product Report.vi will run. • Create New Log File. This command is only available for the operator of the RIM system after he/she has logged into the system. If this button is clicked, the New Logfile.vi will run. • EXIT PROGRAM. This command is only available for the operator of the RIM system after he/she has logged into the system. If this button is clicked, the RIM system will stop.

New Logfile.vi	This VI will display a message that a new logfile will be created. The user has the option to cancel the creation of the new logfile, or to go ahead and create a new logfile. These options are indicated by two command buttons: • OK If this button is clicked, a new logfile will be created. The name of the new logfile is the current date and time. • BACK If this button is clicked, the current logfile will remain in use and Display.vi will be displayed again.
System Report.vi	This VI allows the user to enter the following: • The logfile to be used for the System Report. • The date and time from where the System Report should start. • The date and time up to where the System Report should end. Two command buttons are available: • OK If this button is clicked, the System Report will be created using the System Fault Detector.dll, the System Report Template created in Excel and the recorded Macros. System Report Message.vi will be displayed.

	• BACK If this button is clicked, the System Report will not be created and Display.vi will be displayed again.
System Fault Detector.dll	The purpose of this DLL is to find the times from and times to when the system was down and give a reason why the system was down. This information will be saved in a temporary file to be used by the System Report.vi. The user will specify date and time from, date and time to and a logfile from which information must be extracted. These three values will be the Input Parameters to this DLL.
System Report Message.vi	This VI states that the System Report was created successfully. It tells remote users that they should click the link on the Web Page in order to download and open the System Report. It has an OK button which, when clicked, will close all System Report related VIs and return to Display.vi. It also has an Open System Report command button. This command is only available for the operator of the RIM system after he/she has logged into the system. If this button is clicked, Open System Report.vi will run.
Open System Report.vi	This VI is not a visible VI. Its purpose is to open the System Report.
Product Report.vi	This VI allows the user to enter the following:

	• The logfile to be used for the Product Report. • The date and time from where the Product Report should start. • The date and time up to where the Product Report should end. Two command buttons are available: • OK If this button is clicked, the Product Report will be created using the Product Counter.dll, the Product Report Template created in Excel and the recorded Macros. Product Report Message.vi will be displayed. • BACK If this button is clicked, the Product Report will not be created and Display.vi will be displayed again.
Product Counter.dll	The purpose of this DLL is to count the number of products produced from a certain date (provided as Input Parameter) to another date (provided as Input Parameter) from a specified logfile (provided as Input Parameter). The numbers of different products produced will then be saved in a temporary file to be used by the Product Report.vi.
Product Report Message.vi	This VI states that the Product Report was created successfully. It tells remote users that they should click the link on the Web

	Page in order to download and open the Product Report. It has an OK button which, when clicked, will close all Product Report related VIs and return to Display.vi. It also has an Open Product Report command button. This command is only available for the operator of the RIM system after he/she has logged into the system. If this button is clicked, Open Product Report.vi will run.
Open Product Report.vi	This VI is not a visible VI. Its purpose is to open the Product Report.

The front panels, connector panes and block diagrams of the VIs, as well as the software code of the DLLs, are shown in Appendix A. Unit testing is performed on all VIs and DLLs to ensure that they are error free.

Two template files are created in Microsoft Excel. These template files will be used to create the System Report and the Product Report.

The first template file is the System Report Template. Three Macros are recorded in this template file:

- First_format Macro is used to insert a heading for the report, a report description, the date and column headings.
- Insert_data Macro is used to open the text file created by the System Fault Detector DLL. The data from this text file is then copied into the System Report Template file. The text file created by the System Fault Detector DLL is then closed again.

- Last_format Macro is used to format the Excel file to make it more presentable.

The LabVIEW Report Generation Toolkit has a VI called the Excel Run Macro.vi. This VI is used in the System Report VI to run these Macros. To make the System Report printer friendly, the page layout of the System Report Template is changed before it is saved.

The second template file is the Product Report Template. Three Macros are recorded in this template file:

- First_format Macro is used to insert a heading for the report, a report description, the date and column headings.
- Insert_data Macro is used to open the text file created by the Product Counter DLL. The data from this text file is then copied into the Product Report Template file. The text file created by the Product Counter DLL is then closed again.
- Last_format Macro is used to format the Excel file to make it more presentable.

The Excel Run Macro VI is used in the Product Report VI to run these Macros. To make the Product Report printer friendly, the page layout of the Product Report Template is changed before it is saved.

To make the application available via the Internet, the LabVIEW Web Server is activated on the computer available at the Automated Manufacturing System. When the Web Server is activated, the computer is changed to a Web Server and a folder is created where all the files that will be accessed via the Internet, should be saved. The Web Server can be activated at LabVIEW's options, which is available under the Tools Menu.

In order to create the Web Page and to do system testing, the RIM system is installed on the computer at the Automated Manufacturing System.

By using the Web Publishing Tool (also available under the Tools Menu), LabVIEW created a Web Page that embeds the Display VI. Using Notepad, the HTML code of this Web Page is edited. The following is added:

- A heading and description of the RIM system.
- Links to the two Web Cameras that are monitoring the Automated Manufacturing System.
- Links to the System and Product Reports.
- Footer with copyright information and dates.
- Overall formatting of the Web Page to change the appearance.

5.2.2 Generate Test Data and Systems Documents

The Automated Manufacturing System is used to generate test data. The RIM system logged the specified data from the PLC connected to the Automated Manufacturing System. Unit testing is done to ensure that the data saved to the logfile, is correct. These logfiles will serve as test data.

When testing is done, all possible entries from the user have to be tested. Dates and times that fall outside the boundaries of a logfile have to be entered to ensure that these errors are provided for.

User and Operator Manuals are created to explain to users how to operate the system. These manuals are attached in Appendix B and C.

5.2.3 Prepare for Transition

No previous system was in place; therefore no data conversion is necessary. No organisational issues need to be resolved.

5.2.4 Verify System Construction

Integration testing is done by the developer to ensure that all the VIs and DLLs of the RIM system operate according to the requirements. Any problems that exist are addressed and testing is done again, until no problems remain.

System testing is done by the developer to test the RIM system as a whole, including remote access from the Web Site. Both the operator and user manuals are tested.

Using the user manual, acceptance testing is done by Mr. Ben Kotze of the Mechatronics Research Group. No problems are identified and the RIM system is accepted.

5.2.5 Project Management

5.2.5.1 Control Project

Assign Project Tasks

Since the construction of the RIM system is now completed, the next task is the transition of the RIM system. In this task the RIM system will be installed. This task will be done by the developer/researcher.

Motivate Project Participants

Due to the fact that there is only one person involved in the development and the project management of the RIM System, this step doesn't apply.

Track Project Progress

The RIM system is developed and user/developer documentation created by the end of November 2005. Transition is the next stage, which will be finished before the end of December 2005.

Revise Project Plan

The only changes to the project plan are the time schedule changes.

Technology Study: Study the different technologies that make up the AMS and the technologies (hardware & software) that will be used to create the RIM System.

Time frame: July 2004 – November 2004

System Development: Create and install the application.

Time frame: June 2005 – December 2005

Documentation: Complete documentation of the whole research project.

Time frame: January 2006 – April 2006

The project duration is extended by four months.

5.3 RAD SDLC Stage 4: Transition

Figure 5-9 shows the process flow of the Transition stage. The Transition stage consists of four processes:

- Conduct User Training
- Perform Data Conversion
- Install Production System
- Accept System Installation

All four processes are applicable to the development of the RIM system and will be documented in detail.

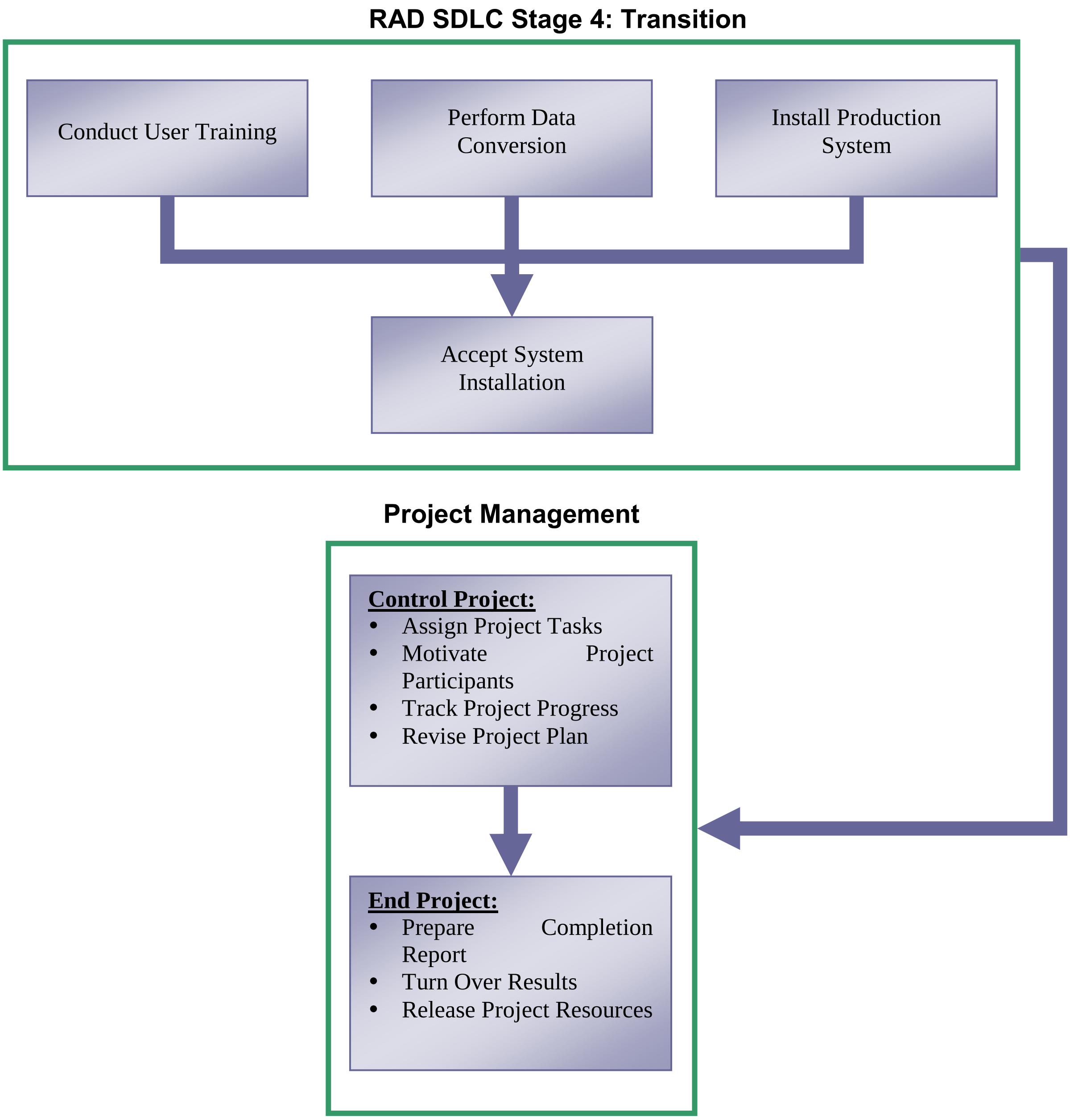


Figure 5-9: Process flow of the Transition stage

The Project Management stages that are applicable to this stage, will also be documented in detail. They are:

- Control Project
- End Project

5.3.1 Conduct User Training

No user training will be conducted, as the RIM system is mainly a monitoring system. Only three inputs are required for each report. The user and operator manuals will aid users in using the RIM system.

5.3.2 Perform Data Conversion

No data conversion is necessary because the RIM system doesn’t interact with software that uses different data formats.

5.3.3 Install Production System

The RIM system was already installed on the computer in the lab where the Automated Manufacturing System is situated during the Rapid Construction stage. The Web Server was also activated during the Rapid Construction stage in order to create the Web Page. It was necessary in order to complete the Web Page and to do the system and acceptance testing.

5.3.4 Accept System Installation

The RIM System is accepted and will be used in future research projects regarding monitoring and maintenance of the Automated Manufacturing System.

5.3.5 Project Management

5.3.5.1 Control Project

Assign Project Tasks

The development of the RIM system is now completed and the only task that remains, is the finalising of the documentation of the whole research project. The documentation is the responsibility of the developer/researcher.

Motivate Project Participants

Due to the fact that there is only one person involved in the development and the project management of the RIM System, this step doesn’t apply.

Track Project Progress

The development and installation of the RIM system was finalised during December 2005. The documentation of the whole research project will be finalised during April 2006.

Revise Project Plan

No revisions to the project plan are necessary.

5.3.5.2 End Project

Now that the technical tasks have been completed and the project products and results have been produced, the End stage brings the project to an orderly conclusion and retains its history for the benefit of subsequent projects.

Prepare Completion Report

This document will act as the completion report, as it includes a project overview describing what happened, what was learned, measurements of the process and the final product and results. It also includes descriptions of the technical architecture and the technology in use.

Turn Over Results

The final product is in place and new research projects that will make use of this research deliverables are already identified.

Release Project Resources

The only project resources to be released are the personnel involved in this research project.

5.4 References

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Chapter 6: Software Development Summary

This chapter will summarise the software development in a practical way by referencing critical elements, as well as problems encountered and how it was overcome.

The development of the RIM system was done using mainly LabVIEW as programming language. The client specified that LabVIEW should be used because of its hardware independence. This means that the system developed in LabVIEW will work with any PLC model.

The engineering environment and the programming language were all relatively unknown to the researcher and an in-depth study of the programming language and connectivity software (OPC Test Client), as well as the interacting hardware (the automated manufacturing system, the PLC and the Ethernet Interface), had to be done.

To create the link from the PLC to the software was relatively easy once the correct software was installed on the researcher’s computer. By using the OPC Test Client Software, which is part of the RSLinx Software, a connection is made to the PLC via the Allen Bradley Ethernet Interface. This made it possible for LabVIEW to connect to the PLC and view the register values. At this stage, the PLC programming was not yet finalised.

The first problem encountered during the programming, was the problem of file handling. LabVIEW has the capability to create a file, write to a file and read from a file. The problem was searching within a file. LabVIEW’s capability to search within a file is very limited. To solve this problem, the researcher considered using other programming languages that will interact with LabVIEW. The answer came in using library files created with Microsoft Visual C++, as LabVIEW interact best with Visual C++.

This came as another challenge to the researcher, who was not very familiar with Visual C++, but had knowledge of Borland C++. Fortunately, this challenge was easy to overcome, as Visual C++ and Borland C++ are quite similar. The library files that handled all the searching through the log files were created and the RIM system will call these library files whenever necessary.

Creating the Excel reports was quite easily done as LabVIEW has a Report Generation Toolkit that can be installed to create spreadsheets or documents. Macros were created within Excel to take care of the spreadsheet formatting and thus creating an appealing report appearance.

Publishing the Web Page on the Internet was not a difficult task as LabVIEW has a Web Publishing Wizard that will change a normal PC into a Web server and will also create a Web Page with the LabVIEW application embedded within it. The researcher had to change the content of the Web page to ensure that it will satisfy user requirements. This was done by changing and adding HTML code.

The second problem that was encountered was the problem of Internet access. Due to the Central University of Technology, Free State's Internet security policy, Internet access outside of the CUT was not possible. This means that the RIM system can be accessed from within the CUT network, but not outside the CUT network.

In an attempt to overcome this problem, the researcher made an appointment with the person in charge of Internet security at the CUT, Mr. Ernst du Plooy. He explained that to solve the problem and to keep the CUT safe from Internet security risks, the RIM system will have to be connected to a new router and a whole new network will have to be created for this purpose. This will not be possible as the costs to do this are much too high. This will also have to be approved by the CUT and someone must be appointed to ensure the security of this new network. In short, this will not happen easily and the researcher had to accept the fact that the RIM system will not be available from outside the CUT network.

The RIM system was tested, accepted and ready for use. Users will be supplied with user manuals to help them use the RIM system.

Chapter 7: Conclusion

7.1 Project Results

The Mechatronics Research Group of the Faculty of Engineering, Information and Communication Technology at the Central University of Technology, Free State has developed an Automated Manufacturing System. Different research areas revolve around this Automated Manufacturing System. The need was identified for a Remote Information Management System to monitor the Automated Manufacturing System from remote locations.

The Rapid Application Development (RAD) Methodology was chosen as the best methodology for the development of the RIM System due to the following:

- It is the best methodology to use in a changing environment.
- It was developed to respond to the need to deliver systems very fast.
- It is suitable to use RAD when the project largely comprises analysis or reporting of the data.

The RAD methodology consists of four stages: Requirements Planning, User Design, Rapid Construction and Transition. Project Management is used throughout these stages to ensure that the project goes according to plan.

During the Requirements Planning stage, the specific requirements of the RIM system were defined. The basic requirements were:

- The RIM system should be created in LabVIEW because it must be able to interact with any PLC model – not only an Allen-Bradley PLC.

- The RIM system should show real-time information of what is happening at the Automated Manufacturing System. This should include Web Camera views of the Automated Manufacturing System.
- The RIM system must create reports of what has happened during certain time periods. There should be two reports: One to indicate how many different types of products was produced during a certain time period and one to indicate downtimes of the Automated Manufacturing System during a certain time period and the reasons why the system was down.
- The RIM system must be available from a remote location via the Internet.

An estimation of the resources required to develop the RIM system was made. These resources include hardware, software and people. An estimated time schedule was drawn up to indicate when different tasks ought to be completed.

A Project Plan was created to enable project management and to monitor project progress. Included in this project plan are full details of the requirements, the estimated resources needed and the projected time schedule.

During the User Design stage, the detailed system area model was drawn up. This area model indicates all the data that will be used in the RIM system and describes the environment in which the RIM system will operate, in detail. Prototypes of the screen layouts were created, following discussions with potential end users of the RIM system. Suggestions from end users were implemented.

Project Management was applied and the project plan was re-evaluated to track progress and make changes to the progress plan, if necessary. At this stage it was found necessary to extend the project duration with one month. The project plan was therefore altered to show the new time schedule.

The Rapid Construction stage is an iterative stage where coding takes place, it is reviewed by the end users, suggestions are made and coding takes place again. This iterates until the end users are satisfied that the system meets their specified requirements.

Data Flow Diagrams was drawn up to show the flow of data in the RIM system and to identify the major processes. The RIM system was created using the LabVIEW programming environment. Two Dynamic Link Libraries (DLLs) was created in Microsoft Visual C++ to do the file handling. These DLLs are used by the RIM system to search through the appropriate logfile. The reports were created in Microsoft Excel with the use of Macros.

The RIM system was installed at the Automated Manufacturing System. The RIM system was used to log data from the PLC to logfiles. Unit testing was done to ensure that data are logged correctly and that all units function correctly. Integration testing was done to ensure that the different components of the RIM system work together correctly. These components include the LabVIEW VIs, the DLL files and the Excel Macros. Logfiles were used as test data during system testing. A member of the Mechatronics research group did acceptance testing and the RIM system was accepted. User and Operator manuals were also developed during this stage.

Project Management was applied and the project plan was re-evaluated again to track progress and, if necessary, make changes to the progress plan. At this stage it was found necessary to extend the project duration with four months. The project plan was therefore altered to show the new time schedule.

Not much was left to do during the Transition stage as the system was already installed during the Rapid Construction stage for testing purposes.

Project Management was applied to end the project. The whole development process was documented, the results turned over to the end users and all resources was released.

The final system consisted of a Web Page that can be accessed remotely within the CUT network. Unfortunately it will not be possible to access the Web Page from outside the CUT network, because of security restrictions. On the Web Page there are links to two Web Cameras that are installed at the Automated Manufacturing System. A view of the Virtual Instrument (that was created in LabVIEW) is shown on the Web Page. This Virtual Instrument shows real-time data from the Automated Manufacturing System. Control over this VI can be requested. When control is granted, the user has the option to create two types of reports: a product report and a system report. The user will specify which logfile to use for the report and specify the time period of the report. The product report will show how many different components were produced during the specified time period. The system report will show the Automated Manufacturing System downtimes and reasons for the downtimes during the specified time periods. Links to these reports are below the Virtual Instrument on the Web Page.

The Virtual Instrument is installed on a computer located at the Automated Manufacturing System. The Automated Manufacturing System Operator is able to log in and has additional commands that may be performed. The Operator can create a new logfile and stop the Virtual Instrument. These options are only available for the Operator when logged in.

Two manuals were developed. The Operator Manual has step-by-step instructions for the Operator of the Automated Manufacturing System on how to use the Virtual Instrument. The User Manual has step-by-step instructions for remote users of the RIM System on how to connect to the Web Page and use the RIM System.

A system like the RIM System has advantages in the business world. It can enable telecommuting and will allow employees and managers to monitor and control manufacturing systems, or any system connected to a PLC, from remote locations.

7.2 Possibilities for future studies

Possibilities for future studies are:

- A control system can be created to allow remote control over the manufacturing system. This will allow users to take control over the manufacturing system from almost anywhere in the world.
- A diagnostic system can be created to monitor faults and problems at a manufacturing plant and to predict and prevent system downtimes. In this way near-zero downtime of the production plant can be a possibility.

7.3 Satisfying the hypothesis

The aim of this study was to demonstrate the following:

- LabVIEW can be used to create an Information Management System that will interact with the Automated Manufacturing System via a PLC.
- LabVIEW's Web features can be used to create a Web site that will provide remote access to the Information Management System and thus to the Automated Manufacturing System.

In order to satisfy the hypothesis, the following criteria needed to be met:

- Real-time data can be captured from the Automated Manufacturing System via LabVIEW and made available for reporting.
- Accurate and timeous reports on the system performance and product manufacturing can be drawn.
- Remote access to the Automated Manufacturing System and Information Management System via the World Wide Web can be established.

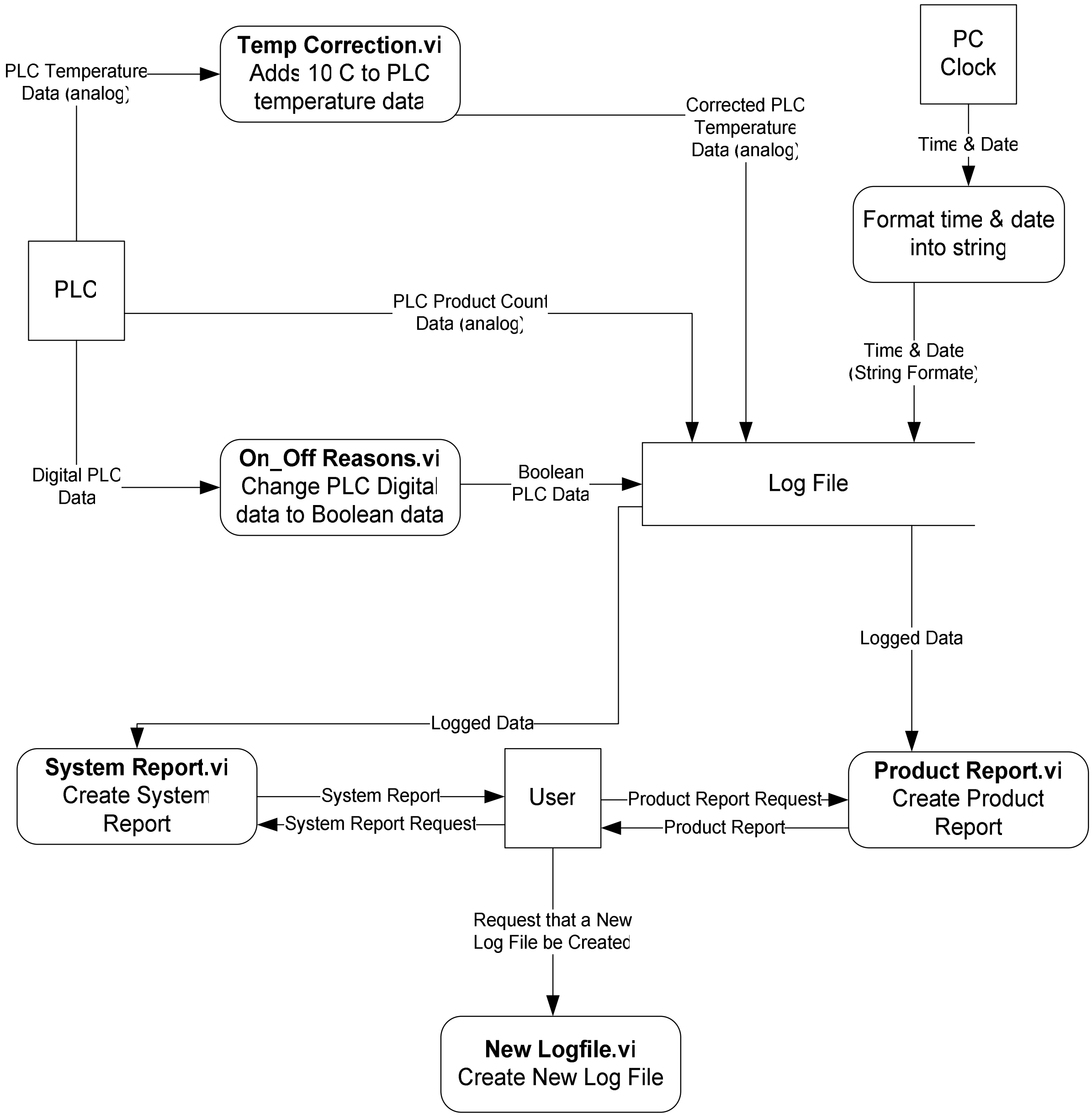
The criteria were met as follows:

- The RIM system was created using LabVIEW. It accesses the PLC to provide users with real-time data from the Automated Manufacturing System. These data is stored in logfiles to be used for reporting.
- By using the data saved in the logfiles, accurate system and product reports can be drawn for time periods specified by the user in Microsoft Excel.
- Remote access via the WWW to the RIM system was made available within the CUT network using LabVIEW's Web Publishing Tool. Due to the tight security restrictions of the CUT, the RIM system will not be remotely available from outside the CUT network.

