PROJECT REFCOMP: REFURBISHED COMPUTERS IN SCHOOLNET SA - A COMPARATIVE CASE STUDY

FINAL TECHNICAL REPORT

(incorporating Final Project Narrative and Scientific Outputs)

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1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

In 2000, SchoolNet SA (SNSA) embarked simultaneously on two projects involving the provision of computers and computer training to a large number of schools in South Africa. The common objective of these two projects was to improve the provision of education in South African schools by supplementing existing educational processes with an additional process which would utilise technology as the delivery platform within a mediated environment. Key to this process would be the provision of educator development in the use of this technology, as well as the provision of the technology itself to the schools. Thus, in order to achieve the primary objective, the two key deliverables of both projects were a) the provision of educator training in the use of computers, and b) the provision of computers to schools.

The projects, sponsored by two large corporate organisations, were similar but different. A fundamental difference between the two projects was the fact that one project utilised new computers only, to build school computer networks, whilst the other utilised a mixture of new and refurbished computers for the same purpose. The latter project did not fulfil all expectations, and many schools were left with dysfunctional computer networks, incomplete educator training and much disappointment and disillusionment.

The fact that the two projects were executed concurrently and that the unfulfilling project utilised refurbished computers, strongly suggested that the perceived poor reliability of refurbished computers was the cause of the problems, particularly in the light of other reports of disappointing results with such computers. This also led to the notion that refurbished computers were unsuitable for school projects. Because of the importance to SNSA of projects of this nature, SNSA required answers to questions such as: **Are refurbished computers suitable for schools? Were the project processes used adequate? Is a more systematic approach required in the execution of such projects?**

As the two projects were run concurrently, one utilising refurbished computers and the other not, with the same project staff from SNSA, and with some of the subcontractors common to both projects, an ideal opportunity presented itself to make a comparative analysis between the two projects, in order to understand the implications of utilising refurbished computers in schools projects.

As a consequence, SNSA, with the financial support of the International Development Research Centre (IDRC) of Canada, initiated research to be carried out on the two projects with the general objective of building capacity to guide school computer projects to success in terms of performance and sustainability, with a high degree of achievement. In addition, a number of specific objectives were set which would form the basis of guidelines for further projects of this nature.

The audiences targeted with the outcomes of this research, both in South Africa and in other African countries, are essentially the decision-making bodies in the context of school computer projects, as well as the participating schools and any companies contracted to execute services related to the supply of computers and computer networks. The decision-making bodies include the national and provincial Departments/Ministries of Education and Communications, projects sponsors such as large corporates, telecommunications operators, and any other organisation which intends to sponsor a school computer project. Dissemination of the outcomes of this research will be by means of the distribution of this report and by means of a seminar, schedule for the 13th and 14th October 2004, to be attended by representatives of the targeted audiences. In addition, the material resulting from this research will be used in a strategic planning conference on the future of SNSA, to be held later in 2004.

1.2 RESEARCH METHODOLOGY

As part of the execution of the two projects, various reports were written. In addition, a detailed audit of the status of the equipment delivered, installed and commissioned, and other quantitative data on the project utilising refurbished computers was carried out. However none of the information and data contained in these documents had ever been analysed in any depth with respect to the lack of success on the project utilising refurbished computers. In 2002, an evaluation of the projects was carried out, focusing largely on the training component of the projects. This required extensive field research and data gathering through visits to several of the schools involved in the projects. In order to avoid a repetition of field work and in view of the existence of unanalysed statistics in the audit report, it was decided that the methodology for this research should primarily constitute desk research involving the appraisal of data already collected, ie meta research. This desk research would include the appraisal of reports of other similar projects. The desk research would be supported by interviews of participants of the project, relevant persons in Government, donor institutions, industry and visits to a small number of schools in order to verify some of the data provided in the audit report. In addition, institutions similar to SNSA, in some other African countries, would be visited. The detailed research plan that was applied is as follows:

- Review the project documentation, interview participants and visit a sample of schools in order to understand how the projects were executed and what developments took place;
- Execute a literature survey on the subject matter to identify relevant documentation on other similar projects and review such documentation, as well as relevant theory;
- Interview central and provincial Government representatives as well as Non-Government Organisation (NGO), academic and industry representatives in order to obtain a greater insight into needs, education policy, norms and standards;
- Visit organisations similar to SNSA in Namibia, Kenya and Mozambique to establish an understanding of the experiences with similar projects in these countries, specifically in the use of refurbished computers;
- Analyse the developments of the two projects with respect to relevant theory and other experiences;
- Draw conclusions in general with respect to the execution of school computer projects;
- Evaluate the specific objectives in the form of guidelines for future projects; and
- Develop recommendations to SNSA and other similar organisations.