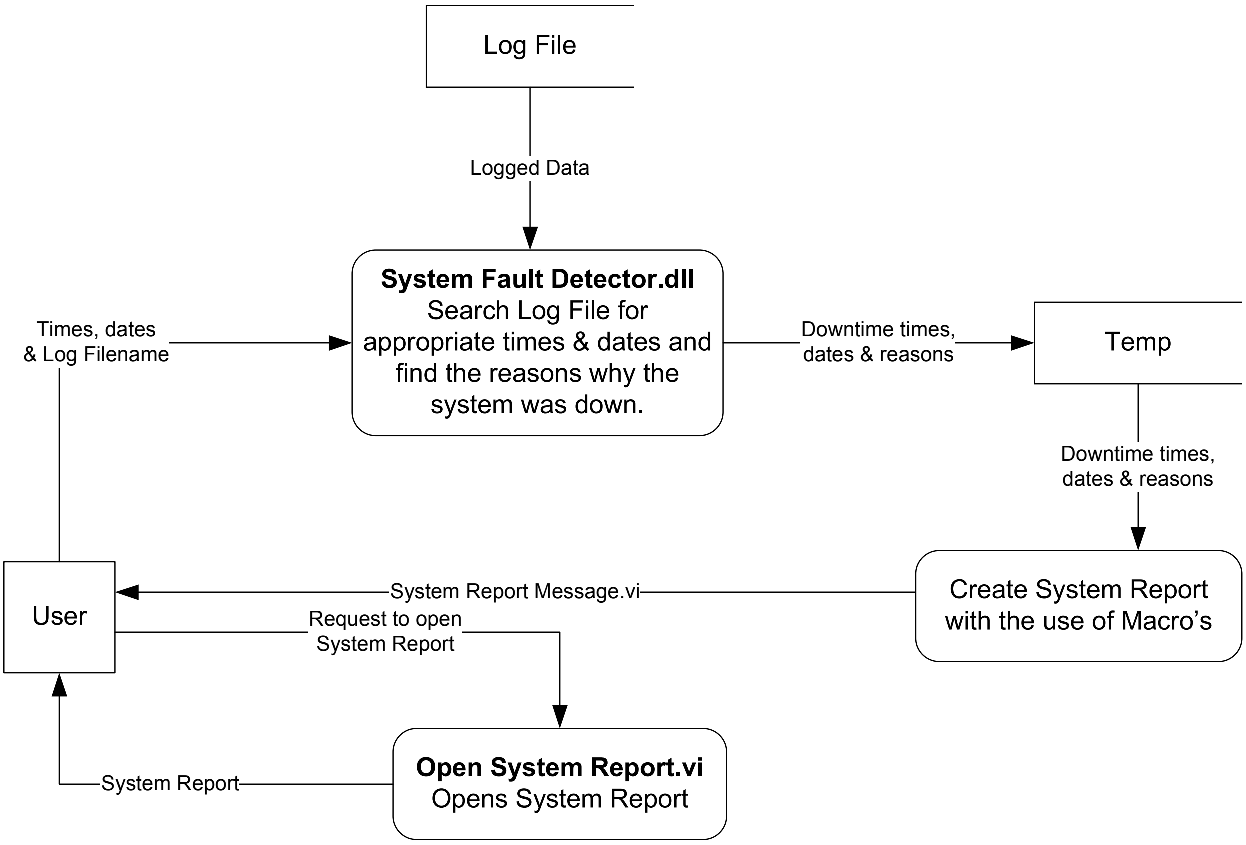
Appendix A: Software Code and Data Flow Diagrams

1. Data Flow Diagrams

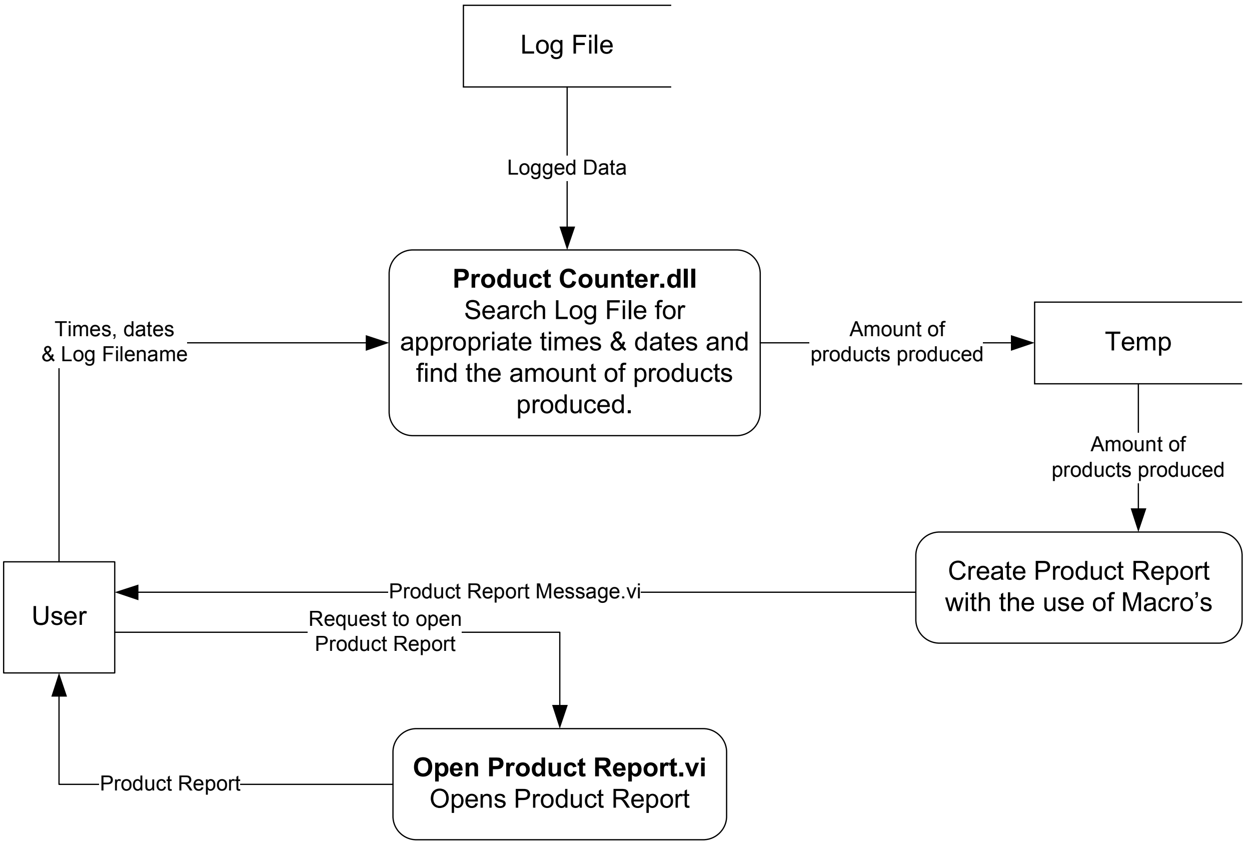
Display.vi Data Flow Diagram (First Refinement)



System Report.vi Data Flow Diagram (Second Refinement)


Log File
Logged Data
System Fault Detector.dll
Search Log File for appropriate times & dates and find the reasons why the system was down.
Times, dates & Log Filename
Downtime times, dates & reasons
Temp
Downtime times, dates & reasons
User
System Report Message.vi
Create System Report with the use of Macro's
Request to open System Report
System Report
Open System Report.vi
Opens System Report

Product Report.vi Data Flow Diagram
(Second Refinement)

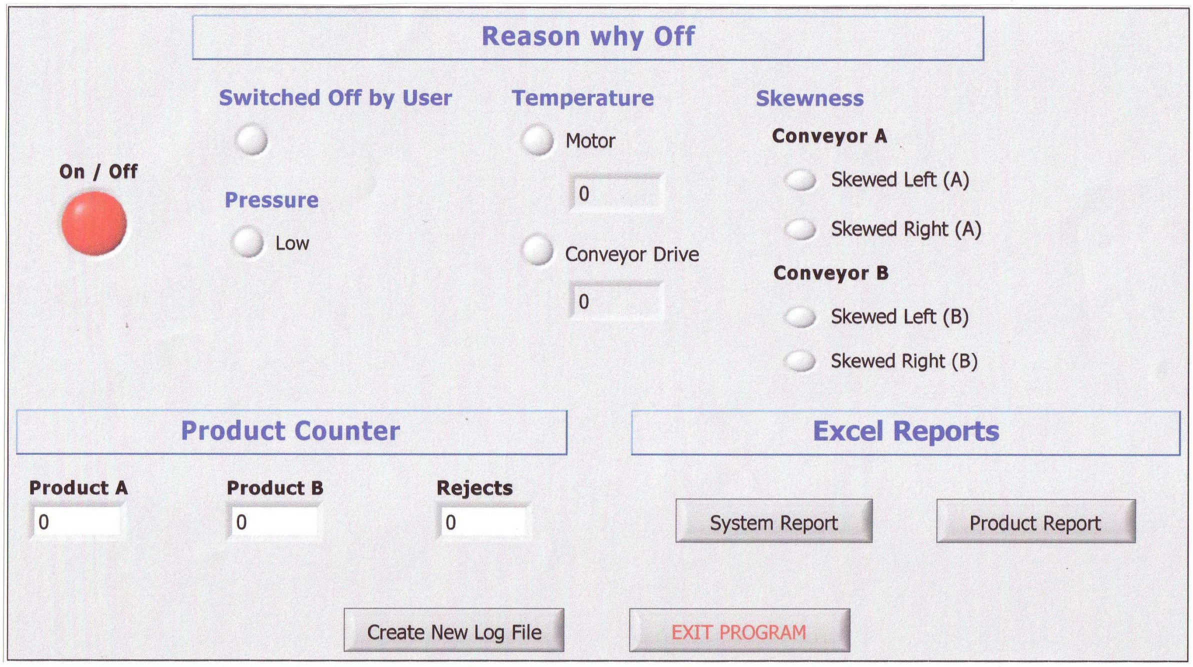


2. LabVIEW Application

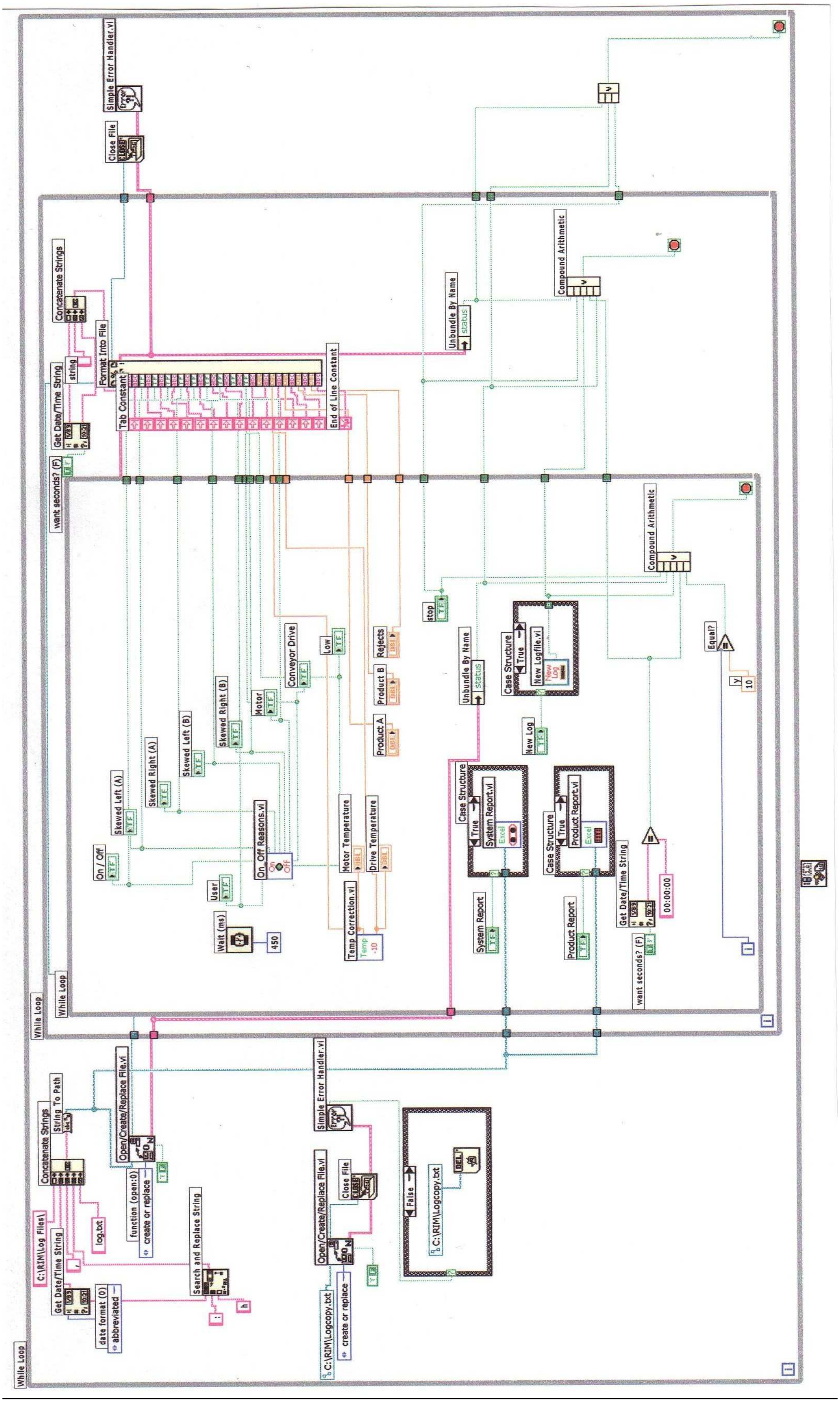
2.1 Display.vi

<u>Connector Pane</u>

<u>Front Panel</u>

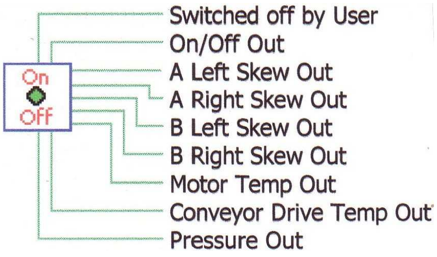


Block Diagram

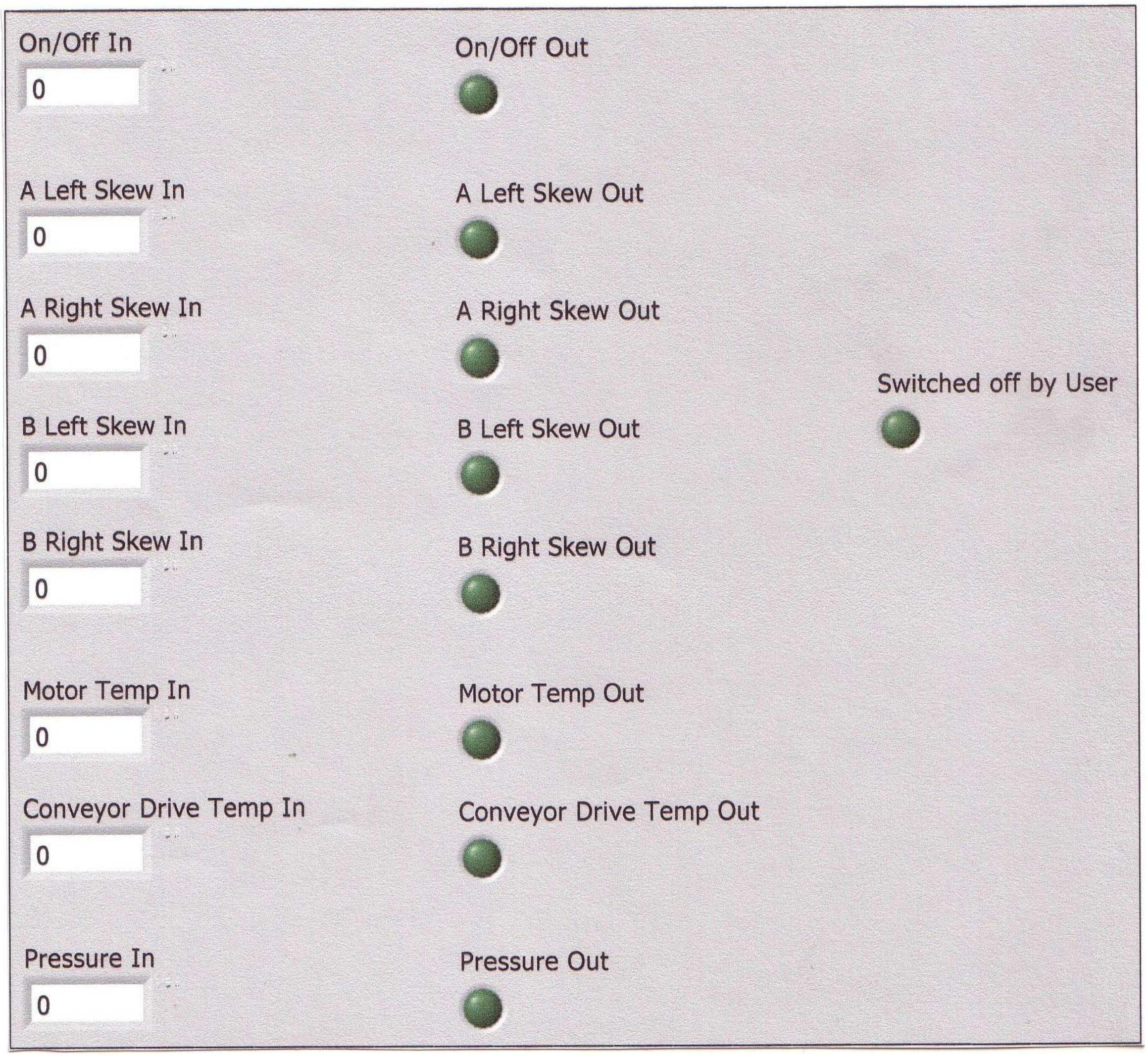


2.2 On_Off Reasons.vi

Connector Pane



Front Panel



On/Off In
0

A Left Skew In
0

A Right Skew In
0

B Left Skew In
0

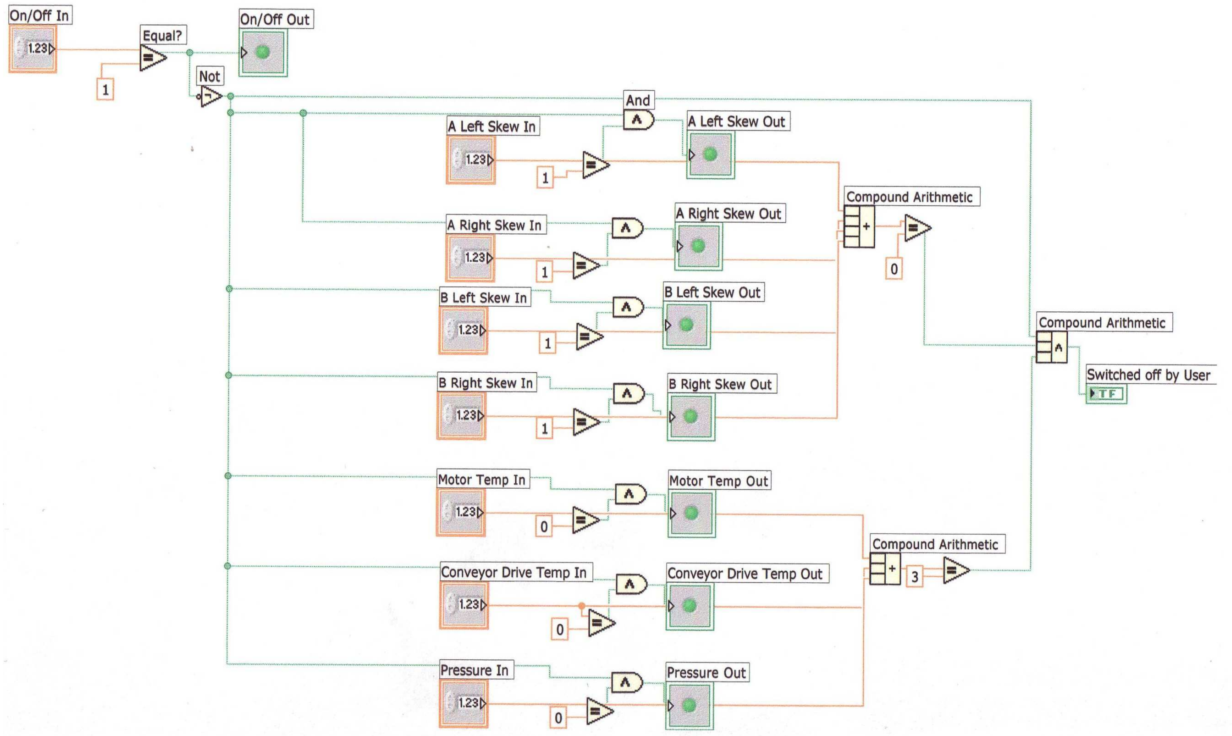
B Right Skew In
0

Motor Temp In
0

Conveyor Drive Temp In
0

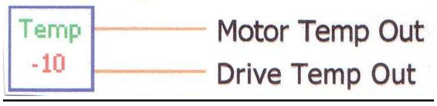
Pressure In
0

Block Diagram

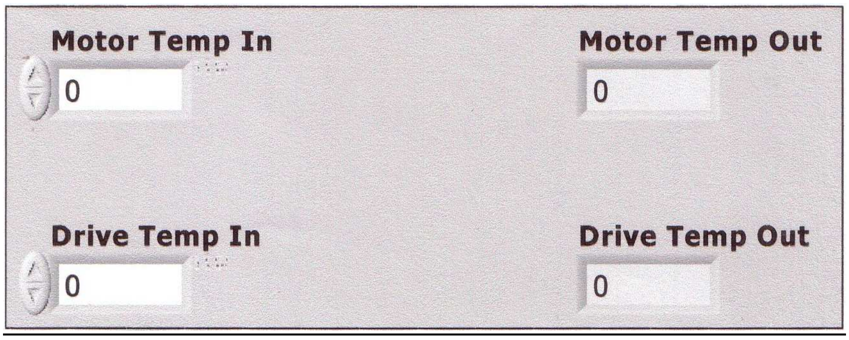


2.3 Temp Correction.vi

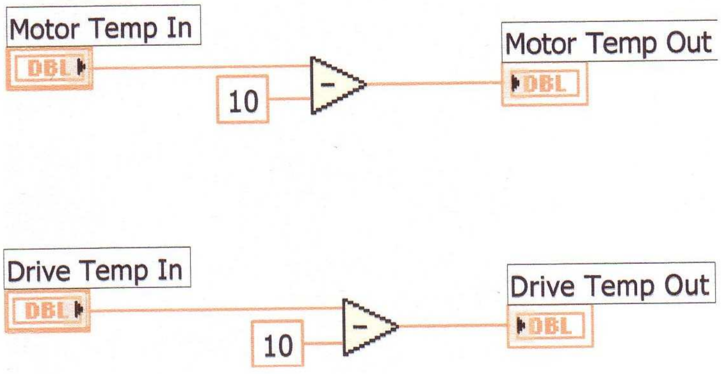
Connector Pane



Front Panel

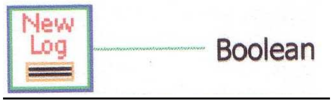


Block Diagram

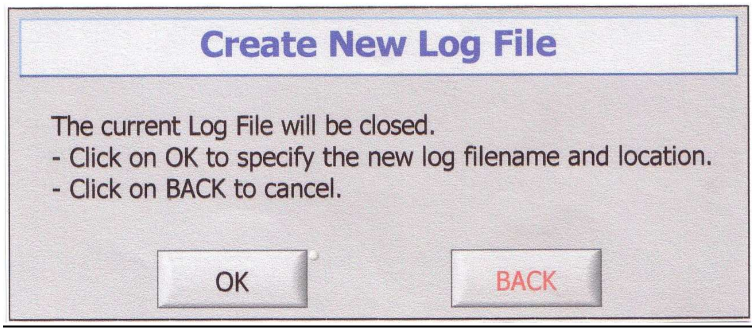


2.4 New Logfile.vi

Connector Pane

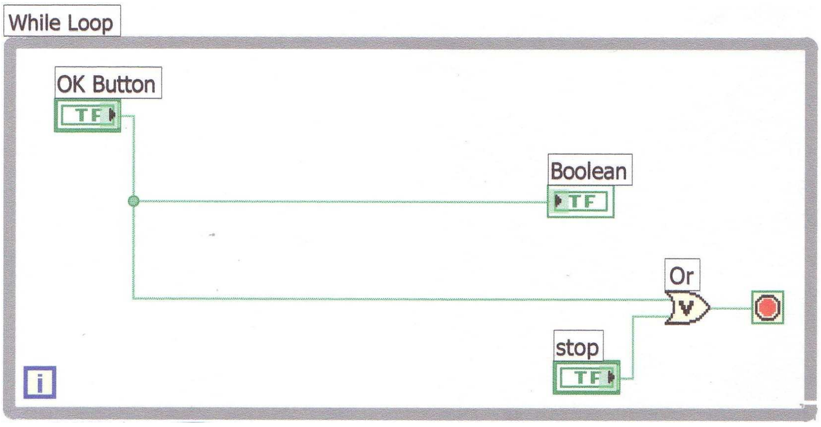


Front Panel



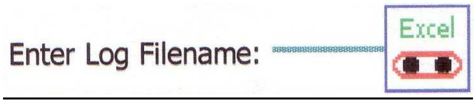
The current Log File will be closed.
- Click on OK to specify the new log filename and location.
- Click on BACK to cancel.

Block Diagram

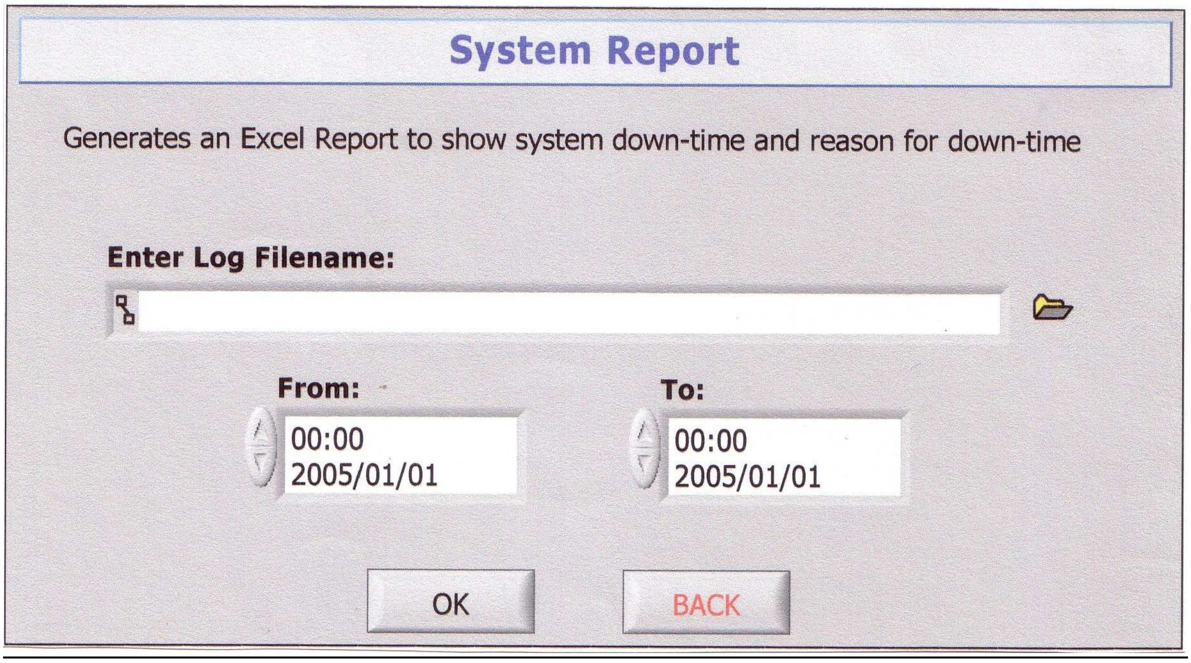


2.5 System Report.vi

Connector Pane



Front Panel



System Report

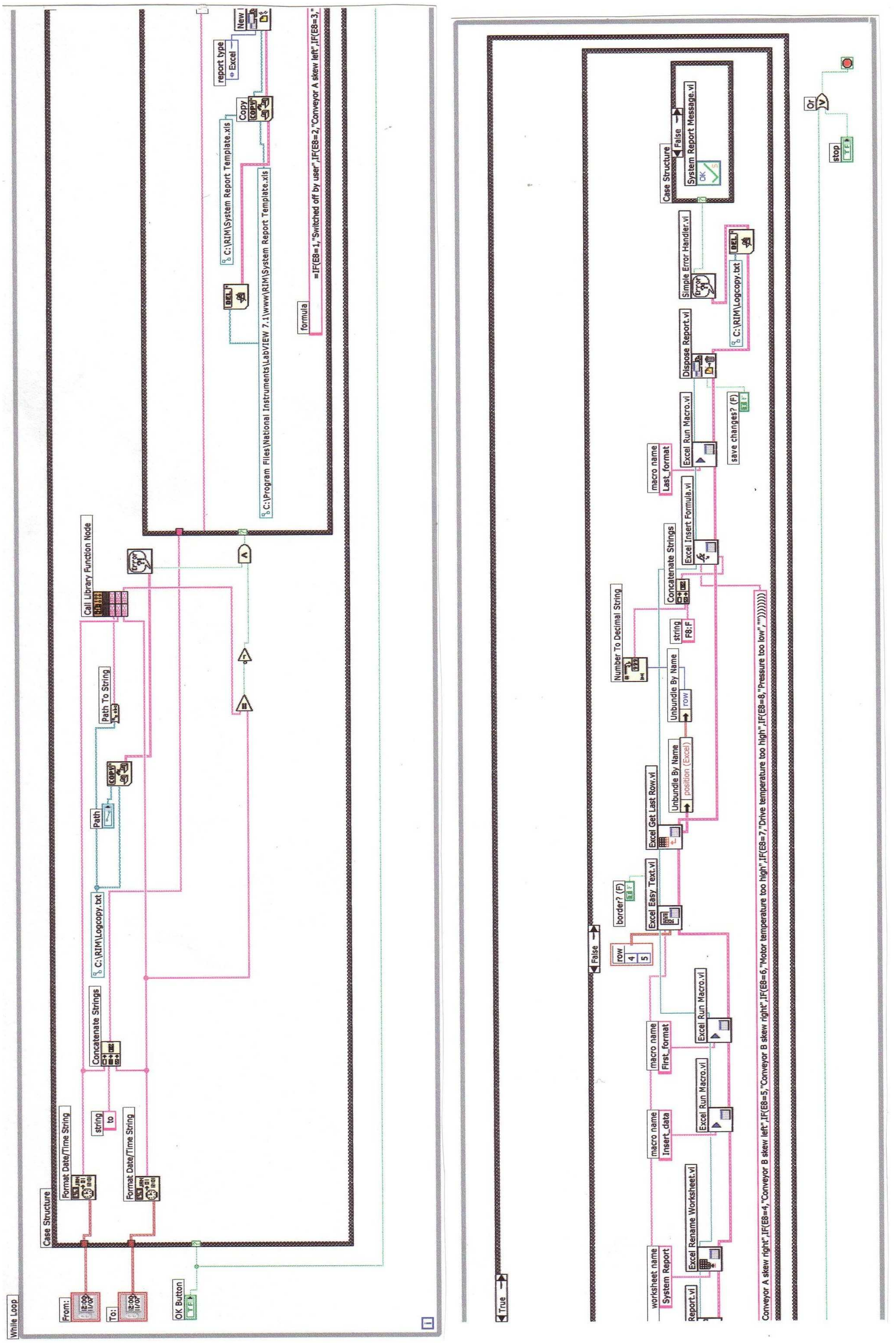
Generates an Excel Report to show system down-time and reason for down-time

Enter Log Filename:

From:
00:00
2005/01/01

To:
00:00
2005/01/01

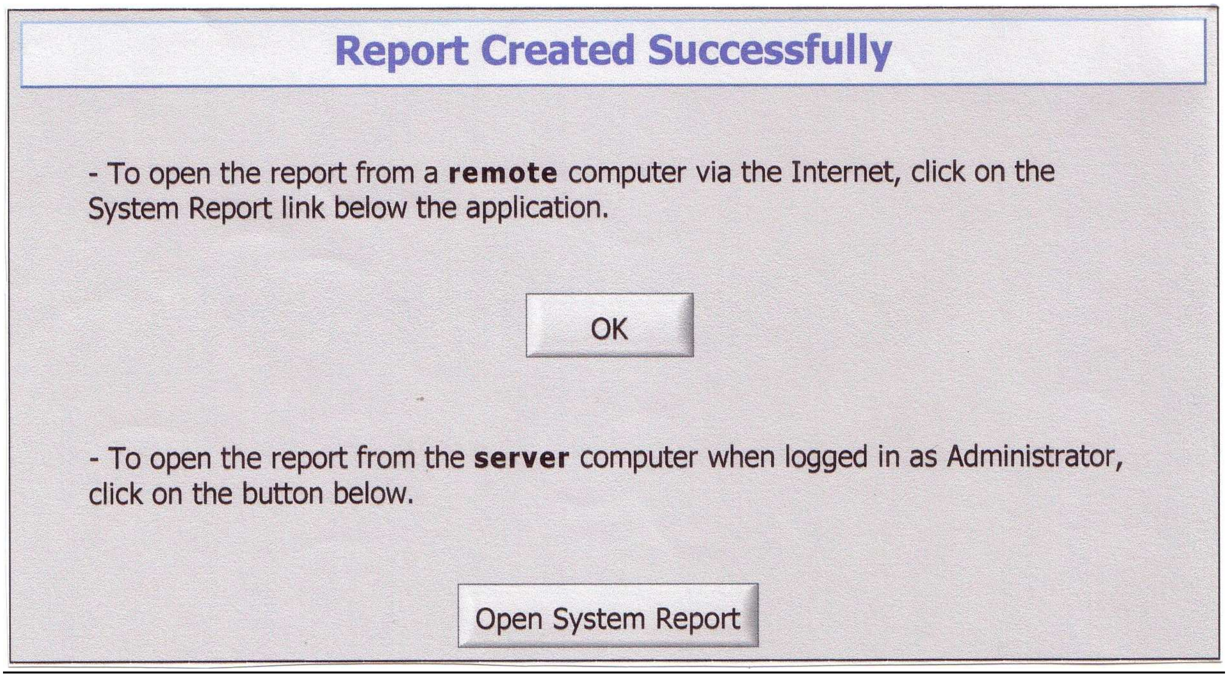
Block Diagram



2.6 System Report Message.vi

Connector Pane

Front Panel

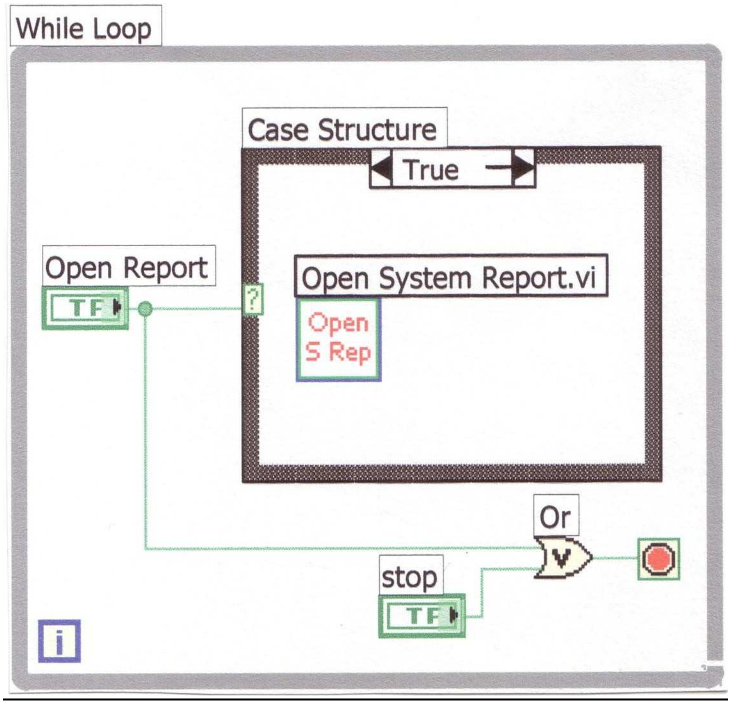


Report Created Successfully

- To open the report from a **remote** computer via the Internet, click on the System Report link below the application.

- To open the report from the **server** computer when logged in as Administrator, click on the button below.

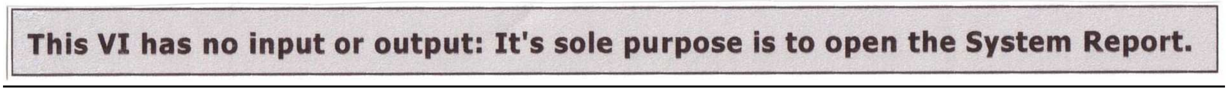
Block Diagram



2.7 Open System Report.vi

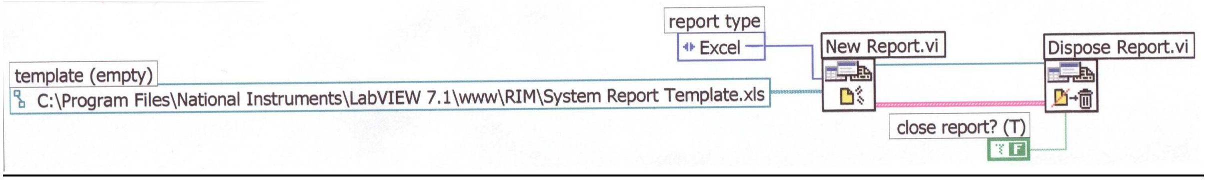
Connector Pane

Front Panel



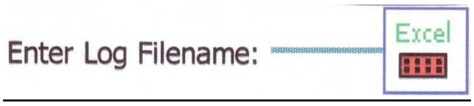
This VI has no input or output: It's sole purpose is to open the System Report.

Block Diagram

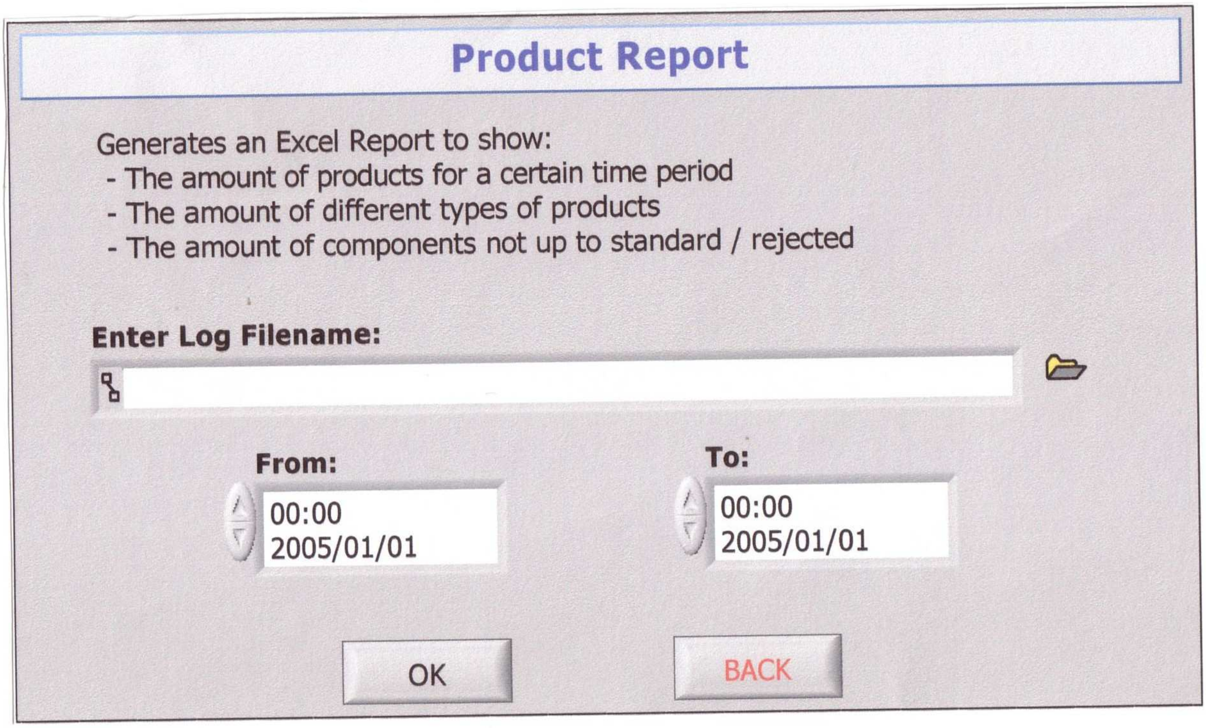

report type
Excel
New Report.vi
Dispose Report.vi
template (empty)
C:\Program Files\National Instruments\LabVIEW 7.1\www\RIM\System Report Template.xls
close report? (T)
F

2.8 Product Report.vi

Connector Pane



Front Panel



Product Report

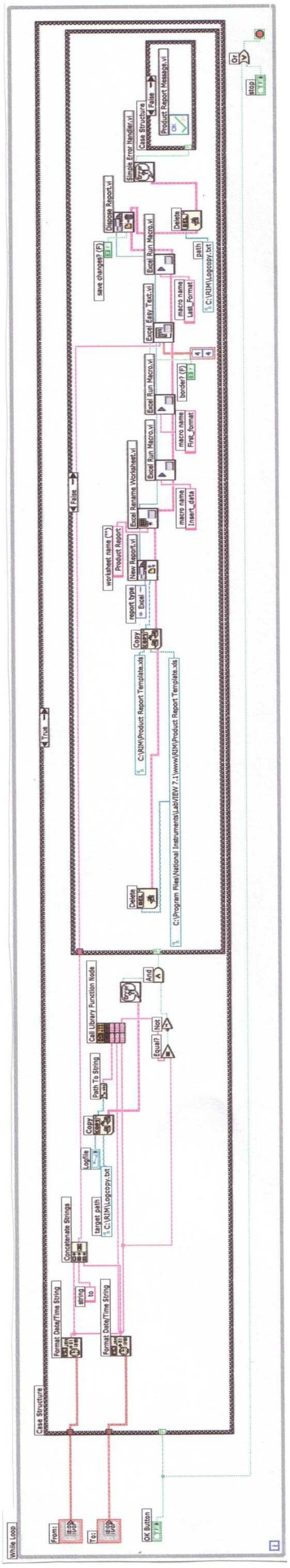
Generates an Excel Report to show:
- The amount of products for a certain time period
- The amount of different types of products
- The amount of components not up to standard / rejected

Enter Log Filename:

From:
00:00
2005/01/01

To:
00:00
2005/01/01

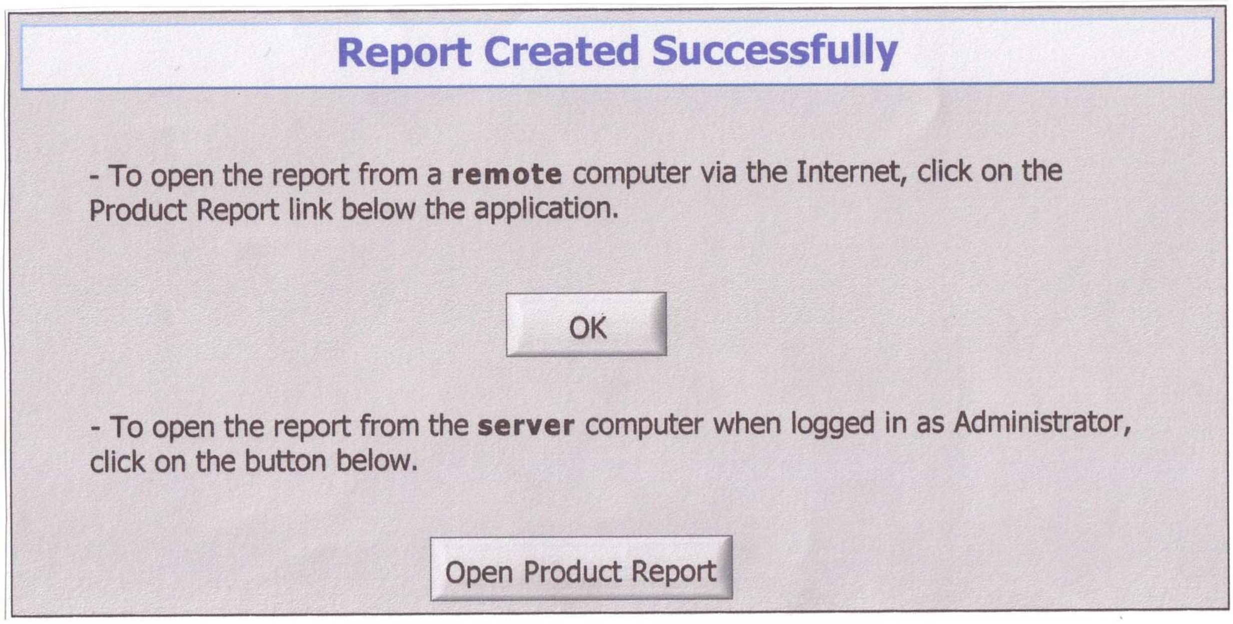
Block Diagram



2.9 Product Report Message.vi

Connector Pane

Front Panel

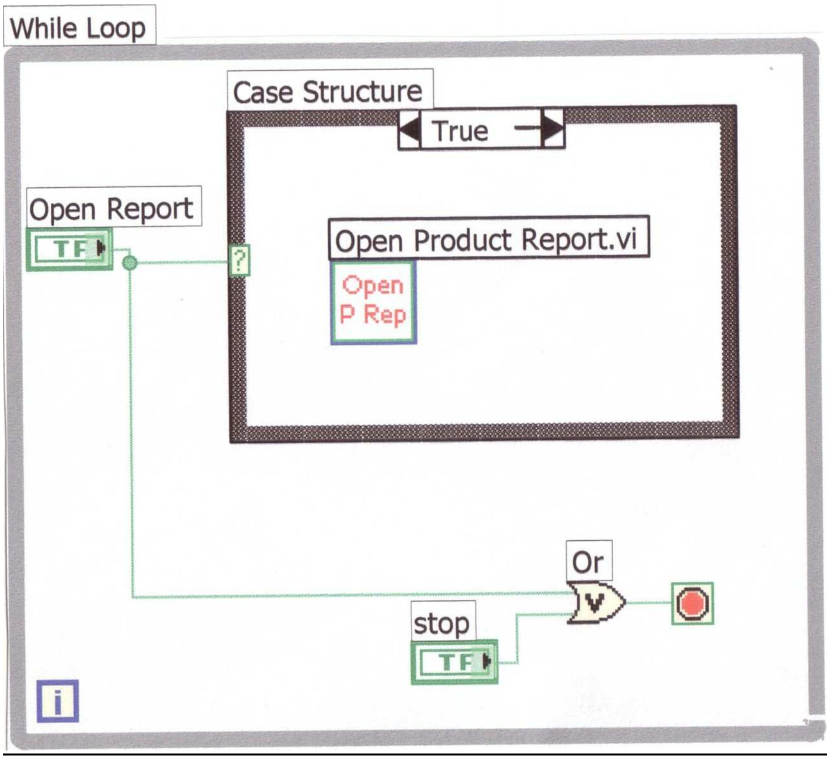


Report Created Successfully

- To open the report from a **remote** computer via the Internet, click on the Product Report link below the application.

- To open the report from the **server** computer when logged in as Administrator, click on the button below.

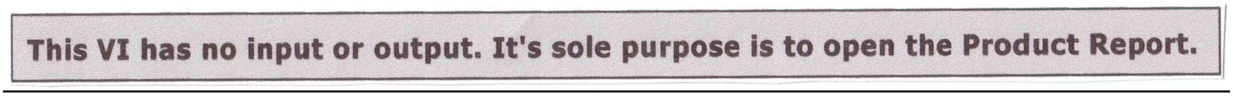
Block Diagram



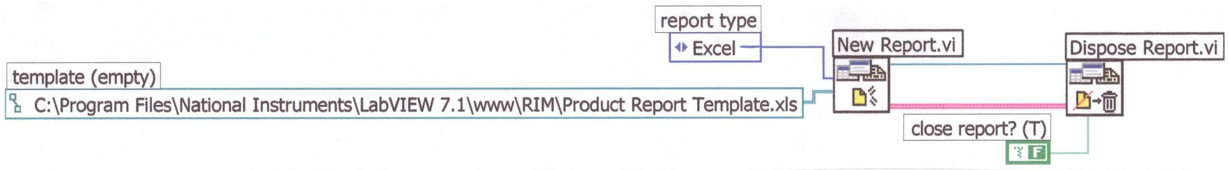
2.10 Open Product Report.vi

Connector Pane

Front Panel


This VI has no input or output. It's sole purpose is to open the Product Report.

Block Diagram


report type
Excel
New Report.vi
Dispose Report.vi
template (empty)
C:\Program Files\National Instruments\LabVIEW 7.1\www\RIM\Product Report Template.xls
close report? (T)
F

3. Dynamic Link Libraries (DLLs)

3.1 System Fault Detector.cpp

```
//Call Library source file: System Fault Detector.dll

//Created by: Linda Pretorius
//Last modified on: 06 December 2005

//This Dynamic Link Library will be called by the System Report VI (Virtual
//Instrument) created in LabVIEW.

//The purpose of this Dynamic Link Library is to find the times from and
times
//to when the system was down and give a reason why the system was down.
This
//information will be saved in a temporary file to be used by the LabVIEW
//application. The user will specify a date and time from and date and time
to //and a logfile from which information must be extracted. These three
values //will be the Input Parameters to this Dynamic Link Library.

#include "extcode.h"
#include "stdafx.h"
#include <fstream.h>
#include <stdlib.h>
#include <iostream.h>
#include <string.h>
#include <conio.h>

extern "C"
{
_declspec(dllexport) void SystemFault(char Pathname[], char DTFrom[], char
DTTo[]);
}

_declspec(dllexport) void SystemFault(char Pathname[], char DTFrom[], char
DTTo[])
{

  char Date[28], Time[12];
  char CurrentDate[28] = "", PreviousDate[28] = "";
  char CurrentTime[12] = "", PreviousTime[12] = "";
  char OnOff[7], User[7], SLA[7], SRA[7], SLB[7], SRB[7];
  char Motor[7], ConDr[7], Low[7];
  char TrueStr[7] = "TRUE", CompNeg[7] = "";
  char FalseStr[7] = "FALSE", CompPos[7] = "FALSE";
  char MTemp[12], DTemp[12], A[20], B[20], R[20];
  int ch, flag = 0;
  int n1, n2, n3;
  int reason;
  bool Found1, Found2;

  ifstream inFile;
  ofstream outFile;
  inFile.open(Pathname,ios::nocreate);
  //Open the file specified by the Pathname Input Parameter.
  outFile.open("C:/RIM/temp.txt");
  //Open a temporary file to write the downtimes and error codes to.

  if (inFile.fail())
  {
    cout << "\nThe file was not successfully opened"
       <<endl;
    exit(1);
    //Error message if the file specified by the Pathname Input Parameter
    //won't open.
  }
  else
  {
    Found1 = false;
    //Value to indicate that the DTFrom Input Parameter value is not found
yet.
    Found2 = false;
    //Value to indicate that the DTTo Input Parameter value is not found
yet.
    reason = 0;

    while ( (ch = inFile.peek()) != EOF )
    {
      inFile >> Date >> Time
           >> OnOff >> User >> SLA >> SRA >> SLB >> SRB
           >> Motor >> ConDr >> Low
           >> MTemp >> DTemp >> A >> B >> R;
      //Read the values in one line of the file specified by Pathname.

      strcpy(CurrentDate,Date);
      //To keep record of the date in the line just read.
      strcpy(CurrentTime,Time);
      //To keep record of the time in the line just read.

      strcat(Date," ");
      strcat(Date,Time);
      //Copy the time to the date.

      n1 = strncmp(Date,DTFrom,18);
      //Compare whether the date read is the same as the date specified in
      //the DTFrom Input Parameter. (Seconds are compared too.)
      if (n1 > 0)
        n1 = strncmp(Date,DTFrom,16);
        //Seconds are ignored.

      n2 = strncmp(Date,DTTo,16);
      //Compare whether the date read is the same as the date specified in
      //the DTTo Input Parameter. (Seconds are ignored.)

      if (n1 < 0)
        strcpy(CompNeg,TrueStr);
      //If CompNeg is TRUE it indicates that a date read was
      //smaller than DTFrom Input Parameter.

      if (n1 > 0)
        strcpy(CompPos,TrueStr);
      //If CompPos is TRUE it indicates that a date read was
      //larger than DTFrom Input Parameter
      n3 = strncmp(CompNeg,CompPos,7);

      if (n3 == 0)
        n1 = 0;
      //This is to make provision for the case that DTFrom Input
Parameter's
      //specific time was not found in the log file, but that that time
has
      //indeed passed while the logfile was written.

      if (n1 == 0)
      {
        while (n2 != 0)
        {
          if ((strcmp(FalseStr,OnOff)) == 0)
          //Compare to see whether the system was down.
          {
            outFile << CurrentDate << "  " << CurrentTime << "   ";
            //Write to the temporary file the date and time from when
            //the system was down.

            if ((strcmp(TrueStr,User)) == 0)
              reason = 1;
            //1 indicates that the user switched the system off.
            else if ((strcmp(TrueStr,SLA)) == 0)
              reason = 2;
            //2 indicates that conveyor belt A was skewed left.
            else if ((strcmp(TrueStr,SRA)) == 0)
              reason = 3;
            //3 indicates that conveyor belt A was skewed right.
            else if ((strcmp(TrueStr,SLB)) == 0)
              reason = 4;
            //4 indicates that conveyor belt B was skewed left.
            else if ((strcmp(TrueStr,SRB)) == 0)
              reason = 5;
            //5 indicates that conveyor belt B was skewed right.
            else if ((strcmp(TrueStr,Motor)) == 0)
              reason = 6;
            //6 indicates that the Motor temperature was too high.
            else if ((strcmp(TrueStr,ConDr)) == 0)
              reason = 7;
            //7 indicates that the Conveyor Drive temperature was too
high.
            else if ((strcmp(TrueStr,Low)) == 0)
              reason = 8;
            //8 indicates that the Pressure was too low.

            while ( ((strcmp(FalseStr,OnOff)) == 0) && ((ch =
            inFile.peek()) != EOF) && (n2 != 0) )
            {
              strcpy(PreviousDate,CurrentDate);
              strcpy(PreviousTime,CurrentTime);
              //Keep track of the previous time and date.

              inFile >> Date >> Time
                   >> OnOff >> User >> SLA >> SRA >> SLB >> SRB
                   >> Motor >> ConDr >> Low
                   >> MTemp >> DTemp >> A >> B >> R;
              //Read a new line from the specified logfile.
```

```
    strcpy(CurrentDate,Date);
    strcpy(CurrentTime,Time);
    //Keep track of the current date and time.

    strcat(Date," ");
    strcat(Date,Time);
    //Copy time to date.

    n1 = strncmp(Date,DTFrom,16);
    n2 = strncmp(Date,DTTo,16);
    //Compare the current date read to the specified dates.

  }

  if ((ch = inFile.peek()) == EOF)
  {
    outFile << PreviousDate << "    " << PreviousTime
         << " " << reason << endl;
    break;
    //If the end of file is reached, write the previous time
    //and date and the reason to the temporary file and stop
    //the while loop.
  }
  else if (n2 == 0)
  {
    if ((strcmp(FalseStr,OnOff)) == 0)
    {
      outFile << CurrentDate << "  " << CurrentTime
           << " " << reason << endl;
      //If the specified date is found and the system was
      //down at that time, write the current time and date
      //and the reason to the temporary file.
    }
    else
    {
      outFile << PreviousDate << " " << PreviousTime
           << " " << reason << endl;
      //If the specified date is found and the system was
      //not down at that time, write the previous time and
      //date and the reason to the temporary file.
    }
  }
  else if ((strcmp(FalseStr,OnOff)) != 0)
  {
    outFile << PreviousDate << "    " << PreviousTime
         << " " << reason << endl;
    //If the system was not down at the line currently read,
    //write the previous time and date and the reason to
    //the temporary file.
  }
}

else
{
  //If the system was not down at the line currently read,
  //read the next line from the specified logfile and compare
  //the date again to the date specified.

  inFile >> Date >> Time
        >> OnOff >> User >> SLA >> SRA >> SLB >> SRB
        >> Motor >> ConDr >> Low
```

```
                  >> MTemp >> DTemp >> A >> B >> R;

              strcpy(CurrentDate,Date);
              strcpy(CurrentTime,Time);

              strcat(Date," ");
              strcat(Date,Time);

              n1 = strncmp(Date,DTFrom,16);
              n2 = strncmp(Date,DTTo,16);
            }
          }

          Found1 = true;
          //Found1 will get the value true if DTFrom Input Parameter was
found
          //in the specified logfile.

          if (n2 == 0)
          {
            Found2 = true;
            break;
            //Found2 will get the value true if DTTo Input Parameter was
found
            //in the specified logfile and will break from the while loop.
          }
        }

      }
      if (Found1)
      {
        if (Found2)
        {

        }
        else
        {
          outFile << "Date or time to not found in specified log file." <<
endl;
          outFile << "Reached end of file at " << PreviousDate << " " <<
          PreviousTime << endl;
          //Error message written to the temporary file.
        }
      }
      else
        outFile << "Date or time from not found in specified log file." <<
endl;
        //Error message written to the temporary file.

  }
  inFile.close();
  outFile.close();
  //Close all open files.
}
```

3.2 Product Counter.cpp

```
//Call Library source file: Product Counter.dll

//Created by: Linda Pretorius
//Last modified on: 06 December 2005

//This Dynamic Link Library will be called by the Product Report VI
(Virtual
//Instrument) created in LabVIEW.

//The purpose of this Dynamic Link Library is to count the amount of
products
//produced from a certain date (provided as input parameter) to another
date
//(provided as input parameter) from a specified logfile (provided as input
//parameter). The amounts of different products produced will then be saved
in
//a temporary file to be used by the LabVIEW application.

#include "extcode.h"
#include "stdafx.h"
#include <fstream.h>
#include <stdlib.h>
#include <iostream.h>
#include <string.h>
#include <conio.h>

extern "C"
{
_declspec(dllexport) void ProductCounter(char Pathname[], char DTFrom[],
char DTo[]);
}

_declspec(dllexport) void ProductCounter(char Pathname[], char DTFrom[],
char DTTo[])
{

   char Date[28] = "", Time[12], EndDate[20];
   char OnOff[7], User[7], SLA[7], SRA[7], SLB[7], SRB[7];
   char Motor[7], ConDr[7], Low[7];
   char MTemp[12], DTemp[12], A[20], B[20], R[20];
   int ch, flag = 0;
   int n1, n2, n3;
   char TrueStr[7] = "TRUE", CompNeg[7] = "", CompPos[7] = "FALSE";
   char A1[20], A2[20], B1[20], B2[20], R1[20], R2[20];
   int A1Int, A2Int, B1Int, B2Int, R1Int, R2Int;
   int TotalA, TotalB, TotalR;
   bool Found1, Found2;

   ifstream inFile;
   ofstream outFile;

   inFile.open(Pathname,ios::nocreate);
   //Open file specified by Pathname.
   outFile.open("C:/RIM/temp.txt");
   //Open temporary file to write the amount of products produced to.
```

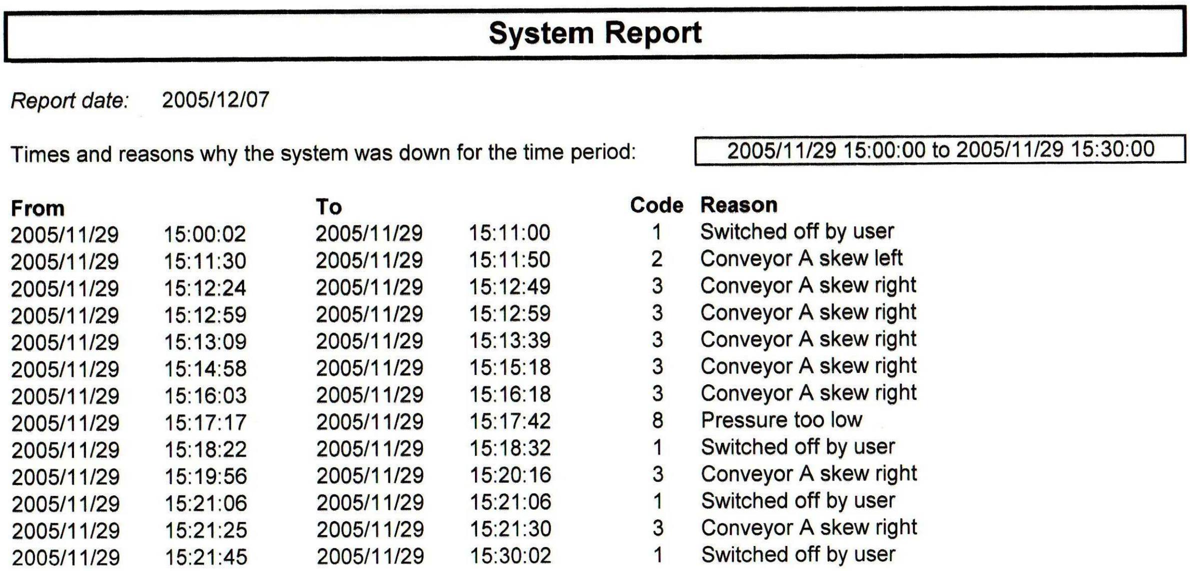
```
  if (inFile.fail())
  {
    //Error message if file will not open.
    cout << "\nThe file was not successfully opened"
       <<endl;
    exit(1);
  }
  else
  {
    Found1 = false;
    //False value to indicate that the from date is not found yet.
    Found2 = false;
    //False value to indicate that the to date is not found yet.

    while ( (ch = inFile.peek()) != EOF )
    {
      strcpy(EndDate,Date);
      //To keep record of the previous date.
      //For the first loop EndDate will have a value of "".

      inFile >> Date >> Time
           >> OnOff >> User >> SLA >> SRA >> SLB >> SRB
           >> Motor >> ConDr >> Low
           >> MTemp >> DTemp >> A >> B >> R;
      //Read the values from one line in the logfile.

      strcat(Date," ");
      strcat(Date,Time);
      //Add the time to the date.

      n1 = strncmp(Date,DTFrom,18);
      //Compare whether the date read from the file is the same as
      //DTFrom Input Parameter. (Seconds are compared too)
      if (n1 > 0)
        n1 = strncmp(Date,DTFrom,16);
      //Ignore seconds.

      n2 = strncmp(Date,DTTo,16);
      //Compare whether the date read from the file is the same as
      //DTTo Input Parameter. (Seconds are ignored.)

      if (n1 < 0)
        strcpy(CompNeg,TrueStr);
      //If CompNeg is TRUE it indicates that a date read was
      //smaller than DTFrom Input Parameter.

      if (n1 > 0)
        strcpy(CompPos,TrueStr);
      //If ComPos is TRUE it indicates that a date read was
      //larger than DTFrom Input Parameter.

      n3 = strncmp(CompNeg,CompPos,7);

      if (n3 == 0)
        n1 = 0;
      //This  is  to  make  provision  for  the  case  that  DTFrom  Input
Parameter's
      //specific time was not found in the log file, but that that time
has
      //indeed passed while the logfile was written.
      if (n1 == 0)
      {
        if (!Found1)
        {
          //When the DTFrom is found, get the product values.
          strcpy(A1,A);
          strcpy(B1,B);
          strcpy(R1,R);
          Found1 = true;
        }
      }

      strcpy(A2,A);
      strcpy(B2,B);
      strcpy(R2,R);
      //Keep record of the current product values.

      if (n2 == 0)
        Found2 = true;
        //DTTo has been found.

      if (Found1)
      {
        if (Found2)
          break;
          //Stop the while loop.
      }

    }

    if (Found1)
    {
      A1Int = atoi(A1);
      A2Int = atoi(A2);
      B1Int = atoi(B1);
      B2Int = atoi(B2);
      R1Int = atoi(R1);
      R2Int = atoi(R2);
      //Change all the string values to integer.

      TotalA = A2Int - A1Int;
      TotalB = B2Int - B1Int;
      TotalR = R2Int - R1Int;
      //Subtract the product values at DTTo from the product values
      //at DTFrom to find the amount of products produced.

      outFile << TotalA << "  " << TotalB << "  " << TotalR << endl;
      //Write the product values to the temporary file which will
      //be read by the LabVIEW application.

      if (!Found2)
      {
        outFile << "Date or time to not found in specified log file." <<
endl;
        outFile << "Reached end of file at " << EndDate << endl;
        //Write an error message to the temporary file which will
        //be read by the LabVIEW application.
      }
    }
    else
```

```
       outFile << "Date or time from not found in specified log file." <<
endl;
       //Write an error message to the temporary file which will be
       //read by the LabVIEW application.

  }
  inFile.close();
  outFile.close();
  //Close all open files.
}
```