1.3 LIMITATIONS OF THE RESEARCH

It was established relatively early in the execution of this research that a number of limitations to the possible depth of research in certain areas would arise. Firstly, the very aspect of interviewing participants (who are largely members of NGO's or volunteers) in a project about possible shortcomings in their project is not likely to elicit the most fruitful responses, no matter how well the questions are posed in terms of being part of a learning process. Secondly, the sheer volume of research that is being undertaken in this field (computers in education) has had the effect of making practitioners reluctant to avail themselves for much more than brief discussions. Thirdly, due to the elapse of time since the completion of the two projects in 2002, many of the participants have moved onto other ventures and could not be located. These three factors made it quite difficult to arrange interviews with some key participants in the projects.

A further limitation which confronted this research is the fact that some of the key contractors in the projects no longer exist, or have changed form or staff to such a degree

that relevant information relating to their participation in the projects is lost. Lastly, it was soon established that, whilst there were indeed problems associated with the poor reliability of some of the refurbished computers used, there were other problems experienced on the projects that mask the impact of the problems experienced with refurbished computers and make it difficult to draw suitable conclusions with respect to the use of new or refurbished computers.

The important issue in this research was to learn from the experience and not to assign blame to any organisation for the unfulfilled expectations. As a result of these limitations, more effort was therefore directed towards generating guidelines and recommendations than establishing explicitly how some particular development came about.

1.4 FINDINGS

The two projects which are the subject of this research are the Thintana i-Learn Project, funded by Thintana Communications LLC, and the Telkom SuperCentres Project, funded by the Telkom Foundation. It is clear from the developments that took place on these projects that both had their problems, although the i-Learn Project suffered much more than the SuperCentres project. From the analysis of the developments during the projects, it must be concluded that the planned timescales for the projects were too short, the project team was under-resourced, and certain processes that were put in place were inadequate. In addition, the pressure on the i-Learn Project to provide as many computers as possible within a limited budget led to the use of refurbished computers with near end-of-life hard disk drives (ie a high hard disk drive failure rate was experienced), and which were inadequate for the preferred software, in turn leading to the adoption of a hybrid thin/fat client architecture which in itself, brought in a few more problems. Project participants concur with this conclusion.

The first two tasks on both projects which were critical to the commencement of the network installations, namely the schools selection process and the establishment of supplier contracts took about five to six months longer than the planned four months. The schools selection process turned out to be a much longer process involving protracted engagements with the DoE's. Likewise the tendering process in the case of the i-Learn Project and the Telkom internal contracting process in the case of the SuperCentres Project, were both more involved than anticipated.

The decision to change the educator training from face-to-face to mentor-led distance training (with good reason) made the successful delivery and sustainability of the computer networks, in terms of the way in which the projects were designed, a prerequisite for the provision of educator training. On the SuperCentres Project, the delivery of networks was delayed by large thefts but by and large was completed on time. Full sustainability of these networks was ensured by Telkom's ITX Division. By contrast, the delivery of the i-Learn networks suffered extensive delays, and the functioning of these networks became unsustainable.

Notwithstanding these observations, the pioneering achievements within these projects in terms of the mentor-led distance method of training and in terms of disk-based thin-client networks must not go unmentioned. The disadvantages experienced with the latter are the *raison d'être* for the development of highly sustainable diskless thin-client solutions.

1.5 CONCLUSIONS

The significant successes that have been experienced in other countries together with the adherence to guidelines in the refurbishing process justify the conclusion that refurbished computers, if properly selected and refurbished, are suitable for schools.

Formal project processes were applied and adhered to in the execution of the i-Learn and SuperCentres Projects. It can be said that what was achieved (in a positive sense) was due

to this adherence, in the light of the various problems that did occur, particularly in the case of the i-Learn Project. There is scope on future projects to expand on the processes used and to apply a more systematic approach when it comes to requirements analysis, system design and verification processes.

1.6 RECOMMENDATIONS

Several recommendations are made at the Implementation Level, the Organisational Level (of SNSA) and at a National Level, in terms of how to move forward with the objective of supplementing existing educational processes with an additional process which would utilise technology as the delivery platform within a mediated environment.