4. Excel Macros

4.1 System Report Template.xls

Sample Report



System Report

Report date: 2005/12/07

Times and reasons why the system was down for the time period: 2005/11/29 15:00:00 to 2005/11/29 15:30:00

From		To		Code	Reason
2005/11/29	15:00:02	2005/11/29	15:11:00	1	Switched off by user
2005/11/29	15:11:30	2005/11/29	15:11:50	2	Conveyor A skew left
2005/11/29	15:12:24	2005/11/29	15:12:49	3	Conveyor A skew right
2005/11/29	15:12:59	2005/11/29	15:12:59	3	Conveyor A skew right
2005/11/29	15:13:09	2005/11/29	15:13:39	3	Conveyor A skew right
2005/11/29	15:14:58	2005/11/29	15:15:18	3	Conveyor A skew right
2005/11/29	15:16:03	2005/11/29	15:16:18	3	Conveyor A skew right
2005/11/29	15:17:17	2005/11/29	15:17:42	8	Pressure too low
2005/11/29	15:18:22	2005/11/29	15:18:32	1	Switched off by user
2005/11/29	15:19:56	2005/11/29	15:20:16	3	Conveyor A skew right
2005/11/29	15:21:06	2005/11/29	15:21:06	1	Switched off by user
2005/11/29	15:21:25	2005/11/29	15:21:30	3	Conveyor A skew right
2005/11/29	15:21:45	2005/11/29	15:30:02	1	Switched off by user

Visual Basic Code

First_format Macro

```
Sub First_format()
'
' First_format Macro
' Macro recorded 2005/10/27 by lindap
'
'
    Rows("1:1").Select
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Range("A7").Select
    ActiveCell.FormulaR1C1 = "From"
    Range("C7").Select
    ActiveCell.FormulaR1C1 = "To"
    Range("E7").Select
    ActiveCell.FormulaR1C1 = "Code"
    Range("F7").Select
    ActiveCell.FormulaR1C1 = "Reason"
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "System Report"
    Range("A3").Select
    ActiveCell.FormulaR1C1 = "Report date:"
    Range("B3").Select
    ActiveCell.FormulaR1C1 = "=TODAY()"
    Range("A5").Select
    ActiveCell.FormulaR1C1 = _
        "Times and reasons why the system was down for the time period:"
    Range("A1").Select
End Sub
```

Insert_data Macro

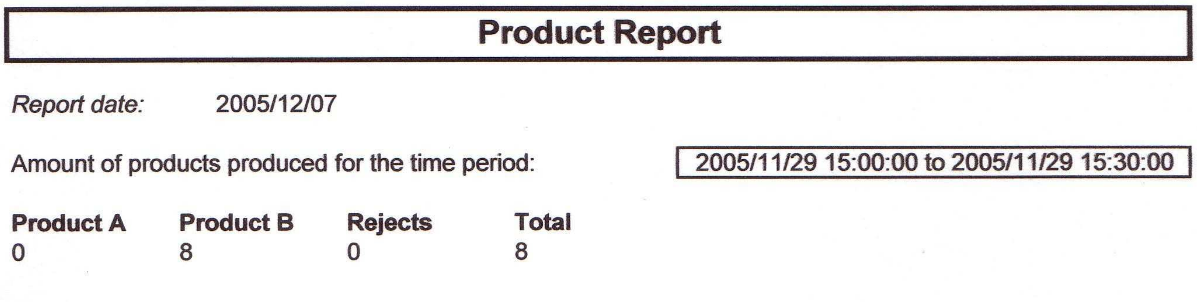
```
Sub Insert_data()
'
' Insert_data Macro
' Macro recorded 2005/10/27 by lindap
'
'
    Workbooks.OpenText Filename:="C:\RIM\temp.txt", Origin:=437, _
        StartRow:=1, DataType:=xlDelimited, TextQualifier:=xlDoubleQuote, _
        ConsecutiveDelimiter:=False,      Tab:=True,      Semicolon:=False,
Comma:=False _
        , Space:=False, Other:=False, FieldInfo:=Array(1, 1), _
        TrailingMinusNumbers:=True
    Columns("A:E").Select
    Selection.Copy
    Windows("System Report Template.xls").Activate
    Columns("A:E").Select
    ActiveSheet.Paste
    Windows("temp.txt").Activate
    ActiveWindow.Close
    Range("A1").Select
End Sub
```

Last_format Macro

```
Sub Last_format()
'
' Last_format Macro
' Macro recorded 2005/10/31 by lindap
'
'
    Columns("A:D").Select
    Selection.ColumnWidth = 12
    With Selection
        .HorizontalAlignment = xlLeft
        .VerticalAlignment = xlBottom
        .WrapText = False
        .Orientation = 0
        .AddIndent = False
        .IndentLevel = 0
        .ShrinkToFit = False
        .ReadingOrder = xlContext
        .MergeCells = False
    End With
    Range("A7:B7").Select
    Selection.Merge
    With Selection
        .HorizontalAlignment = xlLeft
        .VerticalAlignment = xlBottom
        .WrapText = False
        .Orientation = 0
        .AddIndent = False
        .IndentLevel = 0
        .ShrinkToFit = False
        .ReadingOrder = xlContext
        .MergeCells = False
    End With
    Range("C7:D7").Select
    Selection.Merge
    With Selection
        .HorizontalAlignment = xlLeft
        .VerticalAlignment = xlBottom
        .WrapText = False
        .Orientation = 0
        .AddIndent = False
        .IndentLevel = 0
        .ShrinkToFit = False
        .ReadingOrder = xlContext
        .MergeCells = False
    End With
    Columns("E:E").Select
    With Selection
        .HorizontalAlignment = xlCenter
        .VerticalAlignment = xlBottom
        .WrapText = False
        .Orientation = 0
        .AddIndent = False
        .IndentLevel = 0
        .ShrinkToFit = False
        .ReadingOrder = xlContext
        .MergeCells = False
    End With
    Selection.ColumnWidth = 6
    Columns("F:F").Select
    Selection.ColumnWidth = 40#
    Range("A1:F1").Select
    With Selection
        .HorizontalAlignment = xlCenter
        .VerticalAlignment = xlBottom
        .WrapText = False
        .Orientation = 0
        .AddIndent = False
        .IndentLevel = 0
        .ShrinkToFit = False
        .ReadingOrder = xlContext
        .MergeCells = False
    End With
    Selection.Merge
    Selection.Font.Bold = True
    With Selection.Font
        .Name = "Arial"
        .Size = 14
        .Strikethrough = False
        .Superscript = False
        .Subscript = False
        .OutlineFont = False
        .Shadow = False
        .Underline = xlUnderlineStyleNone
        .ColorIndex = xlAutomatic
    End With
    Rows("1:1").RowHeight = 22.5
    With Selection
        .HorizontalAlignment = xlCenter
        .VerticalAlignment = xlCenter
        .WrapText = False
        .Orientation = 0
        .AddIndent = False
        .IndentLevel = 0
        .ShrinkToFit = False
        .ReadingOrder = xlContext
        .MergeCells = True
    End With
    Range("A3").Select
    Selection.Font.Italic = True
    Range("A7:F7").Select
    Selection.Font.Bold = True
    Range("A1:F1").Select
    Selection.Borders(xlDiagonalDown).LineStyle = xlNone
    Selection.Borders(xlDiagonalUp).LineStyle = xlNone
    With Selection.Borders(xlEdgeLeft)
        .LineStyle = xlContinuous
        .Weight = xlMedium
        .ColorIndex = xlAutomatic
    End With
    With Selection.Borders(xlEdgeTop)
        .LineStyle = xlContinuous
        .Weight = xlMedium
        .ColorIndex = xlAutomatic
    End With
    With Selection.Borders(xlEdgeBottom)
        .LineStyle = xlContinuous
        .Weight = xlMedium
        .ColorIndex = xlAutomatic
    End With
    With Selection.Borders(xlEdgeRight)
        .LineStyle = xlContinuous
        .Weight = xlMedium
        .ColorIndex = xlAutomatic
    End With
    Selection.Borders(xlInsideVertical).LineStyle = xlNone
    Range("F5").Select
    With Selection
        .HorizontalAlignment = xlCenter
        .VerticalAlignment = xlBottom
        .WrapText = False
        .Orientation = 0
        .AddIndent = False
        .IndentLevel = 0
        .ShrinkToFit = False
        .ReadingOrder = xlContext
        .MergeCells = False
    End With
    Selection.Borders(xlDiagonalDown).LineStyle = xlNone
    Selection.Borders(xlDiagonalUp).LineStyle = xlNone
    With Selection.Borders(xlEdgeLeft)
        .LineStyle = xlContinuous
        .Weight = xlThin
        .ColorIndex = xlAutomatic
    End With
    With Selection.Borders(xlEdgeTop)
        .LineStyle = xlContinuous
        .Weight = xlThin
        .ColorIndex = xlAutomatic
    End With
    With Selection.Borders(xlEdgeBottom)
        .LineStyle = xlContinuous
        .Weight = xlThin
        .ColorIndex = xlAutomatic
    End With
    With Selection.Borders(xlEdgeRight)
        .LineStyle = xlContinuous
        .Weight = xlThin
        .ColorIndex = xlAutomatic
    End With
    Range("A1:F1").Select
End Sub
```

4.2 Product Report Template.xls

Sample Report



Product Report

Report date: 2005/12/07

Amount of products produced for the time period: 2005/11/29 15:00:00 to 2005/11/29 15:30:00

Product A	Product B	Rejects	Total
0	8	0	8

Visual Basic Code

First_format Macro

```
Sub First_format()
'
' First_format Macro
' Macro recorded 2005/10/28 by lindap
'

'
    Rows("1:1").Select
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Selection.Insert Shift:=xlDown
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "Product Report"
    Range("A7").Select
    ActiveCell.FormulaR1C1 = "Product A"
    Range("B7").Select
    ActiveCell.FormulaR1C1 = "Product B"
    Range("C7").Select
    ActiveCell.FormulaR1C1 = "Rejects"
    Range("D7").Select
    ActiveCell.FormulaR1C1 = "Total"
    Range("D8").Select
    Selection.FormulaR1C1 = "=SUM(RC[-3]:RC[-1])"
    Range("A3").Select
    ActiveCell.FormulaR1C1 = "Report date:"
    Range("B3").Select
    ActiveCell.FormulaR1C1 = "=TODAY()"
    Range("A5").Select
    ActiveCell.FormulaR1C1 = "Amount of products produced for the time
period:"
    Columns("A:D").Select
    Selection.ColumnWidth = 12#
    Range("A7:D7").Select
    Selection.Font.Bold = True
End Sub
```

Insert_data Macro

```
Sub Insert_data()
'
' Insert_data Macro
' Macro recorded 2005/11/23 by lindap
'

'
    Workbooks.OpenText       Filename:="C:\RIM\temp.txt",       Origin:=437,
StartRow:=1 _
        , DataType:=xlDelimited, TextQualifier:=xlDoubleQuote, _
        ConsecutiveDelimiter:=False,      Tab:=True,      Semicolon:=False,
Comma:=False _
        ,   Space:=False,   Other:=False,   FieldInfo:=Array(Array(1,   1),
Array(2, 1), _
        Array(3, 1)), TrailingMinusNumbers:=True
    Columns("A:C").Select
    Selection.Copy
    ActiveWindow.Close
    ActiveSheet.Paste
End Sub
```

Last_format Macro

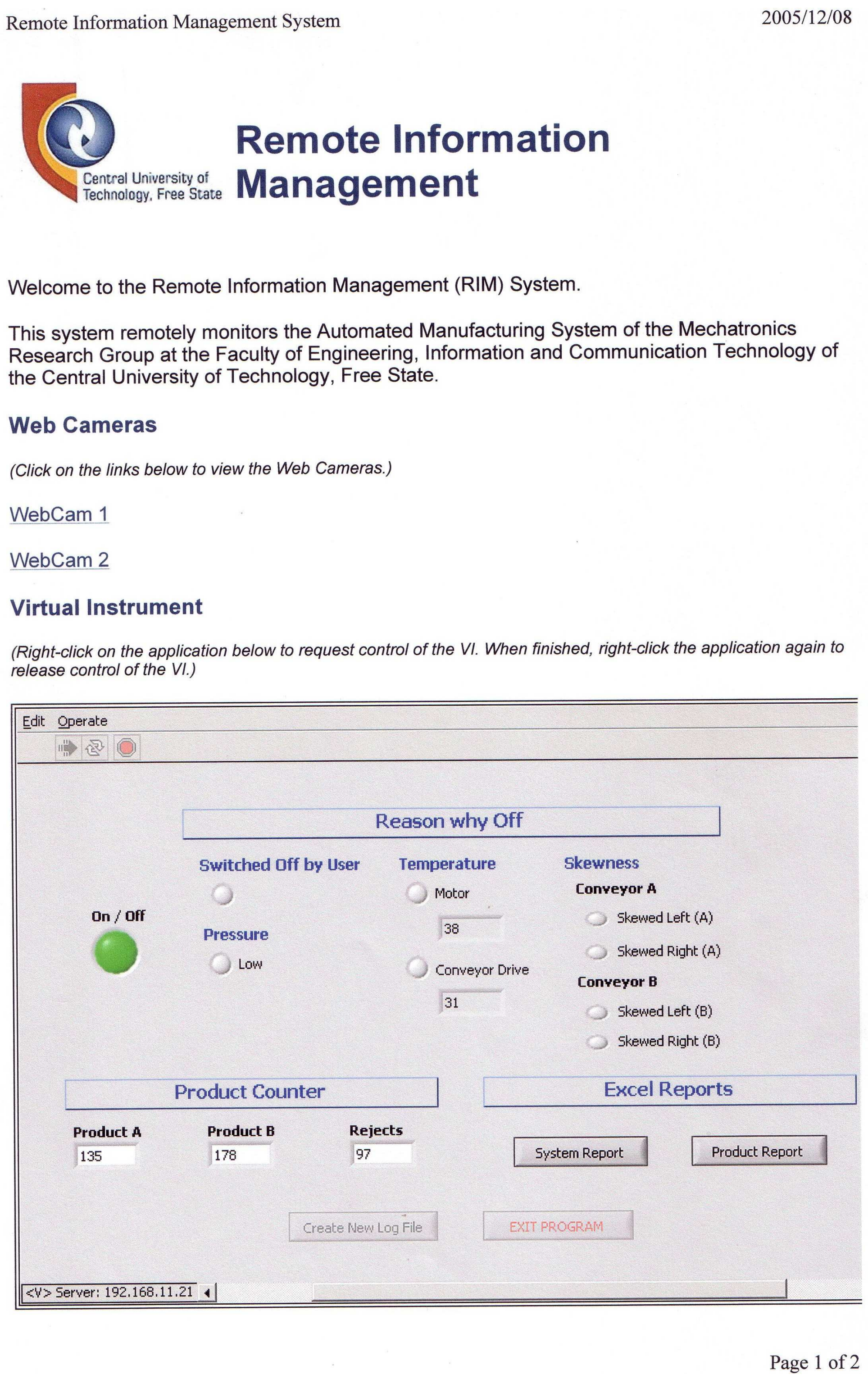
```
Sub Last_format()
'
' Last_format Macro
' Macro recorded 2005/10/31 by lindap
'

'
    Columns("A:D").Select
    Selection.ColumnWidth = 12
    Columns("E:H").Select
    Selection.ColumnWidth = 9
    Range("A1:H1").Select
    With Selection
        .HorizontalAlignment = xlCenter
        .VerticalAlignment = xlBottom
        .WrapText = False
        .Orientation = 0
        .AddIndent = False
        .IndentLevel = 0
        .ShrinkToFit = False
        .ReadingOrder = xlContext
        .MergeCells = False
    End With
    Selection.Merge
    Selection.Borders(xlDiagonalDown).LineStyle = xlNone
    Selection.Borders(xlDiagonalUp).LineStyle = xlNone
    With Selection.Borders(xlEdgeLeft)
        .LineStyle = xlContinuous
```

```
     .Weight = xlMedium
     .ColorIndex = xlAutomatic
End With
With Selection.Borders(xlEdgeTop)
     .LineStyle = xlContinuous
     .Weight = xlMedium
     .ColorIndex = xlAutomatic
End With
With Selection.Borders(xlEdgeBottom)
     .LineStyle = xlContinuous
     .Weight = xlMedium
     .ColorIndex = xlAutomatic
End With
With Selection.Borders(xlEdgeRight)
     .LineStyle = xlContinuous
     .Weight = xlMedium
     .ColorIndex = xlAutomatic
End With
Selection.Borders(xlInsideVertical).LineStyle = xlNone
Selection.Font.Bold = True
With Selection.Font
     .Name = "Arial"
     .Size = 14
     .Strikethrough = False
     .Superscript = False
     .Subscript = False
     .OutlineFont = False
     .Shadow = False
     .Underline = xlUnderlineStyleNone
     .ColorIndex = xlAutomatic
End With
Rows("1:1").RowHeight = 22.5
With Selection
     .HorizontalAlignment = xlCenter
     .VerticalAlignment = xlCenter
     .WrapText = False
     .Orientation = 0
     .AddIndent = False
     .IndentLevel = 0
     .ShrinkToFit = False
     .ReadingOrder = xlContext
     .MergeCells = True
End With
Range("A3").Select
Selection.Font.Italic = True
Range("A7:D8").Select
With Selection
     .HorizontalAlignment = xlLeft
     .VerticalAlignment = xlBottom
     .WrapText = False
     .Orientation = 0
     .AddIndent = False
     .IndentLevel = 0
     .ShrinkToFit = False
     .ReadingOrder = xlContext
     .MergeCells = False
End With
Range("E5:H5").Select
With Selection
     .HorizontalAlignment = xlCenter
     .VerticalAlignment = xlBottom
```

```
        .WrapText = False
        .Orientation = 0
        .AddIndent = False
        .IndentLevel = 0
        .ShrinkToFit = False
        .ReadingOrder = xlContext
        .MergeCells = False
    End With
    Selection.Merge
    Selection.Borders(xlDiagonalDown).LineStyle = xlNone
    Selection.Borders(xlDiagonalUp).LineStyle = xlNone
    With Selection.Borders(xlEdgeLeft)
        .LineStyle = xlContinuous
        .Weight = xlThin
        .ColorIndex = xlAutomatic
    End With
    With Selection.Borders(xlEdgeTop)
        .LineStyle = xlContinuous
        .Weight = xlThin
        .ColorIndex = xlAutomatic
    End With
    With Selection.Borders(xlEdgeBottom)
        .LineStyle = xlContinuous
        .Weight = xlThin
        .ColorIndex = xlAutomatic
    End With
    With Selection.Borders(xlEdgeRight)
        .LineStyle = xlContinuous
        .Weight = xlThin
        .ColorIndex = xlAutomatic
    End With
    Selection.Borders(xlInsideVertical).LineStyle = xlNone
    Range("A1:H1").Select
End Sub
```

5. Web Site

Printout of Web Site



Remote Information Management System 2005/12/08

Central University of Technology, Free State

Remote Information Management

Welcome to the Remote Information Management (RIM) System.

This system remotely monitors the Automated Manufacturing System of the Mechatronics Research Group at the Faculty of Engineering, Information and Communication Technology of the Central University of Technology, Free State.

Web Cameras

(Click on the links below to view the Web Cameras.)

WebCam 1

WebCam 2

Virtual Instrument

(Right-click on the application below to request control of the VI. When finished, right-click the application again to release control of the VI.)

On / Off ●

Reason why Off

Switched Off by User ○

Pressure: ○ Low

Temperature: ○ Motor 38; ○ Conveyor Drive 31

Skewness

Conveyor A: ○ Skewed Left (A); ○ Skewed Right (A)

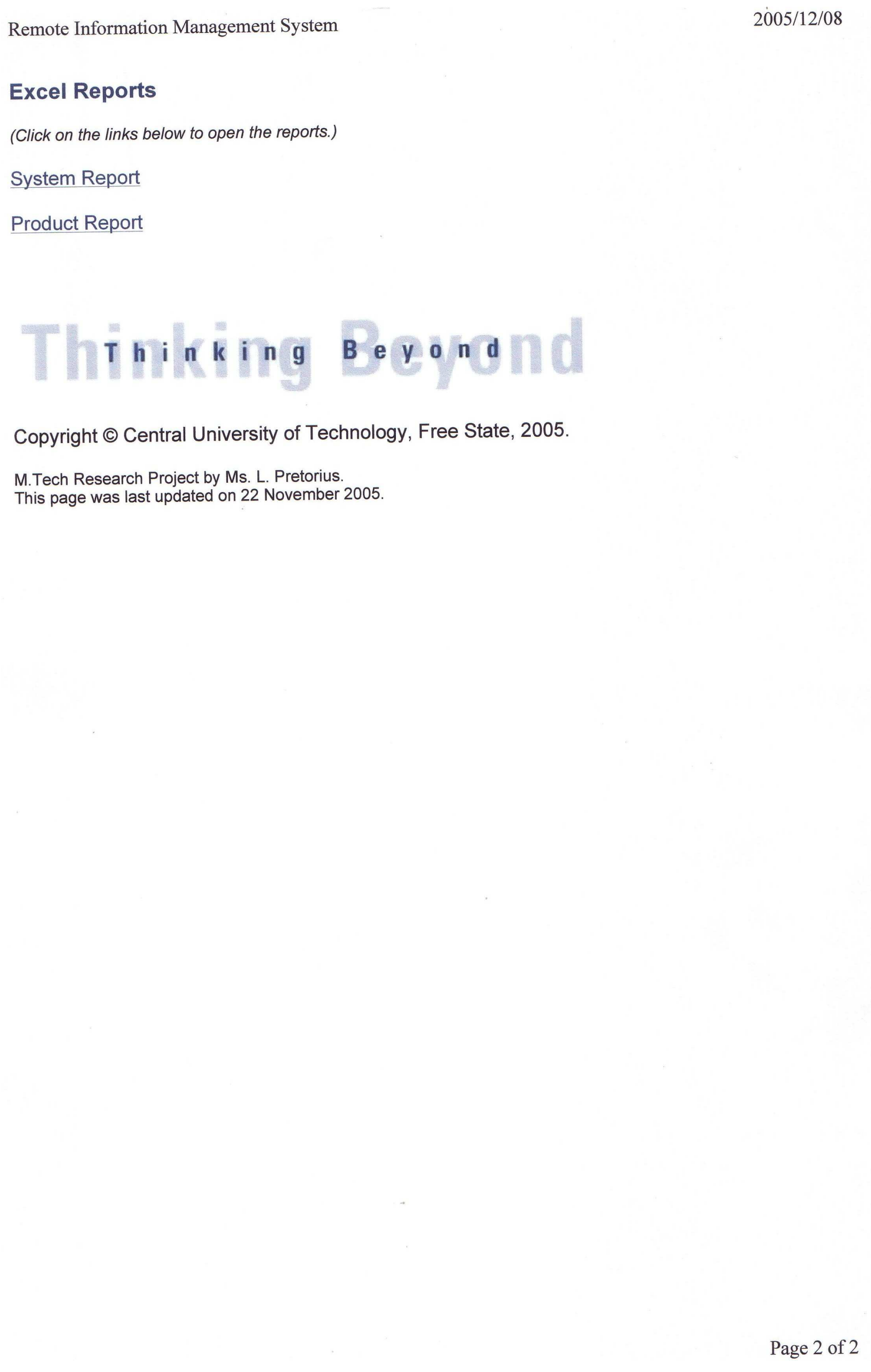
Conveyor B: ○ Skewed Left (B); ○ Skewed Right (B)

Product Counter

Product A	Product B	Rejects
135	178	97

Excel Reports

Page 1 of 2



Remote Information Management System 2005/12/08

Excel Reports

(Click on the links below to open the reports.)

System Report

Product Report

M.Tech Research Project by Ms. L. Pretorius.
This page was last updated on 22 November 2005.

Page 2 of 2

HTML Code

RIM.htm

```
<HTML>

<HEAD>
<TITLE>Remote Information Management System</TITLE>
</HEAD>

<BODY link="#891413" vlink="#09244A" alink="#DCA439">

<p><font face="Arial">
<img border="0" src="CUT%20logo.jpg" width="177" height="113"
align="left"></font></p>
<p>&nbsp;</p>

<h1><font face="Arial" color="#09244A">Remote Information
Management</font></h1>
<p>&nbsp;</p>

<p align="left"><font face="Arial">Welcome to the Remote Information
Management (RIM) System.</font></p>
<p><font face="Arial">This system remotely monitors the Automated
Manufacturing System of the Mechatronics Research Group at the Faculty of
Engineering, Information and Communication Technology of the Central
University of Technology, Free State.</font></p>

<p><b><font face="Arial" size="4" color="#09244A">Web
Cameras</font></b></p>
<p><i><font face="Arial" size="2">(Click on the links below to view the
Web Cameras.)</font></i></p>
<p><font face="Arial">
<a target="_blank" href="http://192.168.11.167/">
WebCam 1</a></font></p>
<p><font face="Arial">
<a target="_blank" href="http://192.168.11.187/">
WebCam 2</a></font></p>

<p><b><font face="Arial" size="4" color="#09244A">Virtual
Instrument</font></b></p>
<p><i><font face="Arial" size="2">(Right-click on the application below to
request control of the VI. When finished, right-click the application again
to release control of the VI.)</font></i></p><P>
<TABLE BORDER = 1 BORDERCOLOR = #000000><TR><TD>
<SCRIPT language="JavaScript"><!--
var lng;
if (navigator.userLanguage) { lng = navigator.userLanguage; };
if (navigator.language) { lng = navigator.language.toLowerCase(); };

var obj = '<OBJECT ID="LabVIEWControl" CLASSID="CLSID:A40B0AD4-B50E-4E58-
8A1D-8544233807AC" WIDTH=723 HEIGHT=477
CODEBASE="ftp://ftp.ni.com/support/labview/runtime/windows/7.1';
if (lng.indexOf("fr") != -1) { obj = obj + '/French'; }
else if (lng.indexOf("de") != -1) { obj = obj + '/German'; }
else if (lng.indexOf("ja") != -1) { obj = obj + '/Japanese'; }
obj = obj + '/LVRunTimeEng.exe">';
```

```
document.write(obj);
// --></SCRIPT>
<PARAM name="LVFPPVINAME" value="Display.vi">
<PARAM name="REQCTRL" value=false>
<EMBED SRC=".LV_FrontPanelProtocol.rpvi71" LVFPPVINAME="Display.vi"
REQCTRL=false TYPE="application/x-labviewrpvi71" WIDTH=723 HEIGHT=477
PLUGINSPAGE="http://digital.ni.com/express.nsf/express?openagent&code=ex3e3
3&"> </EMBED>
</OBJECT>
</TD></TR></TABLE>
<P>

<p><b><font face="Arial" size="4" color="#09244A">Excel
Reports</font></b></p>
<p><i><font face="Arial" size="2">(Click on the links below to open the
reports.)</font></i></p>
<p><font face="Arial">
<a target="_blank"
href="http://192.168.11.21/RIM/System%20Report%20Template.xls">
System Report</a></font></p>
<p><font face="Arial">
<a target="_blank"
href="http://192.168.11.21/RIM/Product%20Report%20Template.xls">
Product Report</a></font></p>
<p>&nbsp;</p>

<p align="left"><img border="0" src="CUT%20beyond.jpg" width="475"
height="81"></p>

<p align="left"><font face="Arial">Copyright © Central University of
Technology, Free State, 2005.</font></p>
<p align="left"><font face="Arial" size="2">M.Tech Research Project by Ms.
L.
Pretorius.<br>
This page was last updated on 22 November 2005.</font></p>
</BODY>

</HTML>
```

Appendix B: Operator Manual

Remote Information Management System

Operator Manual

Linda Pretorius

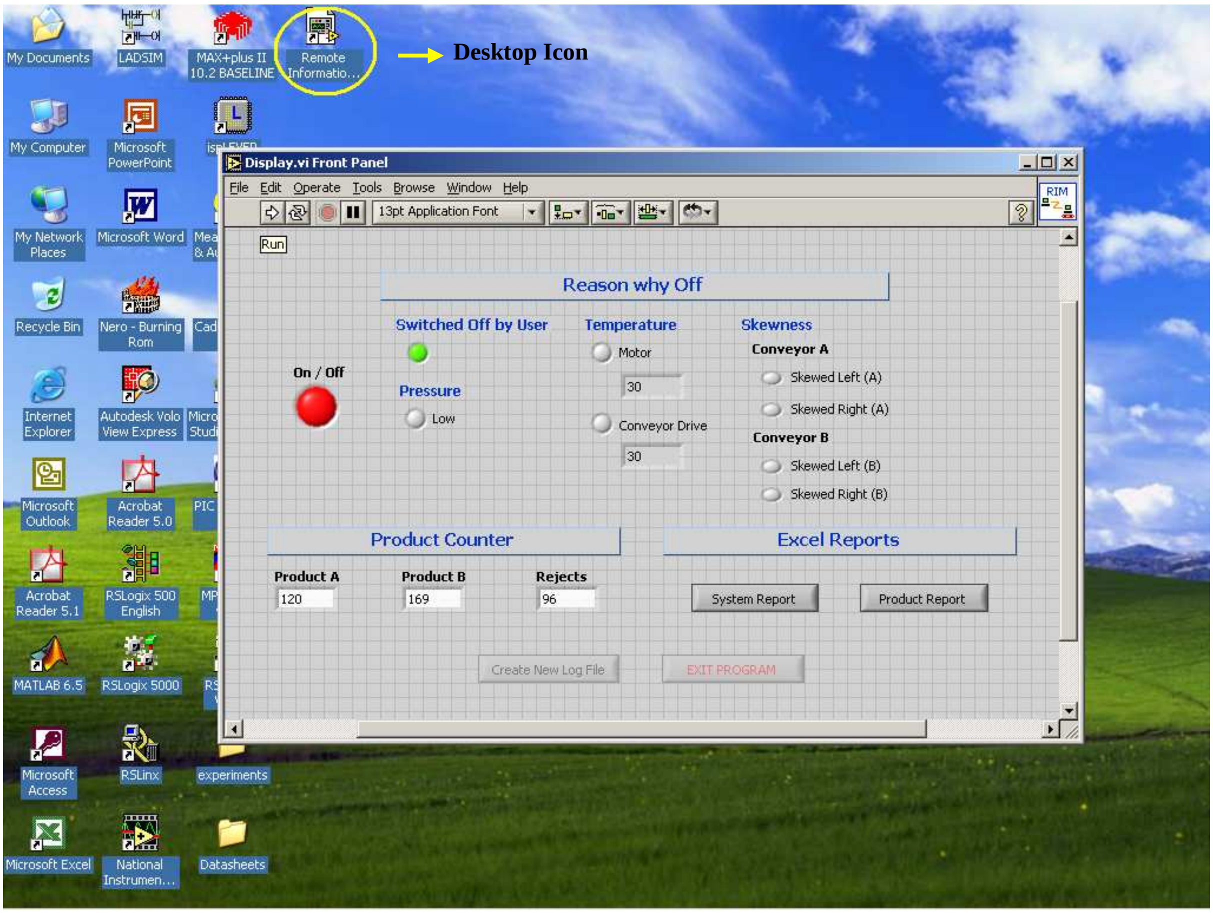
Table of Contents

1. Getting Started

There are two ways to open the Remote Information Management (RIM) System that is installed on the Web Server computer located at the Automated Manufacturing System.

1. Double-click the Icon created on the Desktop.
2. Browse to the directory C:\RIM\ and double-click on the file display.vi to open it.

The Display.vi Front Panel will open as shown in the picture below. Click on the run button ⇨ to start the system.



Desktop Icon

Temperature: Motor 30; Conveyor Drive 30

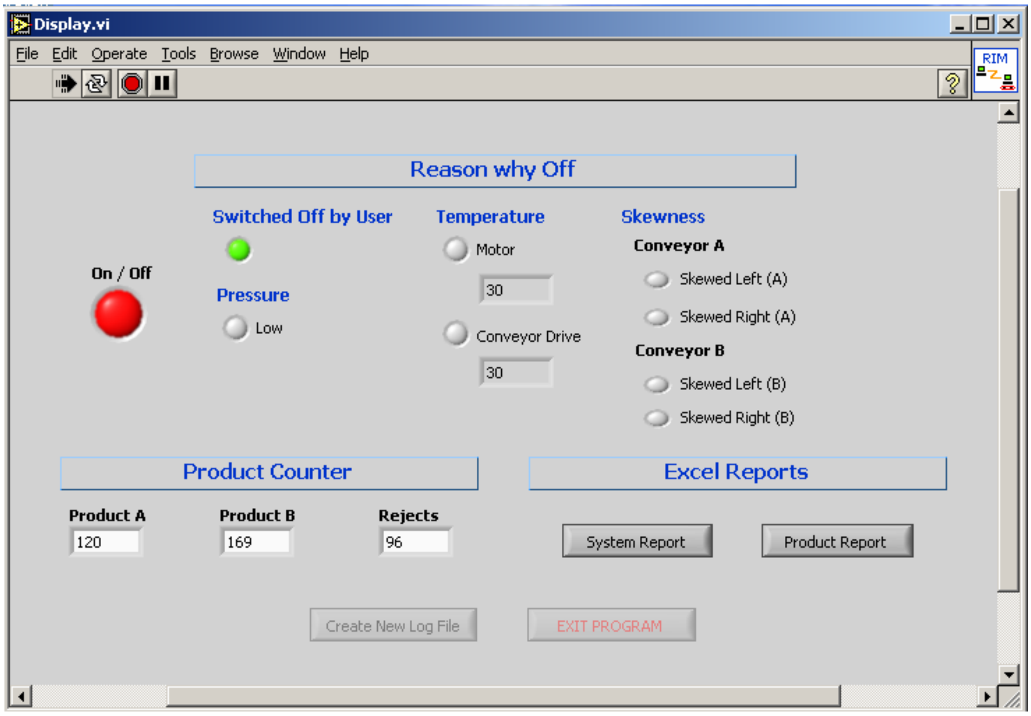
Product A: 120

Product B: 169

Rejects: 96

Font: 13pt Application Font

When the system has started, the gridlines, which are visible in the picture above, will no longer be visible. Real-time information from the Programmable Logic Controller (PLC) will be shown.



Motor: 30

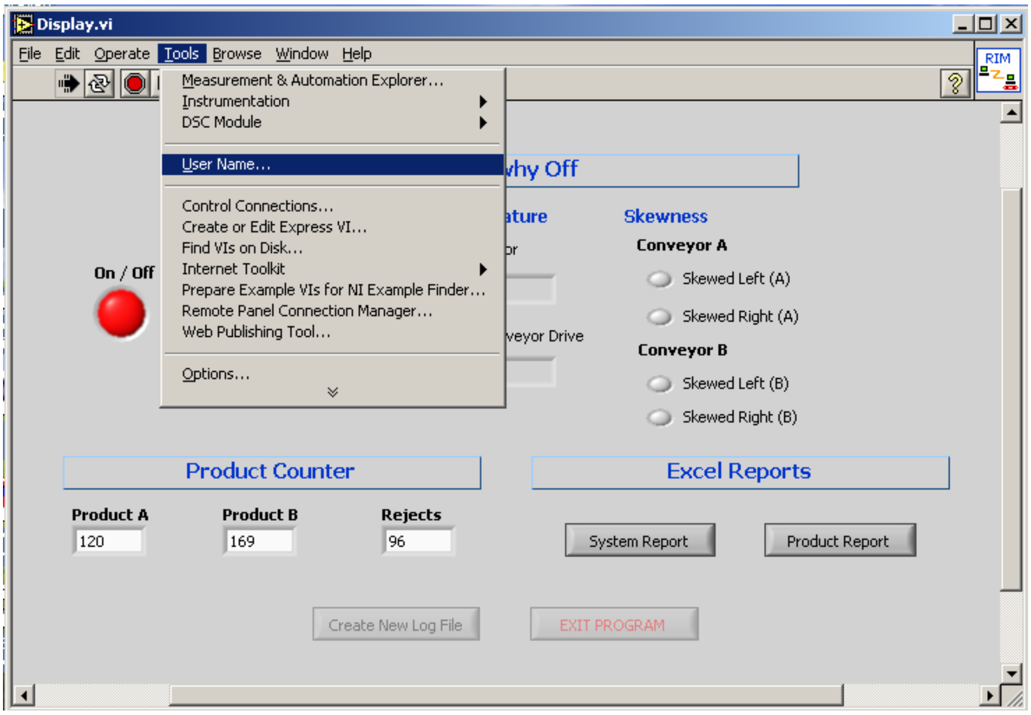
Conveyor Drive: 30

Product A	Product B	Rejects
120	169	96

2. Logging in

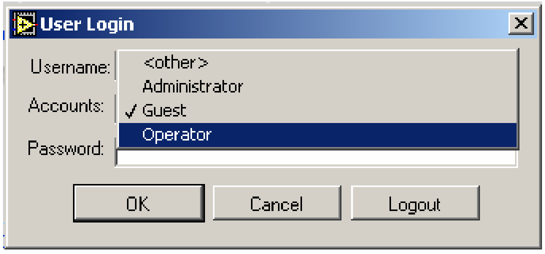
Not all commands will be available unless the operator logs into the system. The System Operator will only be able to log into the RIM system running on the Web Server Computer. Complete the following steps to log into the system:

Step 1: Click on Tools → User Name. The User Login window will appear.

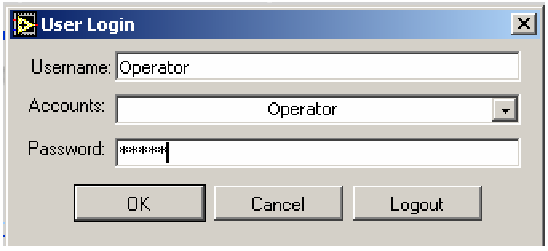


Product A: 120
Product B: 169
Rejects: 96

Step 2: Click on the down arrow next to accounts and choose Operator.



Step 3: Type in your password. The default password is 12345.



Username: Operator
Accounts: Operator
Password: *****

As soon as you are successfully logged into the system, all commands will be available.

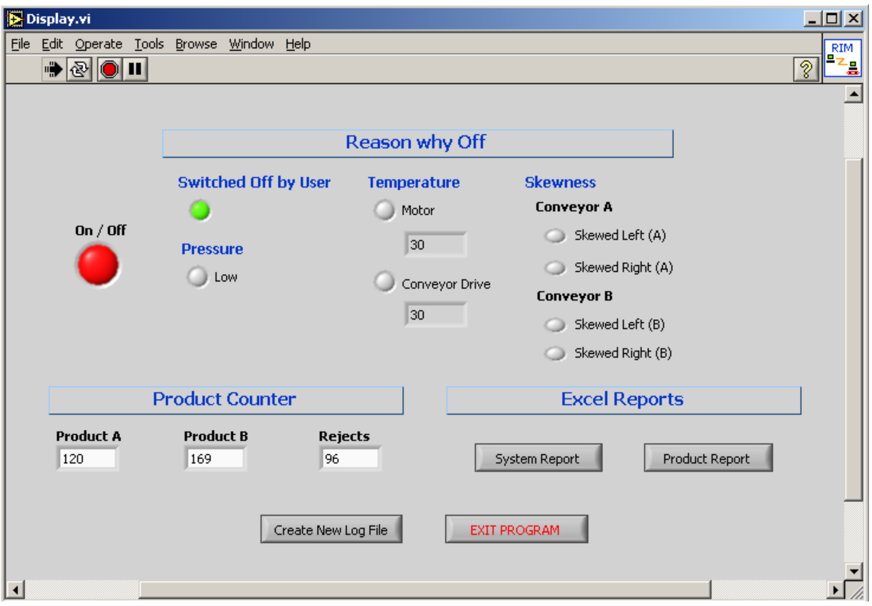
3. Using the Virtual Instrument

The Virtual Instrument is the visible part of the system that can be used to monitor the information from the PLC and to create reports. When the system is running, the VI will always show real-time information of what is happening at the Automated Manufacturing System.

When the system is down, the On/Off LED will indicate it by turning red. The reason why the system is down will also be indicated under the section Reason why Off. The LED of the appropriate reason will turn to green.

There are eight reasons why the system can be down. They are:

1. The system can be switched off by the System Operator.
2. The pressure can be too low.
3. The motor temperature can be too high.
4. The conveyor drive temperature can be too high.
5. Conveyor A can be skewed to the left.
6. Conveyor A can be skewed to the right.
7. Conveyor B can be skewed to the left.
8. Conveyor B can be skewed to the right.



Motor 30

Conveyor Drive 30

Product A 120

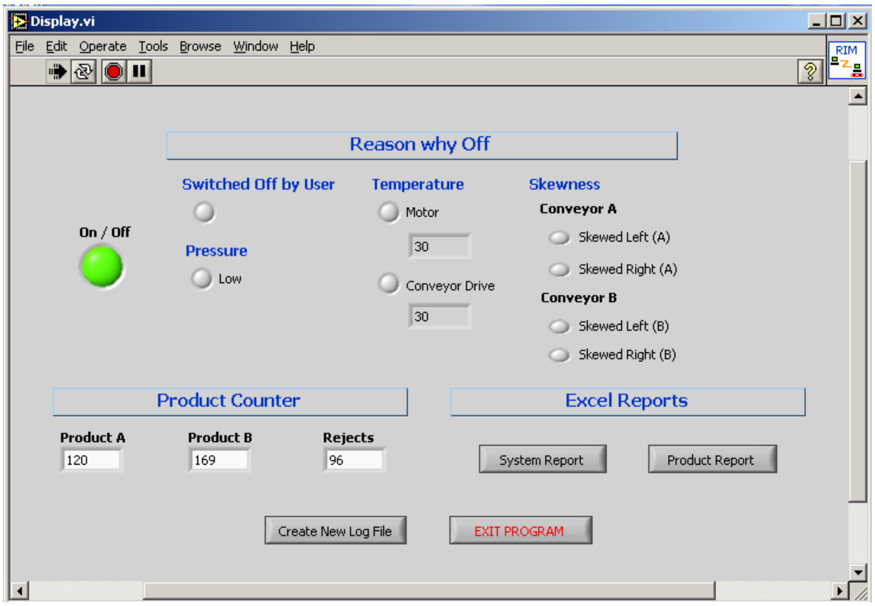
Product B 169

Rejects 96

Under the Product Counter section of the VI the following real-time information can be observed:

1. Number of Product A components produced.
2. Number of Product B components produced.
3. Number of rejected components produced.

When the system is running, the On/Off LED will indicate it by turning green.



Motor 30

Conveyor Drive 30

Product A 120

Product B 169

Rejects 96

Under the Excel Reports section of the VI are two types of reports that can be generated.

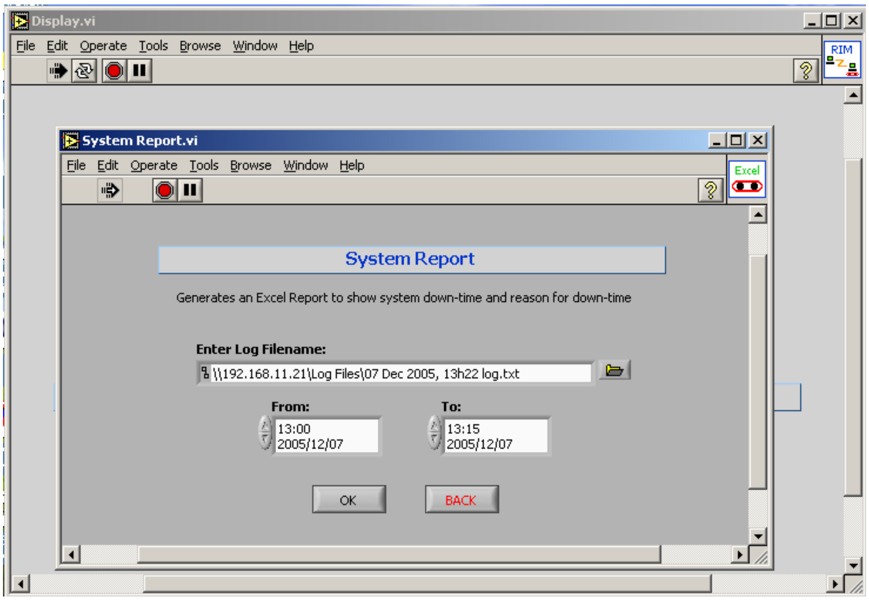
1. The System Report will generate an Excel report indicating the times that the system was down in a certain time period and the reason why the system was down.
2. The Product Report will generate an Excel report indicating the amount of different types of components produced, the amount of components that were not up to standard / rejected, as well as the total amount of components produced for a certain time period.

At the bottom of the VI are two command buttons. They will only be available when the Operator has logged into the system. Otherwise it will be disabled and grayed out. They are the ‘Create New Log File’ command and the ‘Exit Program’ command.

3.1 Create a System Report

The System Report will generate an Excel report indicating the times that the system was down in a certain time period and the reason why the system was down.

To create a System Report, click on the System Report button.



Display.vi
File Edit Operate Tools Browse Window Help
RIM
System Report.vi
File Edit Operate Tools Browse Window Help
Excel

System Report

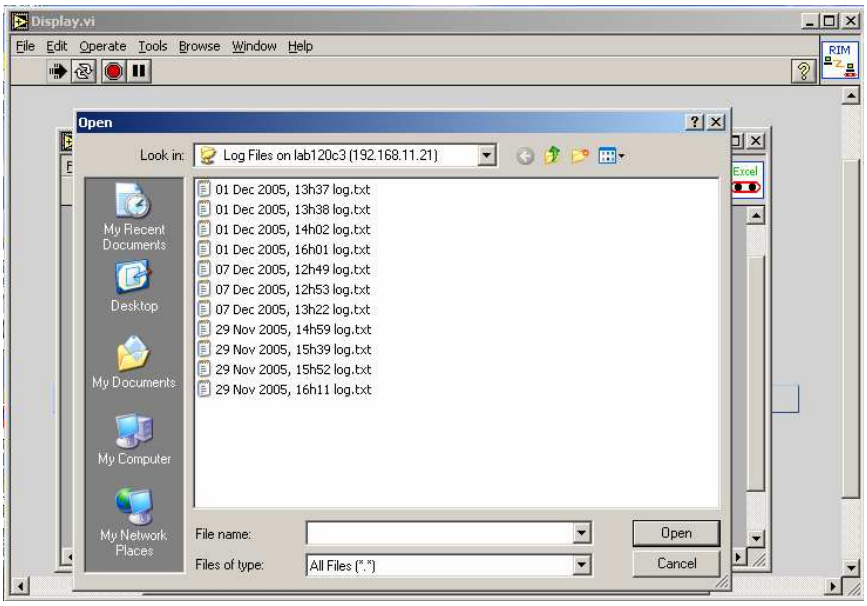
Generates an Excel Report to show system down-time and reason for down-time

Enter Log Filename:
\\192.168.11.21\Log Files\07 Dec 2005, 13h22 log.txt

From:
13:00
2005/12/07

To:
13:15
2005/12/07

The current log file will be the default log filename. Change the log file by clicking on the browse button. The default path will be the log files path. Choose the appropriate log file and click Open.



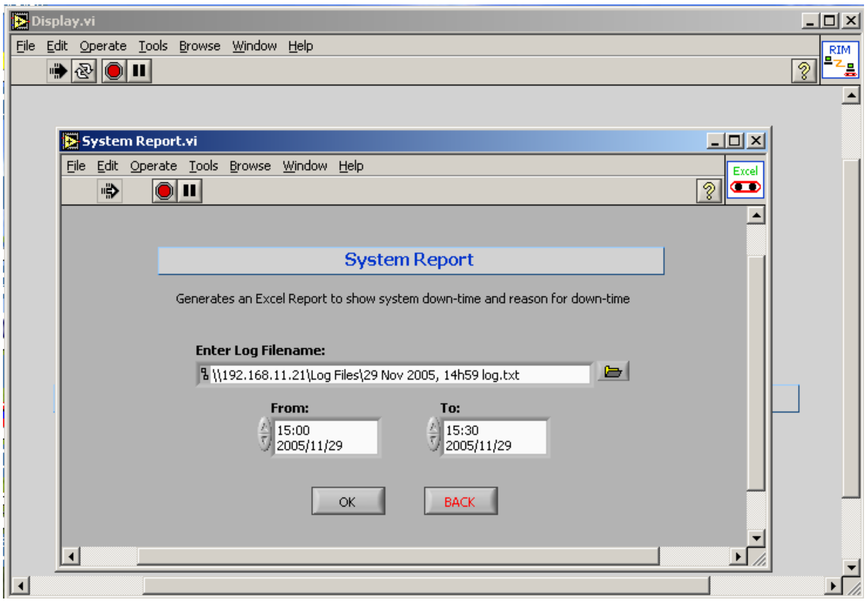
Look in: Log Files on lab120c3 (192.168.11.21)

01 Dec 2005, 13h37 log.txt
01 Dec 2005, 13h38 log.txt
01 Dec 2005, 14h02 log.txt
01 Dec 2005, 16h01 log.txt
07 Dec 2005, 12h49 log.txt
07 Dec 2005, 12h53 log.txt
07 Dec 2005, 13h22 log.txt
29 Nov 2005, 14h59 log.txt
29 Nov 2005, 15h39 log.txt
29 Nov 2005, 15h52 log.txt
29 Nov 2005, 16h11 log.txt

File name:

Files of type: All Files (*.*)

Change Date From to the appropriate date and time. Change Date To to the appropriate date and time. Click OK.



System Report

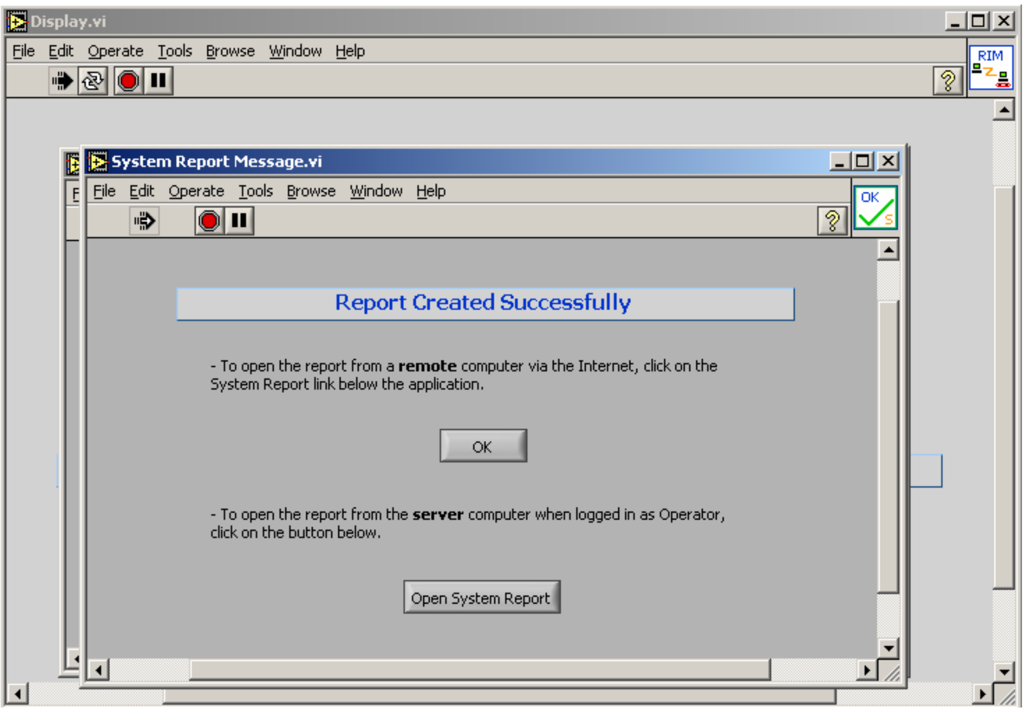
Generates an Excel Report to show system down-time and reason for down-time

Enter Log Filename:
\\192.168.11.21\Log Files\29 Nov 2005, 14h59 log.txt

From:
15:00
2005/11/29

To:
15:30
2005/11/29

A new VI window will appear to notify you that the report was created successfully. Click on OK to return to the main VI or click on Open System Report to open the report in Microsoft Excel. The Open System Report Command will not be available, unless the Operator has logged into the system.



Display.vi
File Edit Operate Tools Browse Window Help
RIM
System Report Message.vi
File Edit Operate Tools Browse Window Help
OK

Report Created Successfully

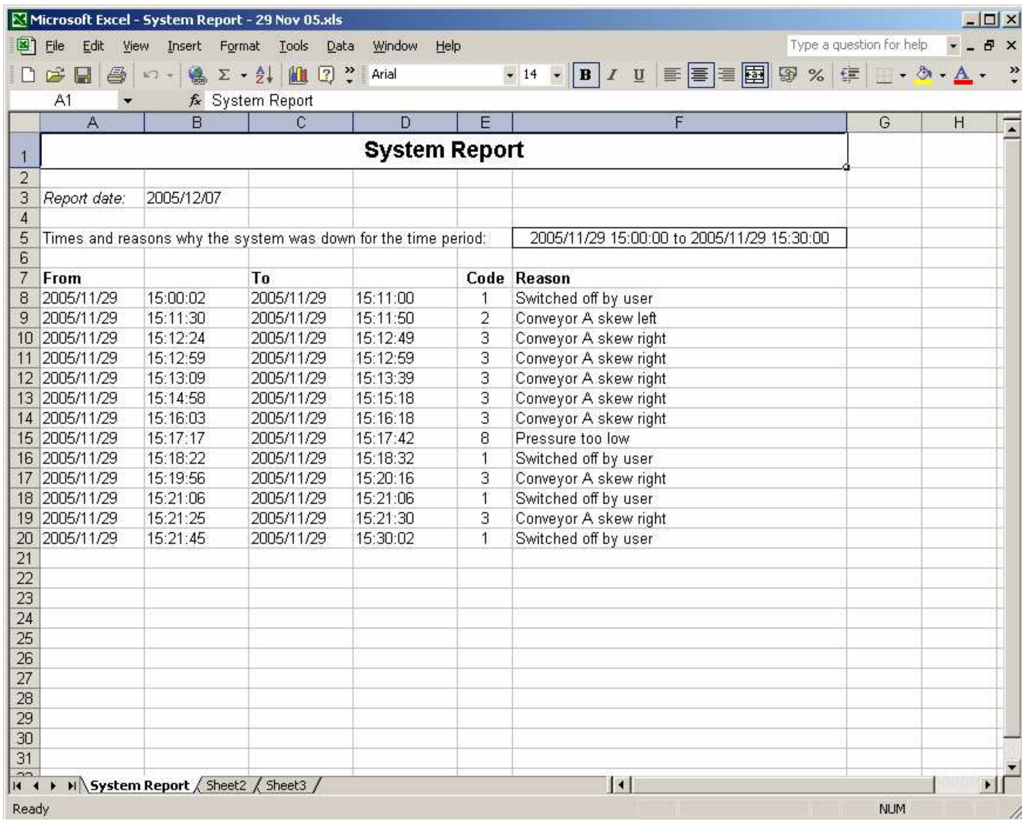
- To open the report from a **remote** computer via the Internet, click on the System Report link below the application.

OK

- To open the report from the **server** computer when logged in as Operator, click on the button below.

Open System Report

When you click on Open System Report the report will open in Microsoft Excel. Depending on your Excel security settings, a message box will appear where you have to indicate whether you want to activate or disable Macros. It doesn’t matter whether Macros are activated or disabled, you will not lose any functionality if you disable Macros. If you don’t see the message, it means that your security settings either automatically activated or automatically disabled Macros.