At the **Implementation Level**, the following recommendations are made:

Readiness

Schools should effectively select themselves to receive such computers by convincing the relevant organisation or authority that the school is ready in terms of commitment, community buy-in, prerequisites in place, training completed and the availability of funds. When it comes to ensuring that the school is physically ready to receive computer infrastructure, there is no alternative to the discipline of actually visiting and inspecting the necessary facilities at the school.

Architecture

The system engineering process should be utilised to establish the project requirements fully within the context of the constraints imposed on a project. A matrix of school needs and optimum technical solutions with costs can be used to design a particular project.

Availability

It should be recognised that a successful school computer network installation quickly becomes mission critical. A system down-time not exceeding one day per term is acceptable and a failed system needs to be restored before the end of the next business day.

Fund Raising

It is essential to budget for network maintenance as poor schools will not be able to finance such costs. In addition it is necessary to negotiate for the longest equipment warranty possible without an inordinate increase in costs.

Internet

Careful analysis of the Internet connectivity requirements is necessary before deciding on the form of Internet connectivity to be provided, and whether a separate server is possibly required or not.

Support

Where standalone computers are to be used then technical training should be provided down to module level. However where it is decided that networked computers are required, then it is imperative to include ongoing field support as a part of the delivery in a project, certainly until a skilled person is available within the school community.

At the **Organisational Level**, it is recommended that SNSA involve itself in on-going implementation in terms of delivering computer infrastructure and training to schools rather than fixed term projects such as the i-Learn and SuperCentres Projects.

At the **National Level**, it is recommended that steps be taken to encourage the development of a service and supply industry to support the provision of computer infrastructure and training.

1.7 REPORT STRUCTURE

This report is structured as follows:

- Chapter 2 provides an introduction to the two projects including the identification and background of the two projects, as well as the objectives of the research and the research methodology;
- Chapter 3 contains details of the execution of the two projects;
- Chapter 4 records the developments that took place on the two projects;
- Chapter 5 provides results of the Literature Survey on the subject matter and identifies relevant documentation on other similar projects and relevant theory;
- Chapter 6 records experiences in other countries;
- Chapter 7 draws conclusions regarding the use of refurbished computers and project processes, drawing on the experiences in other countries and concepts from various sources.
- Chapter 8 provides recommendations for future projects; and
- Chapter 9 contains appendices.

2. INTRODUCTION TO THE TWO PROJECTS AND THE RESEARCH

2.1 BACKGROUND TO THE TWO PROJECTS

In 2002, SNSA embarked simultaneously on two projects involving the provision of computers and computer training to a large number of schools in South Africa. The common objective of these two projects was to improve the provision of education in South African schools by supplementing existing educational processes with an additional process which would utilise technology as the delivery platform within a mediated environment. Key to this process would be the provision of educator development in the use of this technology, as well as the provision of the technology itself to the schools. Thus, in order to achieve the primary objective, the two key deliverables of both projects were a) the provision of educator training in the use of computers, and b) the provision of computers to schools.

The projects, sponsored by two large corporate organisations, were similar but different. A fundamental difference between the projects was the fact that one project utilised new computers only, to build school computer networks, whilst the other utilised a mixture of new and refurbished computers for the same purpose. The latter project did not fulfil all expectations, and many schools were left with dysfunctional computer networks, incomplete educator training and much disappointment and disillusionment. The fact that the two projects were executed concurrently and that the unfulfilling project utilised refurbished computers, strongly suggested that the perceived poor reliability of refurbished computers was the cause of the problems, particularly in the light of other reports of disappointing results with such computers. This also led to the notion that refurbished computers were unsuitable for school projects.

The undertaking by SNSA of these two projects is inextricably linked to the origins of SNSA, its earlier activities, and indeed, to the development of school computer networks worldwide. A brief overview of this history is useful to put various aspects of the two projects into perspective.

With the rapid growth in personal computing and networking technologies, it was inevitable that computers and computer networks became established in schools. In Europe and North America, this was facilitated by government-led strategies, supported with massive funding. As an example, in 1993, Industry Canada, a government agency, launched Canada's SchoolNet to connect all Canadian schools and libraries to the Internet. By mid-2003, 16000 schools and 3500 libraries were connected using 425000 refurbished computers.[1] In South Africa, similar developments took place, led by enthusiasts and supported by various donor-based programmes. Many companies began to donate unwanted computers to schools, with mixed results. The development of the Internet and the availability of user-friendly web browsers led to the development of regional school networks in various countries. Between 1993 and 1998, several such networks were established in South Africa. In 1994, the Western Cape Schools Network was established to provide Internet connectivity and support to schools in its area. In 1995, the origins of the Eastern Cape Schools Network were established, and in 1998, the Gauteng Schools Network merged with the Pretoria Education Network.