Microsoft Excel - System Report - 29 Nov 05.xls
File Edit View Insert Format Tools Data Window Help
Type a question for help
Arial
14
A1
System Report
System Report
Sheet2
Sheet3
Ready
NUM

System Report

Report date: 2005/12/07

Times and reasons why the system was down for the time period: 2005/11/29 15:00:00 to 2005/11/29 15:30:00

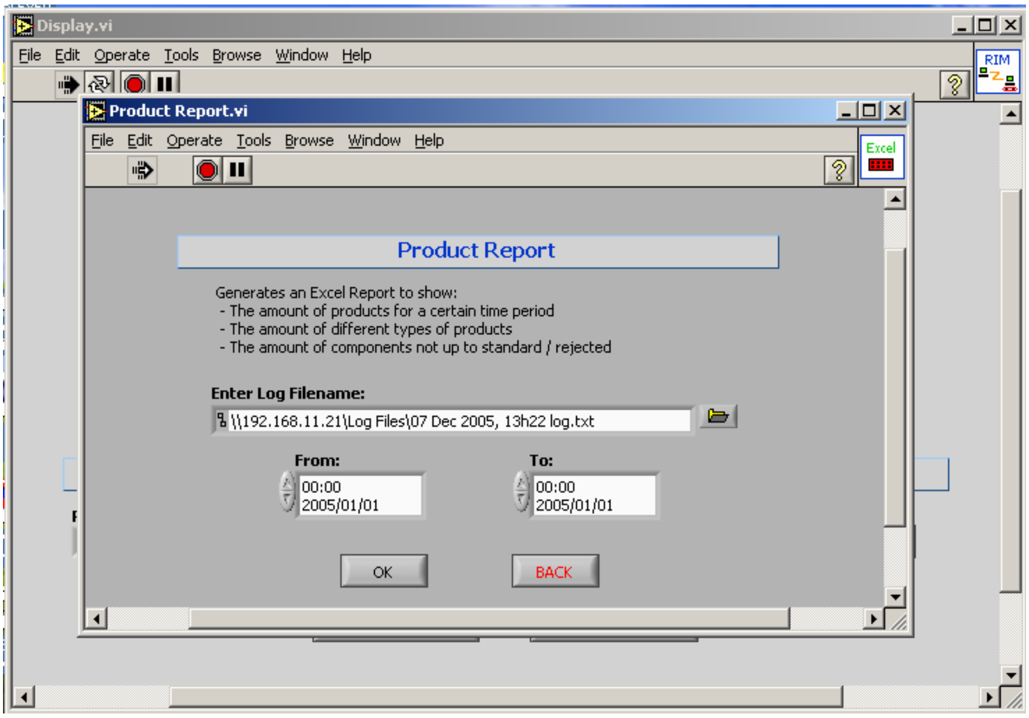
From		To		Code	Reason
2005/11/29	15:00:02	2005/11/29	15:11:00	1	Switched off by user
2005/11/29	15:11:30	2005/11/29	15:11:50	2	Conveyor A skew left
2005/11/29	15:12:24	2005/11/29	15:12:49	3	Conveyor A skew right
2005/11/29	15:12:59	2005/11/29	15:12:59	3	Conveyor A skew right
2005/11/29	15:13:09	2005/11/29	15:13:39	3	Conveyor A skew right
2005/11/29	15:14:58	2005/11/29	15:15:18	3	Conveyor A skew right
2005/11/29	15:16:03	2005/11/29	15:16:18	3	Conveyor A skew right
2005/11/29	15:17:17	2005/11/29	15:17:42	8	Pressure too low
2005/11/29	15:18:22	2005/11/29	15:18:32	1	Switched off by user
2005/11/29	15:19:56	2005/11/29	15:20:16	3	Conveyor A skew right
2005/11/29	15:21:06	2005/11/29	15:21:06	1	Switched off by user
2005/11/29	15:21:25	2005/11/29	15:21:30	3	Conveyor A skew right
2005/11/29	15:21:45	2005/11/29	15:30:02	1	Switched off by user

The report will open indicating the times that the system was down and the reason why the system was down. When you close this window, you will have to indicate whether you want to save the report, or not.

3.2 Create a Product Report

The Product Report will generate an Excel report, indicating the amount of different types of components produced, the amount of components that were not up to standard / rejected, as well as the total amount of components produced for a certain time period.

To create a Product Report, click on the Product Report button.


Display.vi
File Edit Operate Tools Browse Window Help
RIM
Product Report.vi
File Edit Operate Tools Browse Window Help
Excel
OK
BACK

Product Report

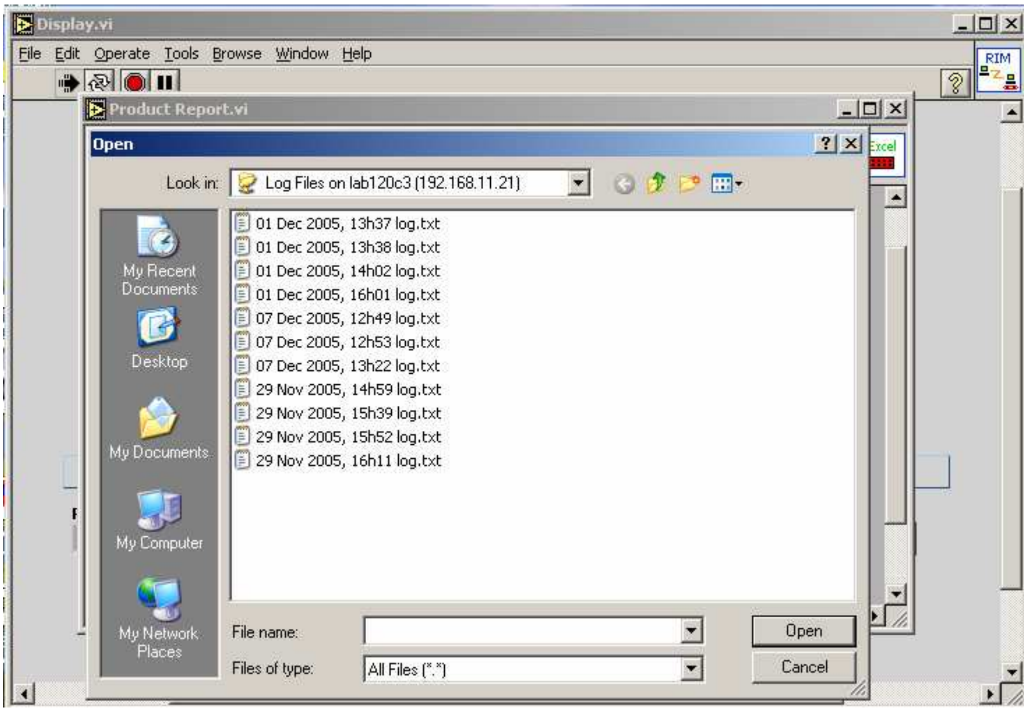
Generates an Excel Report to show:
- The amount of products for a certain time period
- The amount of different types of products
- The amount of components not up to standard / rejected

Enter Log Filename: \\192.168.11.21\Log Files\07 Dec 2005, 13h22 log.txt

From: 00:00 2005/01/01

To: 00:00 2005/01/01

The current log file will be the default log filename. Change the log file by clicking on the browse button. The default path will be the log files path. Choose the appropriate log file and click Open.



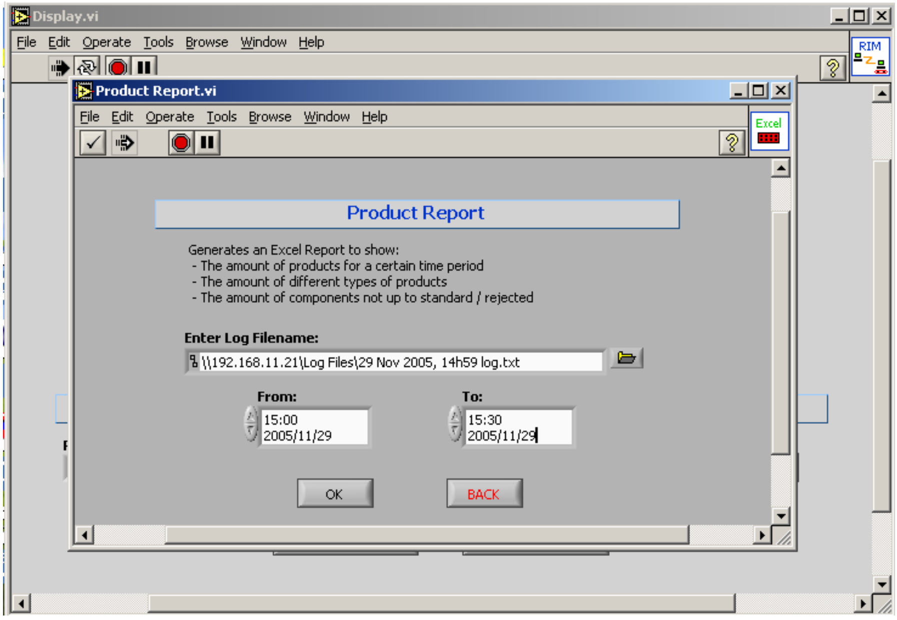
Look in: Log Files on lab120c3 (192.168.11.21)

01 Dec 2005, 13h37 log.txt
01 Dec 2005, 13h38 log.txt
01 Dec 2005, 14h02 log.txt
01 Dec 2005, 16h01 log.txt
07 Dec 2005, 12h49 log.txt
07 Dec 2005, 12h53 log.txt
07 Dec 2005, 13h22 log.txt
29 Nov 2005, 14h59 log.txt
29 Nov 2005, 15h39 log.txt
29 Nov 2005, 15h52 log.txt
29 Nov 2005, 16h11 log.txt

File name:

Files of type: All Files (*.*)

Change Date From to the appropriate date and time. Change Date To to the appropriate date and time. Click OK.


Display.vi
File Edit Operate Tools Browse Window Help
RIM
Product Report.vi
File Edit Operate Tools Browse Window Help
Excel

Product Report

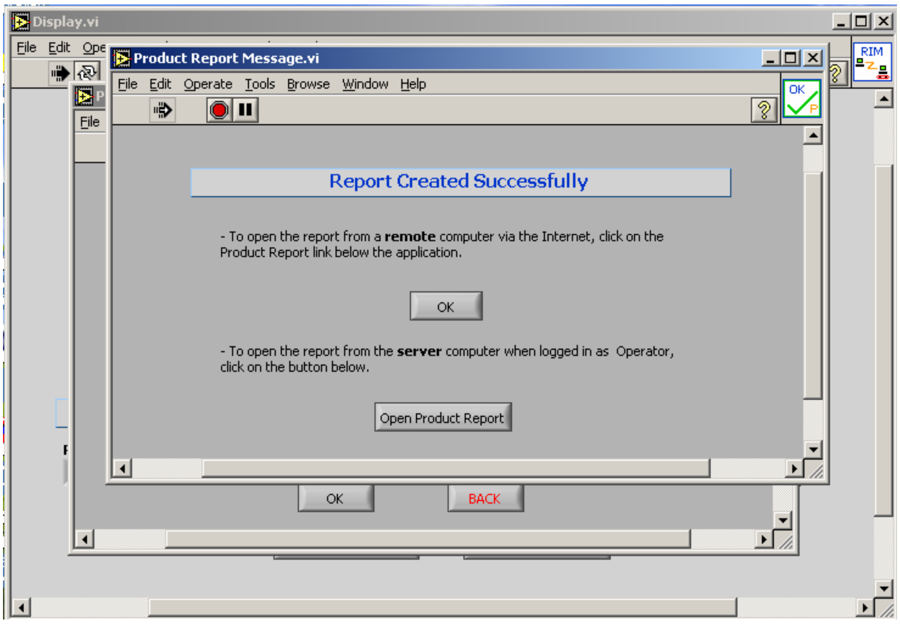
Generates an Excel Report to show:
- The amount of products for a certain time period
- The amount of different types of products
- The amount of components not up to standard / rejected

Enter Log Filename: \\192.168.11.21\Log Files\29 Nov 2005, 14h59 log.txt

From: 15:00 2005/11/29

To: 15:30 2005/11/29

A new VI window will appear to notify you that the report was created successfully. Click on OK to return to the main VI or click on Open Product Report to open the report in Microsoft Excel. The Open Product Report Command will not be available unless the Operator has logged into the system.


Display.vi
File Edit Ope
RIM
Product Report Message.vi
File Edit Operate Tools Browse Window Help
OK

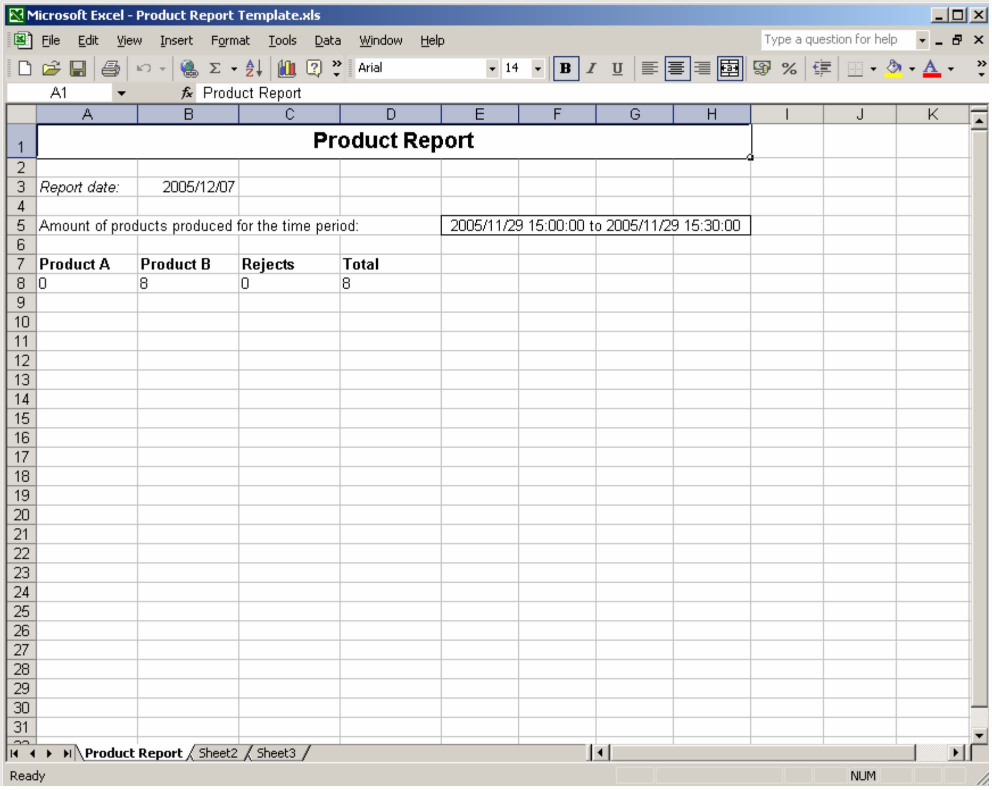
Report Created Successfully

- To open the report from a **remote** computer via the Internet, click on the Product Report link below the application.

- To open the report from the **server** computer when logged in as Operator, click on the button below.

Open Product Report
OK
BACK

When you click on Open Product Report the report will open in Microsoft Excel. Depending on your Excel security settings, a message box will appear where you have to indicate whether you want to activate or disable Macros. It doesn’t matter whether Macros are activated or disabled, you will not lose any functionality if you disable Macros. If you don’t see the message, it means that your security settings either automatically activated or automatically disabled Macros.



Product Report

Report date: 2005/12/07

Amount of products produced for the time period: 2005/11/29 15:00:00 to 2005/11/29 15:30:00

Product A	Product B	Rejects	Total
0	8	0	8

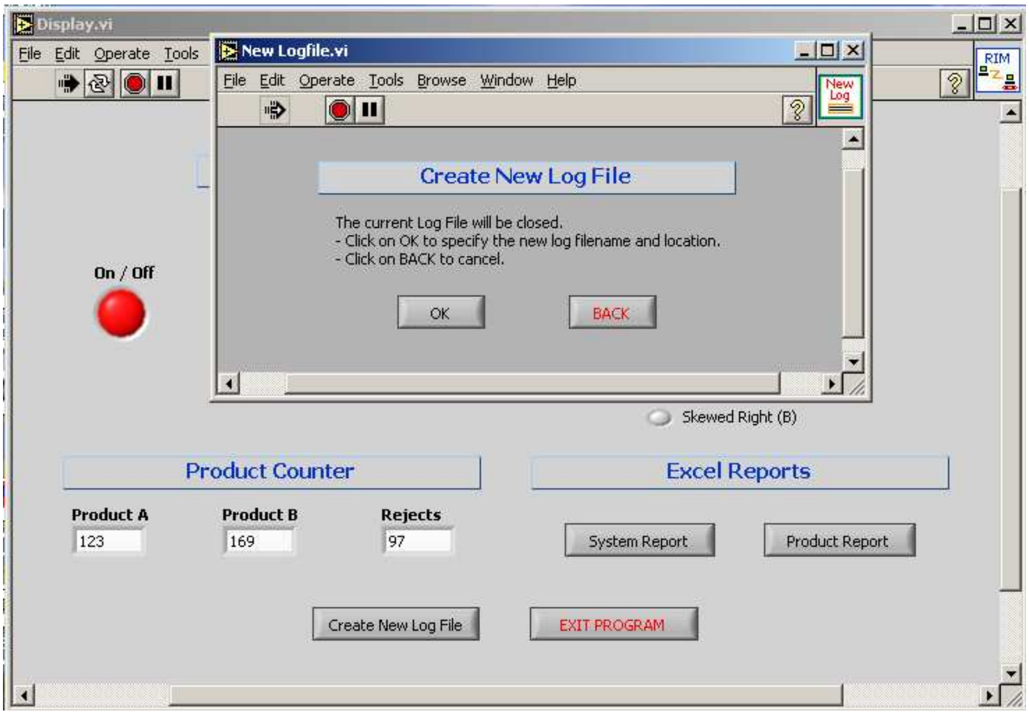
The report will open indicating the times that the system was down and the reason why the system was down. When you close this window, you will have to indicate whether you want to save the report, or not.

3.3 Create a New Log File

In ideal circumstances the system will run continuously. A new log file will automatically be created at 24h00 each day. The Operator can, however, create a new log file at any time. The

‘Create New Log File’ command will not be available unless the Operator has logged into the system.

To create a new log file, click on the Create New Log File command button.



The current Log File will be closed.
- Click on OK to specify the new log filename and location.
- Click on BACK to cancel.

A new window will open to verify that a new log file will be created. Click the BACK command button to continue using the current log file. Click the OK command button to create a new log file. The new log file will be created and the filename will contain the current date and time. The Operator cannot specify a name for the log file. The system will automatically name all log files.

3.4 Exit the Program

The ‘EXIT PROGRAM’ command will only be available if the Operator has logged into the system. Clicking on this command will stop the system. The system will then not be available to remote users and no real-time information will be displayed. No data logging will take place. The gridlines on the VI will be visible again. See Section 1: *Getting Started* for information on how to start the system again.

Note: When a remote user has control over the VI, it will not be possible to exit the program until the remote user has released control over the VI.

Appendix C: User Manual

Remote Information Management System

User Manual

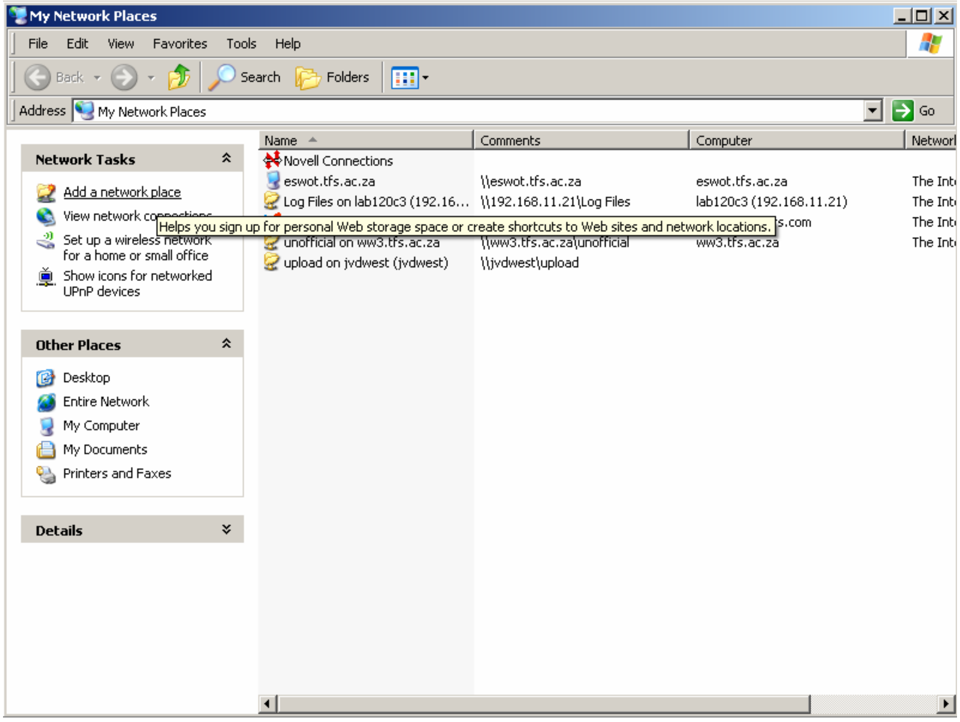
Linda Pretorius

Table of Contents

1. Getting Started

Before you can create any reports with the Remote Information Management (RIM) System, you will have to map the following network drive: \\192.168.11.21\Log files, by completing the following steps:

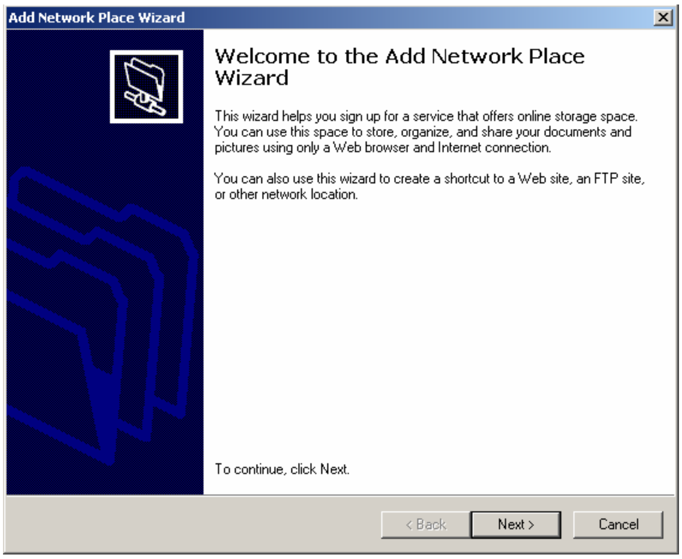
Step 1: Open My Network Places by either clicking the icon on your desktop **or** click on Start → Settings → Network Connections → My Network Places.



Name	Comments	Computer	Networl
Novell Connections			
eswot.tfs.ac.za	\\eswot.tfs.ac.za	eswot.tfs.ac.za	The Int
Log Files on lab120c3 (192.16…	\\192.168.11.21\Log Files	lab120c3 (192.168.11.21)	The Int
		s.com	The Int
unofficial on ww3.tfs.ac.za	\\ww3.tfs.ac.za\unofficial	ww3.tfs.ac.za	The Int
upload on jvdwest (jvdwest)	\\jvdwest\upload		

Helps you sign up for personal Web storage space or create shortcuts to Web sites and network locations.

Step 2: Click on Add a Network Place. The Wizard will open. Click Next.



Add Network Place Wizard

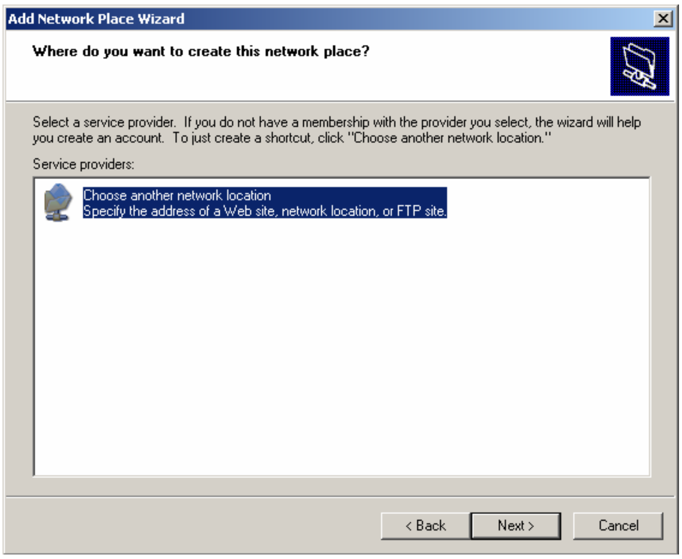
Welcome to the Add Network Place Wizard

This wizard helps you sign up for a service that offers online storage space. You can use this space to store, organize, and share your documents and pictures using only a Web browser and Internet connection.

You can also use this wizard to create a shortcut to a Web site, an FTP site, or other network location.

To continue, click Next.

Step 3: Choose Specify the address of a Web site, network location, or FTP site. Click Next.



Add Network Place Wizard

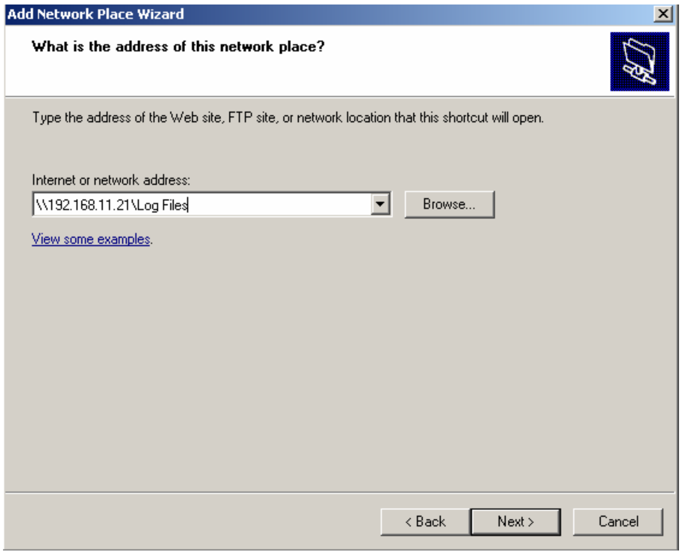
Where do you want to create this network place?

Select a service provider. If you do not have a membership with the provider you select, the wizard will help you create an account. To just create a shortcut, click "Choose another network location."

Service providers:

Choose another network location
Specify the address of a Web site, network location, or FTP site.

Step 4: Insert the following network address: \\192.168.11.21\Log Files. Click Next.

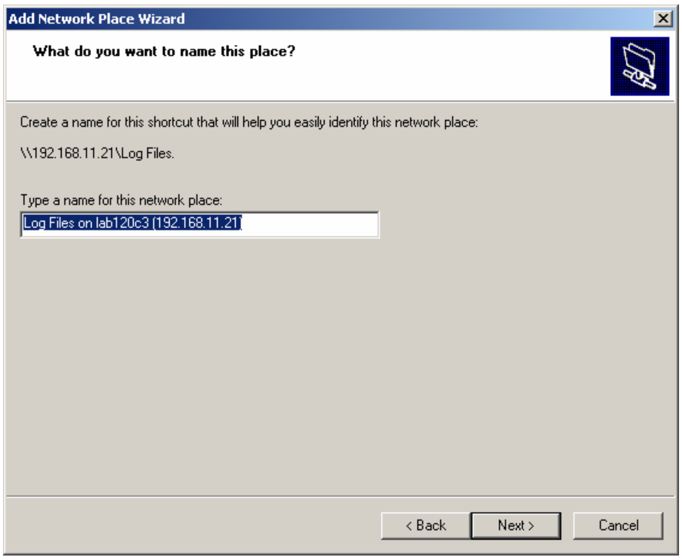


What is the address of this network place?

Type the address of the Web site, FTP site, or network location that this shortcut will open.

Internet or network address: \\192.168.11.21\Log Files

Step 5: You can keep the default name for the network place or change it to your choice. Click Next.



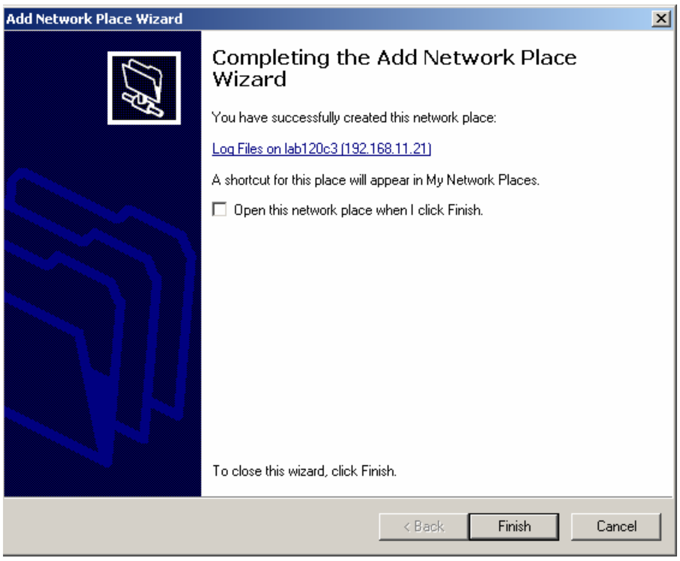
What do you want to name this place?

Create a name for this shortcut that will help you easily identify this network place:

\\192.168.11.21\Log Files.

Type a name for this network place: Log Files on lab120c3 (192.168.11.21)

Step 6: Click Finish.



Completing the Add Network Place Wizard

You have successfully created this network place:

Log Files on lab120c3 (192.168.11.21)

A shortcut for this place will appear in My Network Places.

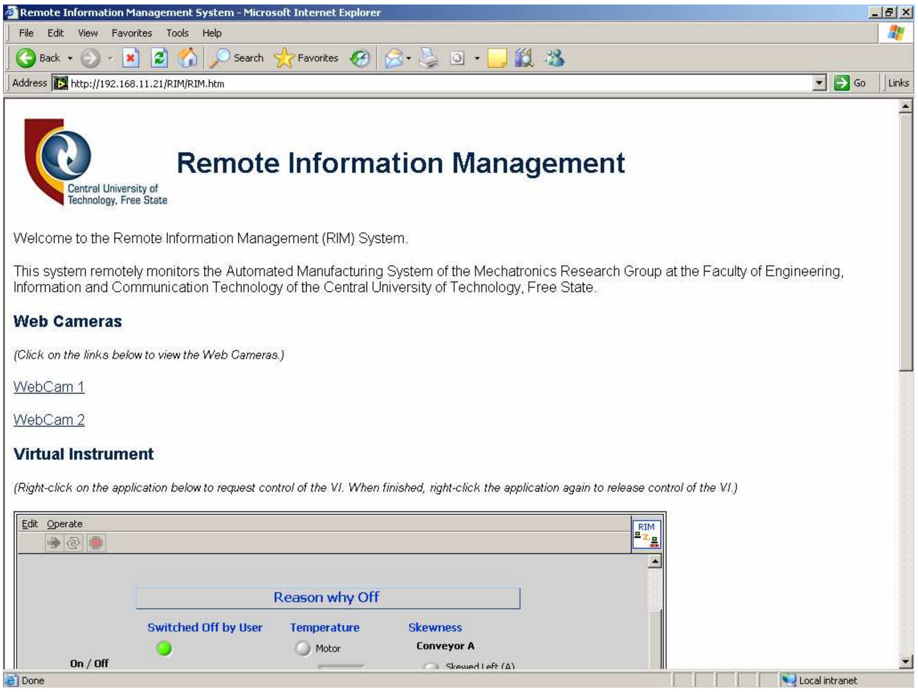
□ Open this network place when I click Finish.

To close this wizard, click Finish.

2. Accessing the Web Site

Open your Web Browser and type the following Web address in the address bar:

http://192.168.11.21/RIM/RIM.htm



Remote Information Management System - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back
Search
Favorites
Address
Go
Links
Central University of Technology, Free State
Edit Operate
RIM
Done
Local intranet

Address: http://192.168.11.21/RIM/RIM.htm

Remote Information Management

Welcome to the Remote Information Management (RIM) System.

This system remotely monitors the Automated Manufacturing System of the Mechatronics Research Group at the Faculty of Engineering, Information and Communication Technology of the Central University of Technology, Free State.

Web Cameras

(Click on the links below to view the Web Cameras.)

WebCam 1

WebCam 2

Virtual Instrument

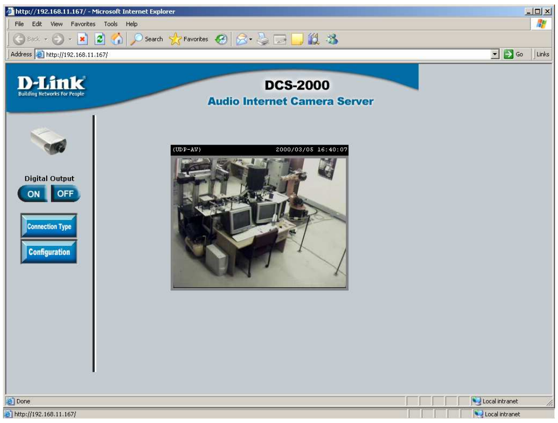
(Right-click on the application below to request control of the VI. When finished, right-click the application again to release control of the VI.)

Note: The Web site will only be accessible if the application is running on the server computer and if the Web site is accessed within CUT. Outside access will not be possible due to Firewall restrictions.

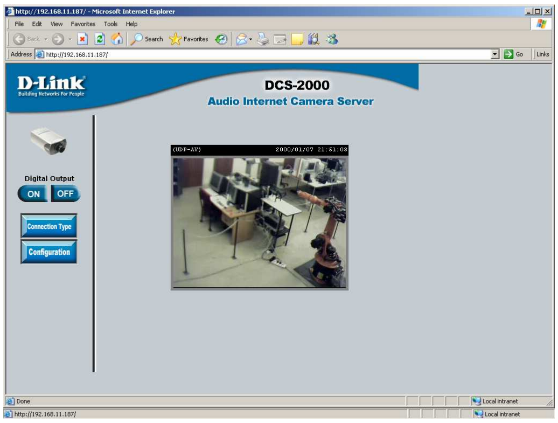
3. Viewing the Web Cameras

Two Web Cameras are monitoring the Automated Manufacturing System. Links to these cameras appear under the Web Cameras section on the Web Site. By clicking on either of these links, a new page will open with the Web Camera image.

WebCam 1


http://192.168.11.167/ - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://192.168.11.167/
D-Link
DCS-2000
Audio Internet Camera Server
Digital Output
ON
OFF
Connection Type
Configuration
Done
Local intranet

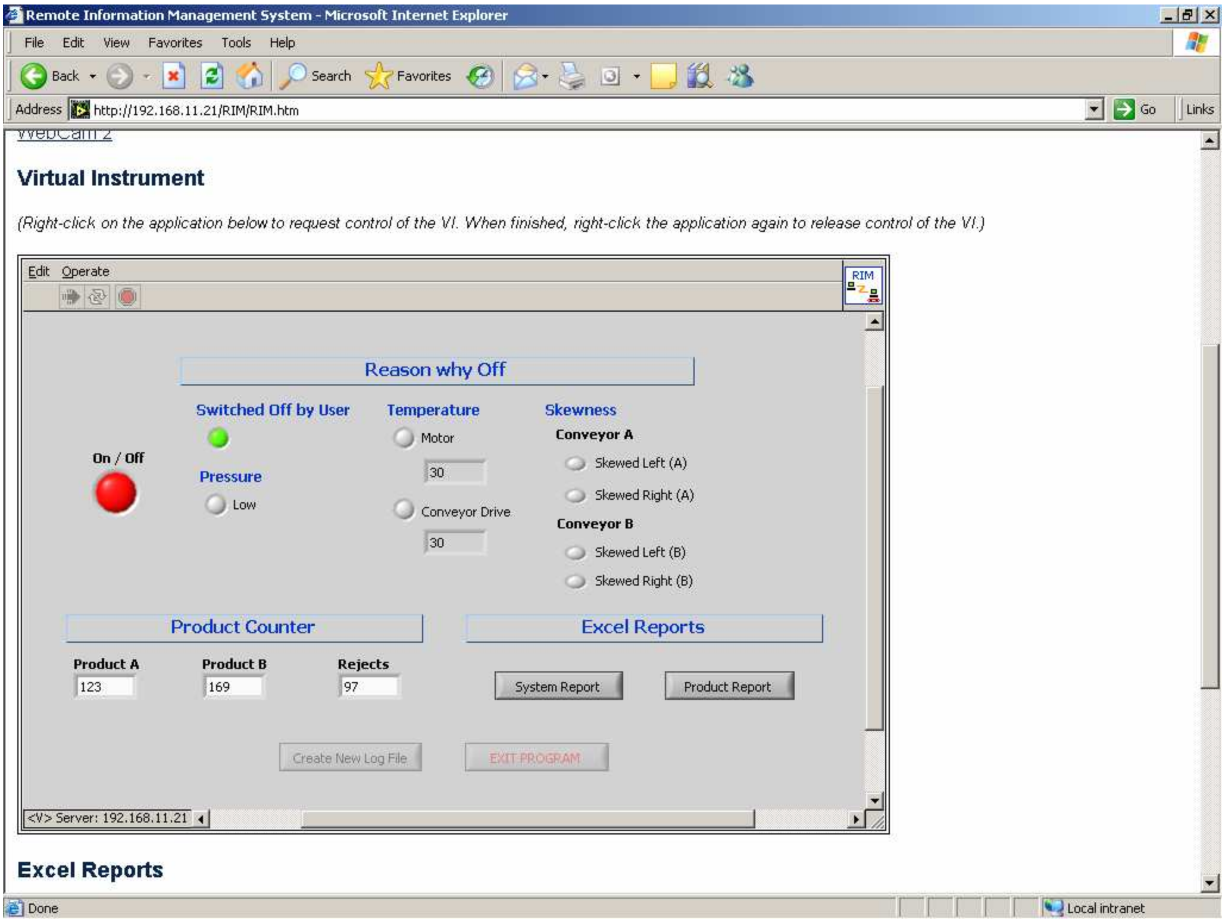
WebCam2


http://192.168.11.187/ - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://192.168.11.187/
D-Link
DCS-2000
Audio Internet Camera Server
Digital Output
ON
OFF
Connection Type
Configuration
Done
Local intranet

4. Using the Virtual Instrument

The Virtual Instrument (VI) can be viewed at the Virtual Instrument section of the Web Site. The VI will always show real-time information of what is happening at the Automated Manufacturing System.

When the system is down, the On/Off LED will indicate it by turning red. The reason why the system is down will also be indicated under the section Reason why Off. The LED of the appropriate reason will turn to green.


Remote Information Management System - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.11.21/RIM/RIM.htm
Go Links
WebCam 2

Virtual Instrument

(Right-click on the application below to request control of the VI. When finished, right-click the application again to release control of the VI.)

Motor: 30

Conveyor Drive: 30

Product A	Product B	Rejects
123	169	97

Excel Reports

There are eight reasons why the system can be down. They are:

1. The system can be switched off by the System Operator.
2. The pressure can be too low.
3. The motor temperature can be too high.
4. The conveyor drive temperature can be too high.
5. Conveyor A can be skewed to the left.
6. Conveyor A can be skewed to the right.

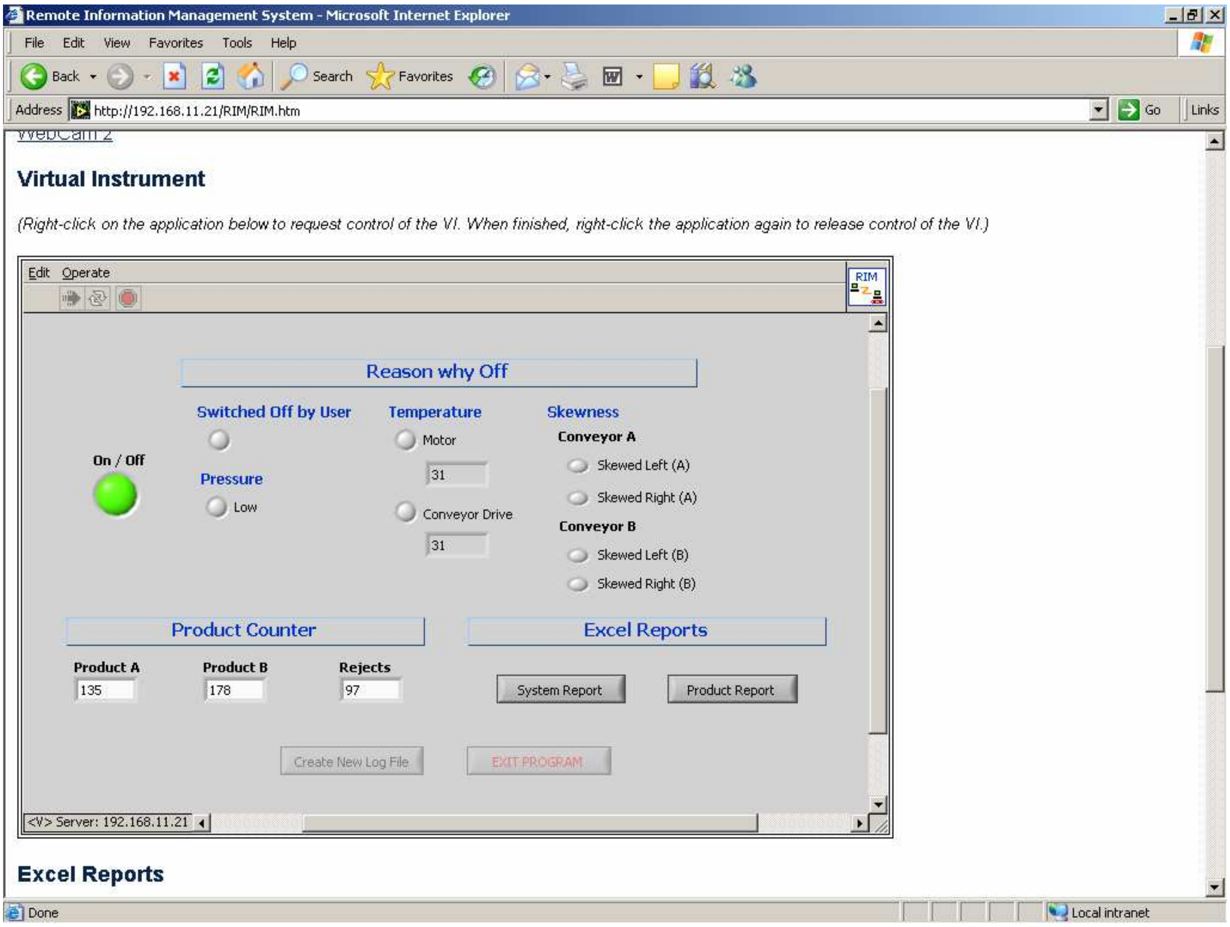
7. Conveyor B can be skewed to the left.

8. Conveyor B can be skewed to the right.

Under the Product Counter section of the VI the following real-time information can be observed:

1. Number of Product A components produced.
2. Number of Product B components produced.
3. Number of rejected components produced.

When the system is running, the On/Off LED will indicate it by turning green.



Address http://192.168.11.21/RIM/RIM.htm

Virtual Instrument

(Right-click on the application below to request control of the VI. When finished, right-click the application again to release control of the VI.)

Motor: 31

Conveyor Drive: 31

Product A	Product B	Rejects
135	178	97

<V> Server: 192.168.11.21

Excel Reports

Under the Excel Reports section of the VI there are two types of reports that can be generated.

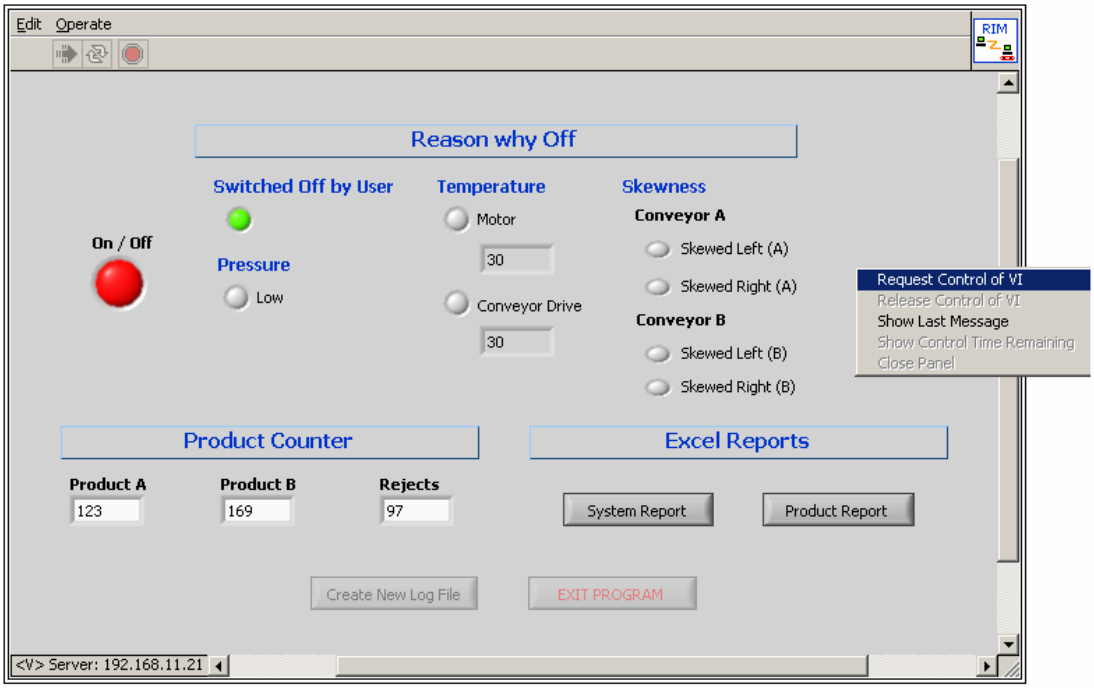
1. The System Report will generate an Excel report indicating the times that the system was down in a certain time period and the reason why the system was down.
2. The Product Report will generate an Excel report indicating the amount of different types of components produced, the amount of components that were not up to standard / rejected, as well as the total amount of components produced for a certain time period.

Two command buttons will be disabled and grayed out. They are the ‘Create New Log File’ command and the ‘Exit Program’ command. Only the System Operator will have access to these command buttons after he/she has logged into the system. The System Operator will only be able to log into the RIM system running on the Web Server Computer.

You will not be able to use the VI unless you request control of the VI.

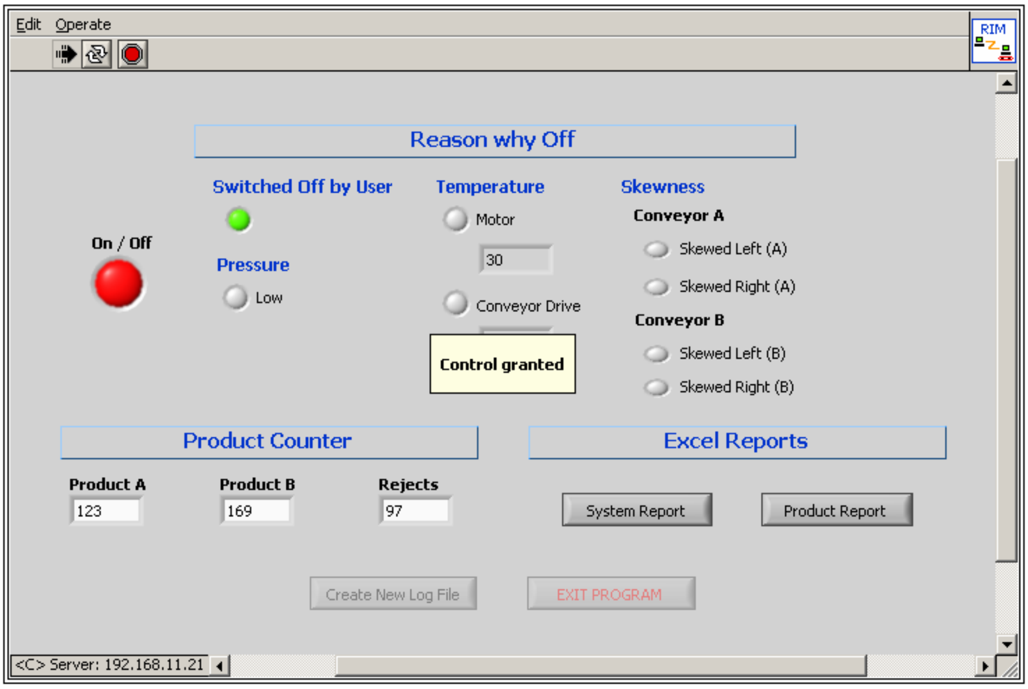
4.1 Request Control of the VI

To use the Virtual Instrument you have to right-click anywhere on the VI. A pop-up menu will appear. Click on Request Control of VI.



Motor: 30
Conveyor Drive: 30
Product A: 123
Product B: 169
Rejects: 97

A message will appear in the middle of the VI indicating that Control is granted. Click anywhere on the VI to hide the message.

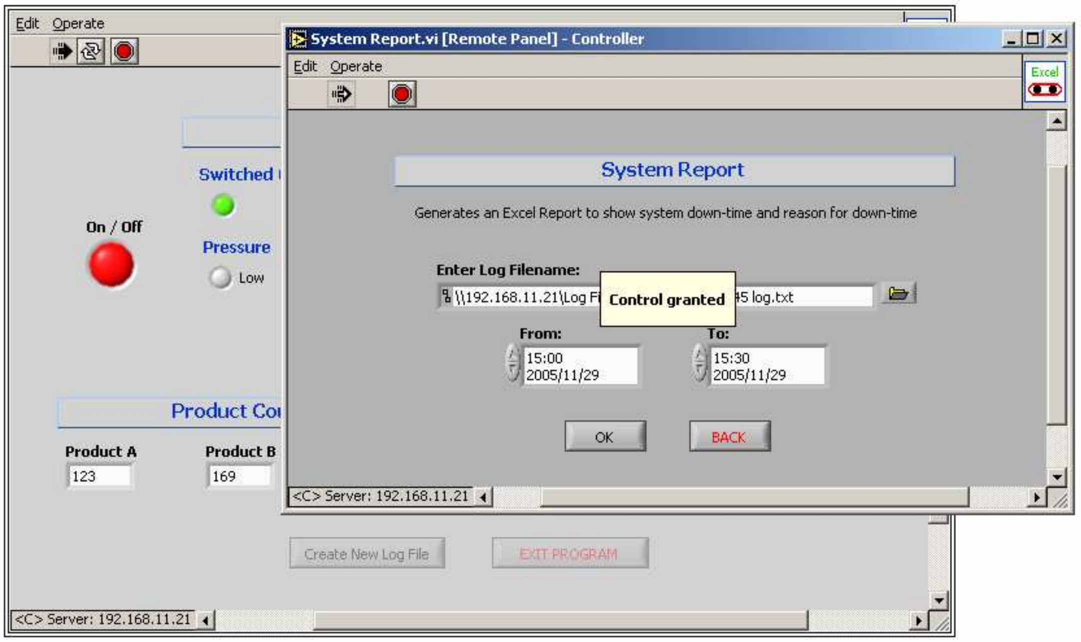


Motor: 30
Control granted
Product A: 123
Product B: 169
Rejects: 97

4.2 Create a System Report

The System Report will generate an Excel report indicating the times that the system was down in a certain time period and the reason why the system was down.

To create a System Report Click on the System Report button. A new VI window will open with a message in the middle of the VI indicating that Control is granted. Click anywhere on the VI to hide the message.



System Report.vi [Remote Panel] - Controller

Generates an Excel Report to show system down-time and reason for down-time

Enter Log Filename: \\192.168.11.21\Log Fi … 5 log.txt

Control granted

From: 15:00 2005/11/29

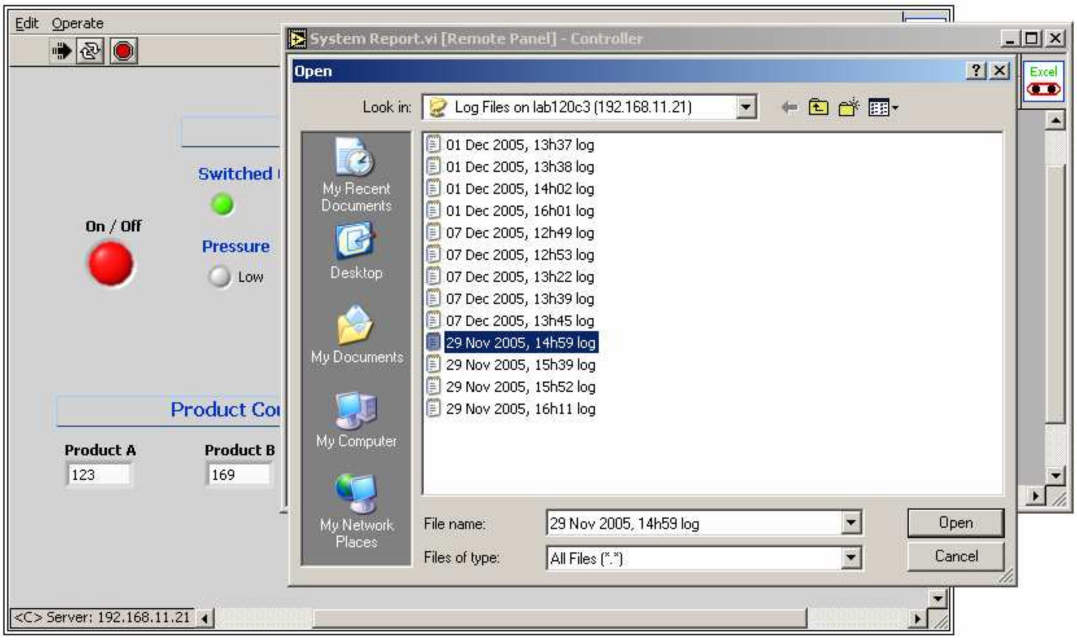
To: 15:30 2005/11/29

<C> Server: 192.168.11.21

Product A: 123

Product B: 169

The current log file will be the default Log Filename. Change the log file by clicking on the browse button. The default path will be the Log files path. Choose the appropriate Log file and click Open.



Look in: Log Files on lab120c3 (192.168.11.21)

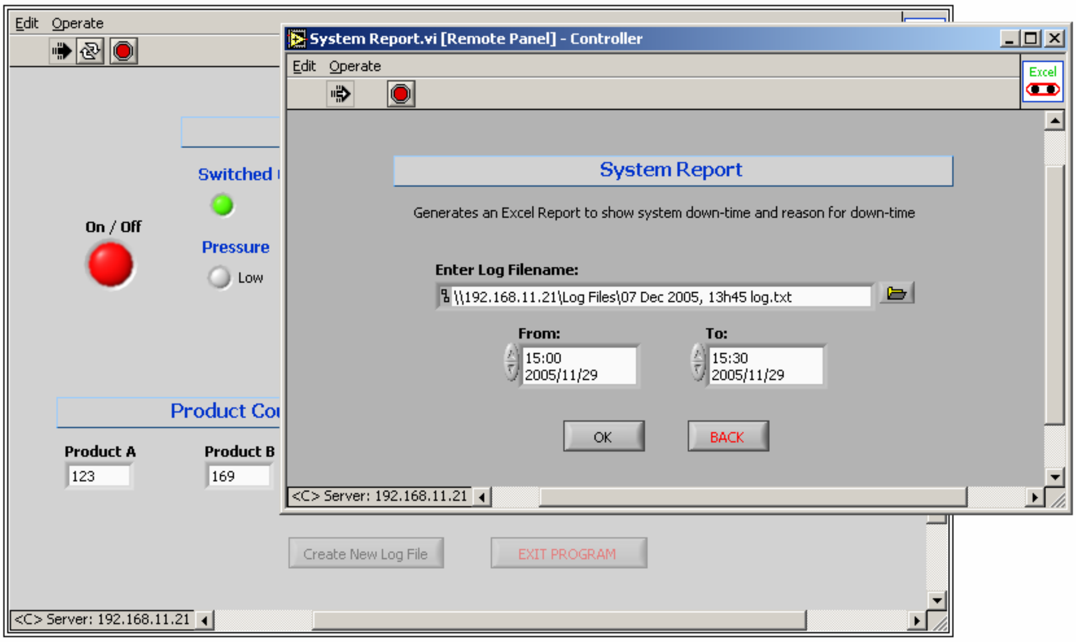
01 Dec 2005, 13h37 log
01 Dec 2005, 13h38 log
01 Dec 2005, 14h02 log
01 Dec 2005, 16h01 log
07 Dec 2005, 12h49 log
07 Dec 2005, 12h53 log
07 Dec 2005, 13h22 log
07 Dec 2005, 13h39 log
07 Dec 2005, 13h45 log
29 Nov 2005, 14h59 log
29 Nov 2005, 15h39 log
29 Nov 2005, 15h52 log
29 Nov 2005, 16h11 log

File name: 29 Nov 2005, 14h59 log
Files of type: All Files (*.*)

Product A: 123
Product B: 169

<C> Server: 192.168.11.21

Change Date From to the appropriate date and time. Change Date To to the appropriate date and time. Click OK.



System Report

Generates an Excel Report to show system down-time and reason for down-time

Enter Log Filename: \\192.168.11.21\Log Files\07 Dec 2005, 13h45 log.txt

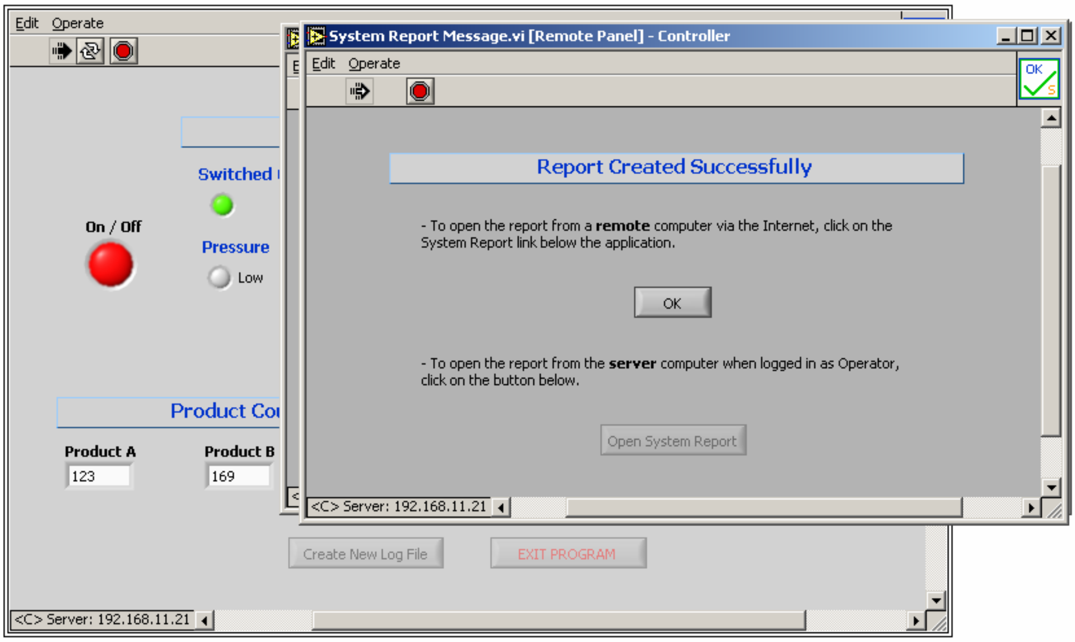
From: 15:00 2005/11/29

To: 15:30 2005/11/29

Product A: 123
Product B: 169

<C> Server: 192.168.11.21

A new VI window will appear to notify you that the report was created successfully. There will be a message in the middle of the screen indicating that control has been granted. Click anywhere on the VI to hide the message. Click on OK to return to the main VI.

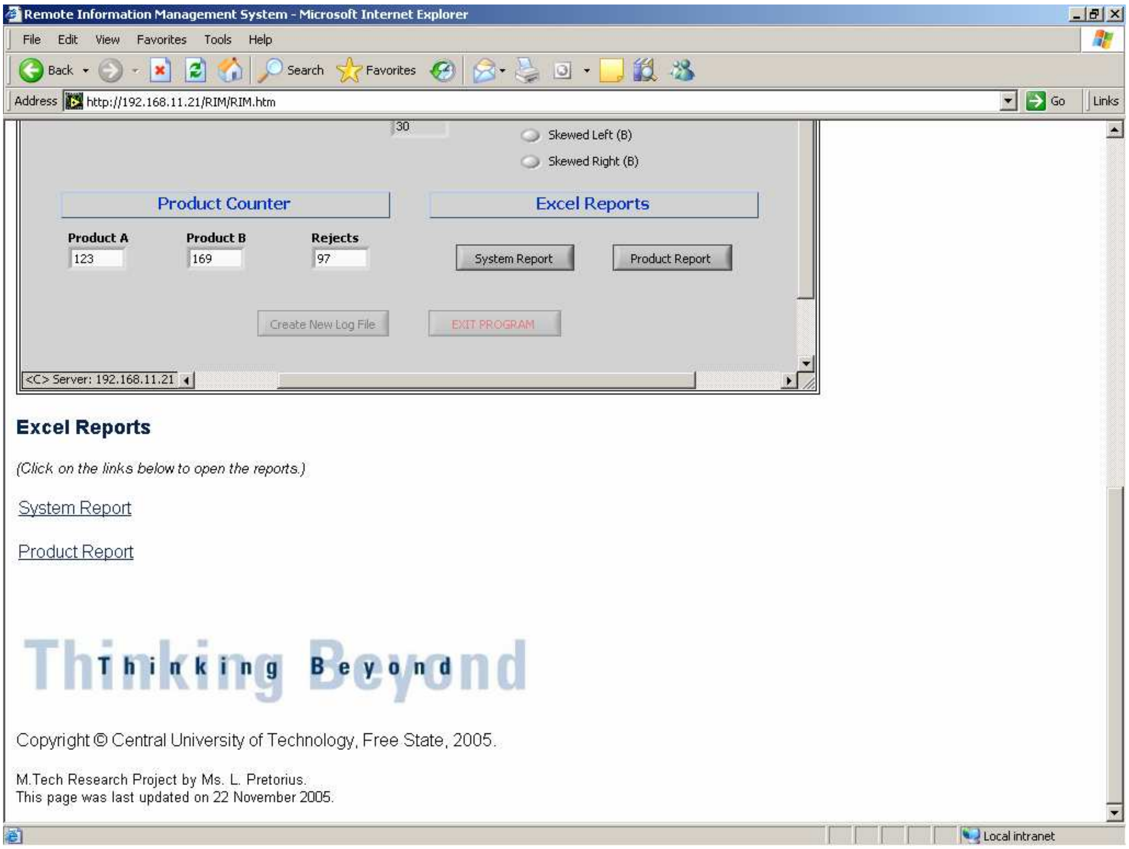


Report Created Successfully

- To open the report from a **remote** computer via the Internet, click on the System Report link below the application.

- To open the report from the **server** computer when logged in as Operator, click on the button below.

To open the report just created, click on the System Report link below the application.



Excel Reports

(Click on the links below to open the reports.)

System Report

Product Report

Thinking Beyond

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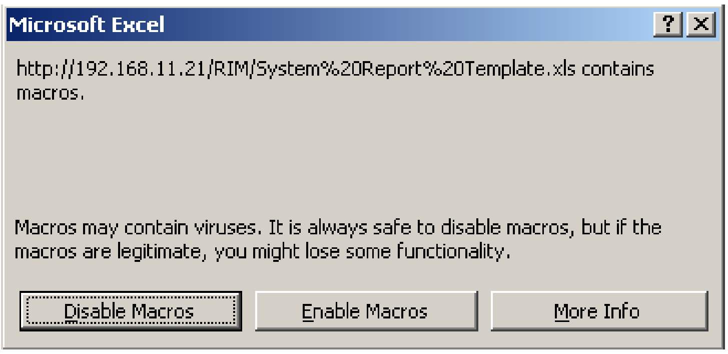
M.Tech Research Project by Ms. L. Pretorius.
This page was last updated on 22 November 2005.

When you click on the System Report link, a new browser window will open. Depending on your Excel security settings, a message box will appear where you have to indicate whether you want to activate or disable Macros. It doesn't matter whether Macros are activated or disabled, you will not lose any functionality if you disable Macros. If you don't see the message, it means that your security settings either automatically activated or automatically disabled Macros.

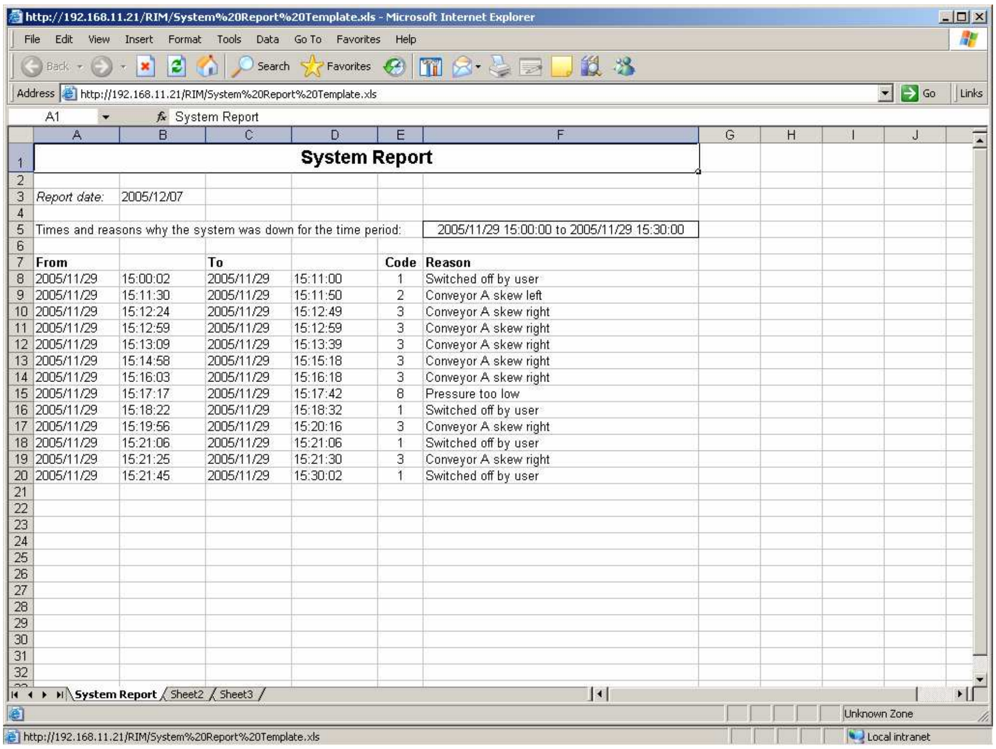


Microsoft Excel

http://192.168.11.21/RIM/System%20Report%20Template.xls contains macros.

Macros may contain viruses. It is always safe to disable macros, but if the macros are legitimate, you might lose some functionality.

The report will open indicating the times that the system was down and the reason why the system was down. When you close this window, you will have to indicate whether you want to save the report, or not.



http://192.168.11.21/RIM/System%20Report%20Template.xls - Microsoft Internet Explorer
File Edit View Insert Format Tools Data Go To Favorites Help
Back Search Favorites
Address http://192.168.11.21/RIM/System%20Report%20Template.xls
Go Links
A1
System Report Sheet2 Sheet3
Unknown Zone
Local intranet

System Report

Report date: 2005/12/07

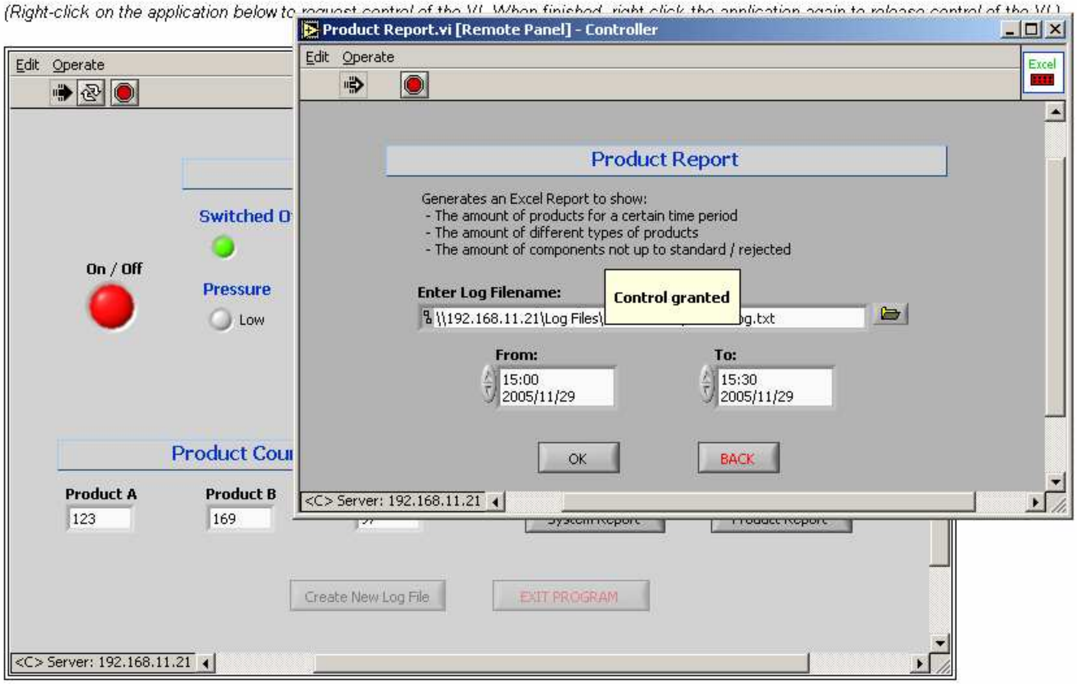
Times and reasons why the system was down for the time period: 2005/11/29 15:00:00 to 2005/11/29 15:30:00

From		To		Code	Reason
2005/11/29	15:00:02	2005/11/29	15:11:00	1	Switched off by user
2005/11/29	15:11:30	2005/11/29	15:11:50	2	Conveyor A skew left
2005/11/29	15:12:24	2005/11/29	15:12:49	3	Conveyor A skew right
2005/11/29	15:12:59	2005/11/29	15:12:59	3	Conveyor A skew right
2005/11/29	15:13:09	2005/11/29	15:13:39	3	Conveyor A skew right
2005/11/29	15:14:58	2005/11/29	15:15:18	3	Conveyor A skew right
2005/11/29	15:16:03	2005/11/29	15:16:18	3	Conveyor A skew right
2005/11/29	15:17:17	2005/11/29	15:17:42	8	Pressure too low
2005/11/29	15:18:22	2005/11/29	15:18:32	1	Switched off by user
2005/11/29	15:19:56	2005/11/29	15:20:16	3	Conveyor A skew right
2005/11/29	15:21:06	2005/11/29	15:21:06	1	Switched off by user
2005/11/29	15:21:25	2005/11/29	15:21:30	3	Conveyor A skew right
2005/11/29	15:21:45	2005/11/29	15:30:02	1	Switched off by user

4.3 Create a Product Report

The Product Report will generate an Excel report, indicating the amount of different types of components produced, the amount of components that were not up to standard / rejected, as well as the total amount of components produced for a certain time period.

To create a Product Report, click on the Product Report button. A new VI window will open with a message in the middle of the VI, indicating that Control is granted. Click anywhere on the VI to hide the message.


(Right-click on the application below to request control of the VI. When finished, right click the application again to release control of the VI.)

Product Report.vi [Remote Panel] - Controller

Product Report

Generates an Excel Report to show:
- The amount of products for a certain time period
- The amount of different types of products
- The amount of components not up to standard / rejected

Enter Log Filename: \\192.168.11.21\Log Files\ ... g.txt

Control granted

From: 15:00 2005/11/29

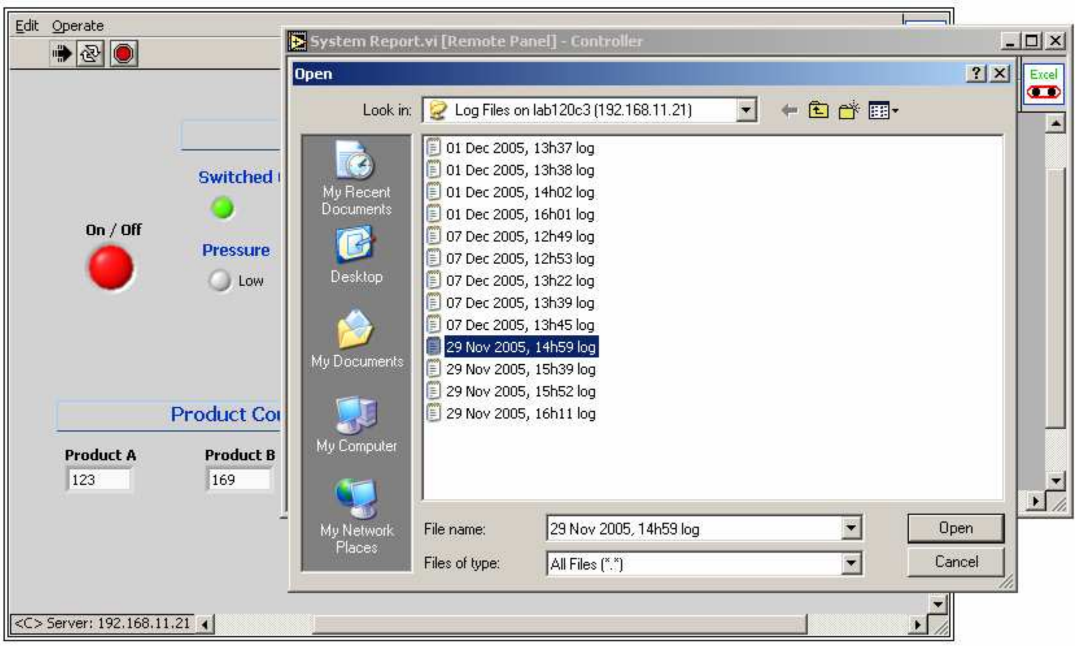
To: 15:30 2005/11/29

<C> Server: 192.168.11.21

Product A: 123

Product B: 169

The current log file will be the default log filename. Change the log file by clicking on the Browse button. The default path will be the log files path. Choose the appropriate log file and click Open.



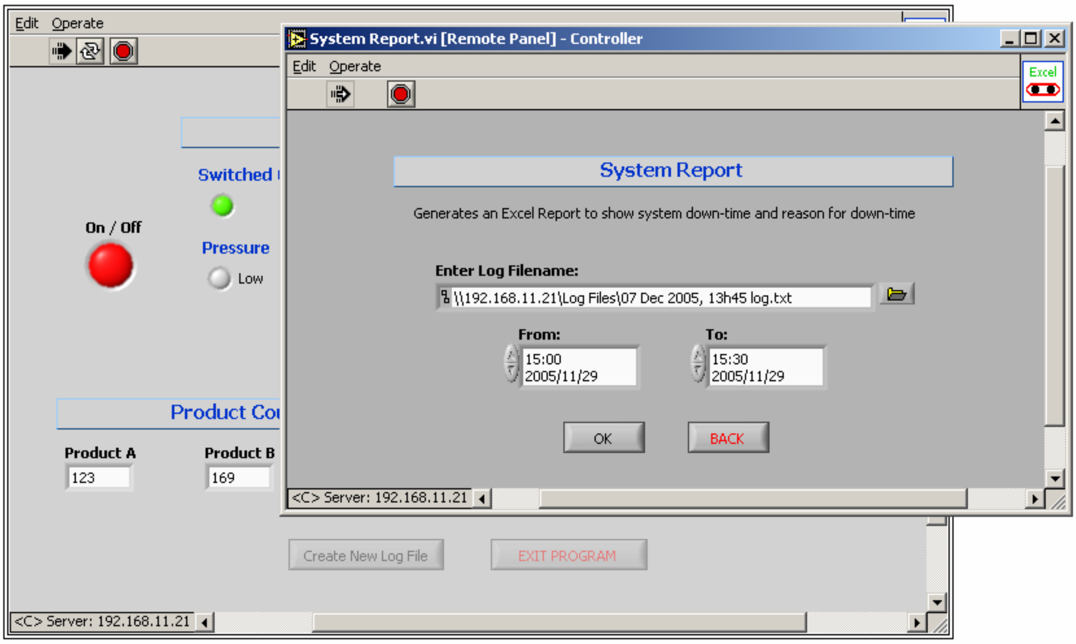
Look in: Log Files on lab120c3 (192.168.11.21)

01 Dec 2005, 13h37 log
01 Dec 2005, 13h38 log
01 Dec 2005, 14h02 log
01 Dec 2005, 16h01 log
07 Dec 2005, 12h49 log
07 Dec 2005, 12h53 log
07 Dec 2005, 13h22 log
07 Dec 2005, 13h39 log
07 Dec 2005, 13h45 log
29 Nov 2005, 14h59 log
29 Nov 2005, 15h39 log
29 Nov 2005, 15h52 log
29 Nov 2005, 16h11 log

File name: 29 Nov 2005, 14h59 log
Files of type: All Files (*.*)

Product A: 123
Product B: 169

Change Date From to the appropriate date and time. Change Date To to the appropriate date and time. Click OK.



System Report

Generates an Excel Report to show system down-time and reason for down-time

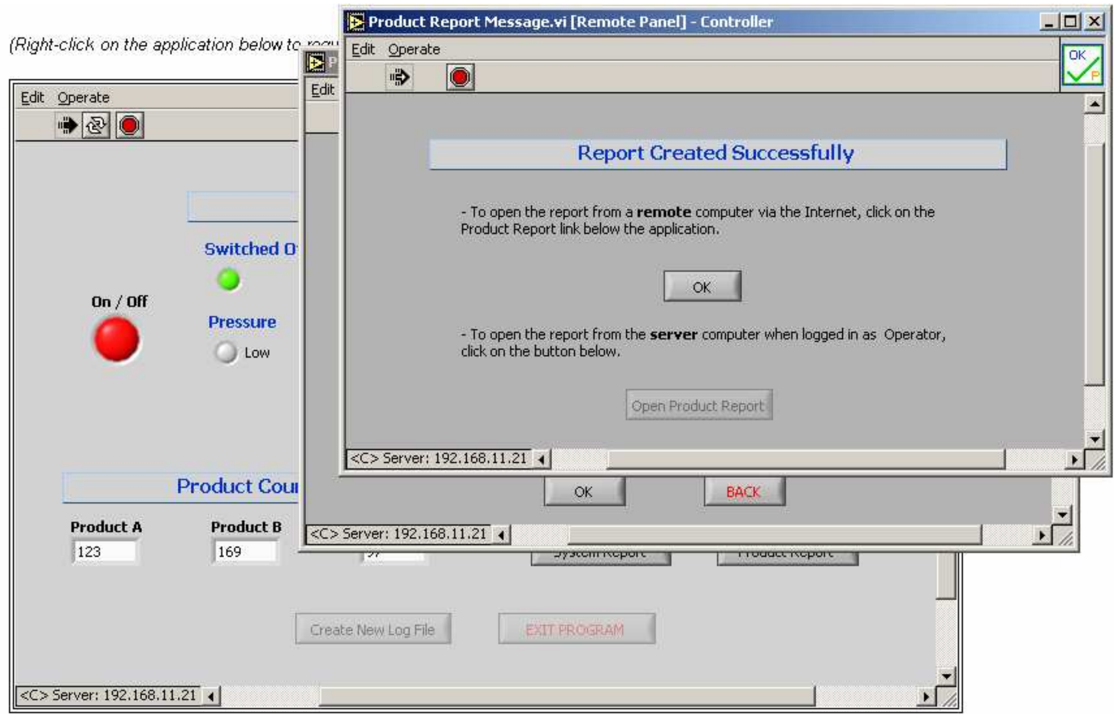
Enter Log Filename:
\\192.168.11.21\Log Files\07 Dec 2005, 13h45 log.txt

From:
15:00
2005/11/29

To:
15:30
2005/11/29

Product A: 123
Product B: 169

A new VI window will appear to notify you that the report was created successfully. There will be a message in the middle of the screen indicating that control has been granted. Click anywhere on the VI to hide the message. Click on OK to return to the main VI.



(Right-click on the application below to ...

Product Report Message.vi [Remote Panel] - Controller

Report Created Successfully

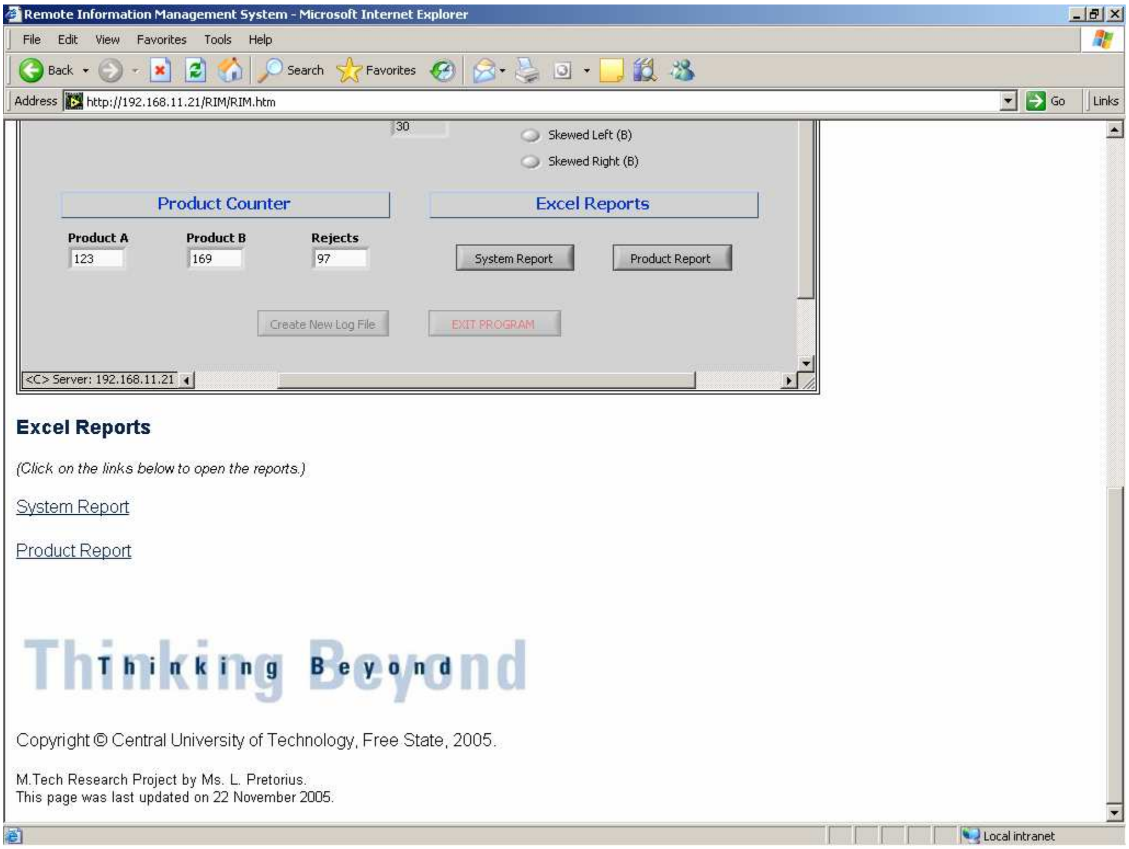
- To open the report from a **remote** computer via the Internet, click on the Product Report link below the application.

- To open the report from the **server** computer when logged in as Operator, click on the button below.

Product A	Product B
123	169

<C> Server: 192.168.11.21

To open the report just created, click on the Product Report link below the application.



Remote Information Management System - Microsoft Internet Explorer

Address http://192.168.11.21/RIM/RIM.htm

Product A	Product B	Rejects
123	169	97

<C> Server: 192.168.11.21

Excel Reports

(Click on the links below to open the reports.)

System Report

Product Report

Thinking Beyond

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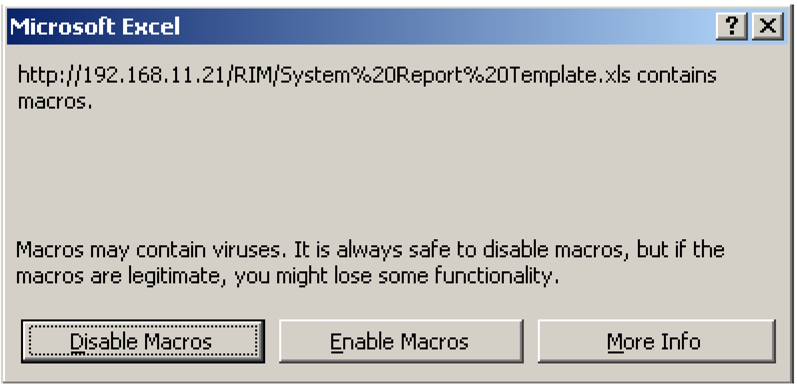
This page was last updated on 22 November 2005.

When you click on the Product Report link, a new browser window will open. Depending on your Excel security settings, a message box will appear where you have to indicate whether you want to activate or disable Macros. It doesn't matter whether Macros are activated or disabled, you will not lose any functionality if you disable Macros. If you don't see the message, it means that your security settings either automatically activated or automatically disabled Macros.

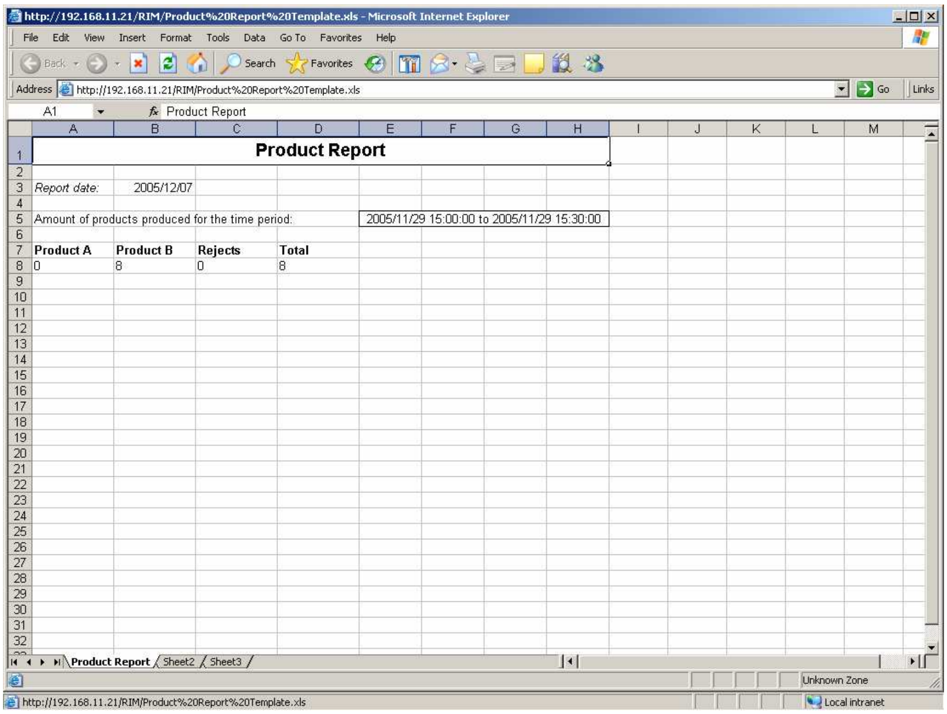


Microsoft Excel

http://192.168.11.21/RIM/System%20Report%20Template.xls contains macros.

Macros may contain viruses. It is always safe to disable macros, but if the macros are legitimate, you might lose some functionality.

The report will open indicating the times that the system was down and the reason why the system was down. When you close this window, you will have to indicate whether you want to save the report, or not.



http://192.168.11.21/RIM/Product%20Report%20Template.xls - Microsoft Internet Explorer

Address http://192.168.11.21/RIM/Product%20Report%20Template.xls

A1 Product Report

Product Report

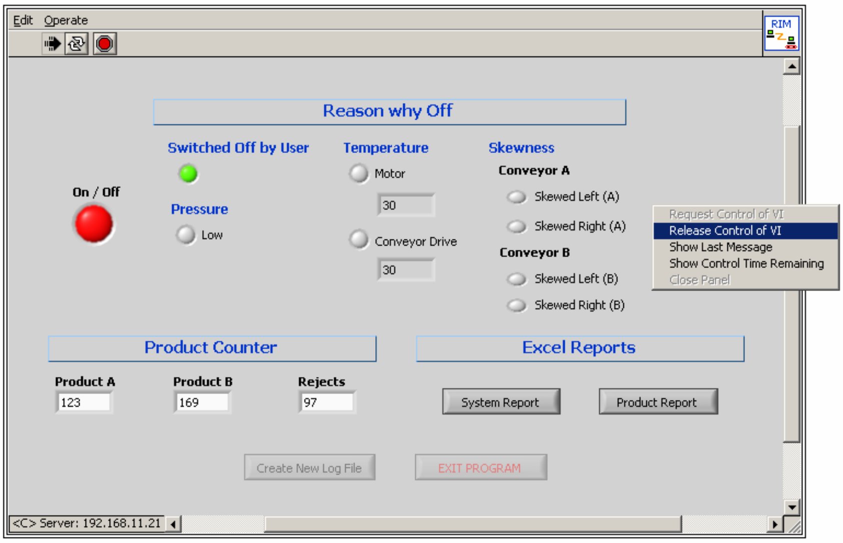
Report date: 2005/12/07

Amount of products produced for the time period: 2005/11/29 15:00:00 to 2005/11/29 15:30:00

Product A	Product B	Rejects	Total
0	8	0	8

4.4 Release Control of the VI

When you have created all the reports you need, release control of the VI. To release control, right-click anywhere on the application. A pop-up window will appear. Click on Release Control of VI.



Note: When you release control of the VI, you will still be able to view the real-time information from the Automated Manufacturing System. You must release control of the VI before anyone else will be able to gain control of the VI.