In terms of organisations with a broader mission, SchoolNet SA was established in 1997.[2] In January of that year, a proposal for a "National Schools Network" was tabled by two provincial networks at meetings hosted by the then (South African) Foundation for Research Development. Later in the year in June, further support for a national network was obtained at a conference which took place in Olifantsfontein in Gauteng. In September of the same

[1] SchoolNet, Fall 2003 p.3.

[2] SchoolNet SA, Annual Report 1998

year, further progress was made at a planning workshop held in Cape Town, and in November 1997, the National Department of Education's Centre for Educational Technology and Distance Education adopted SNSA as one of its projects for 1998. Shortly thereafter, the founding meeting of SNSA took place on the 21st/22nd November 1997. The Interim Executive Council was constituted with five members plus four Government department representatives plus two additional co-opted members. In June and July 1998, both the IDRC and the Open Society Foundation (OSF) each approved a funding grant to SNSA for a period of two years. SNSA then effectively became a part of the Acacia Initiative within the IDRC, and utilised the infrastructure of the IDRC. Following on from developments with respect to the presence of the IDRC in South Africa, in March 2001, SNSA became established as a Section 21 not-for-profit company and acquired its own premises in August of the same year.

The Acacia Initiative referred to above was established in 1997 to invest in the promotion of various school networking projects in various African countries. Countries which benefited in the first three years of the programme included Angola, Lesotho, Mozambique, Namibia, Senegal, South Africa, Uganda Zambia and Zimbabwe. In 1999, SchoolNet Namibia was established.

Upon establishment in 1997, SNSA set about to focus its activities in four specific areas related to the development of information and communication technologies (ICT's) in the general and further education system. These four areas were:

- Internet connectivity and appropriate technology;
- Human resource development and capacity building;
- Content and curriculum management and development; and
- Advocacy and marketing.

In 1998, SNSA adopted the World Links for Development (WorLD) programme as a pilot project to evaluate many of the technologies which were to become critical to the two projects which concern this research. The WorLD programme was funded by the World Bank and implemented in a number of schools in several provinces in South Africa. The aims of WorLD are to "establish global, educational on-line communities for secondary school student and teachers around the world in order to expand distance learning opportunities, enhance cultural understanding across nations, build broad support for economic and social development and train teachers in integrate information technology into the classroom". The objectives of the South African programme were to:

- Establish a server-based local area network (LAN) of 12 computers at each participating school, with dial-up Internet access and email for all users;
- Train educators in using and managing computer equipment and the educational use of ICT's;
- Provide educational support to ensure that schools use ICT's for collaborative projects and activities; and
- Evaluate ICT use at participating schools within the framework of the international WorLD evaluation component.

The World Bank provided the local programme with 275 refurbished Intel 486 processor-based computers. The International Institute for Communication and Development (IICD) provided 13 new Pentium Servers. Several other organisations donated other items. A form of thin-client architecture was utilised and Internet connectivity was included. The project was the first of its type in that it included a training component and a schools selection process. However the large number of technical issues to be resolved absorbed much time and detracted from an otherwise successful project.

The two projects which are the subject of this research are the Thintana i-Learn Project, funded by Thintana Communications LLC, and the Telkom SuperCentres Project, funded by

the Telkom Foundation.[3] [4] These two projects were education sponsorship projects which funded the provision of computer education in selected schools in South Africa. The two projects were similar but different and were managed as one project by SNSA.

The two projects together sponsored the provision of a computer network to each of 300 schools, mostly in rural areas, distributed in all nine provinces (i-Learn Project – 200 schools, and Telkom SuperCentres Project – 100 schools). The differences between the two projects lay in the equipment and support provided by each of the two donors. In the Telkom SuperCentres Project, each of the 100 school networks comprises 21 new computers, a server and various peripherals. Network technical support is provided free-of-charge by Telkom's ITX Division. Telkom subsidised the Internet access call charges of each of the 100 schools in the SuperCentres Project by R300. In the Thintana i-Learn Project, each of the 200 school networks typically comprises 10 refurbished computers, 4 new computers, a server and various peripherals. Schools are responsible for network technical support and all call charges. Schools in both projects received identical education packages and services from SNSA. Both projects deployed Microsoft operating systems and applications.

2.2 OBJECTIVES OF THE RESEARCH

2.2.1 GENERAL OBJECTIVE

The general objective of this research has been to build capacity to guide school network projects to success in terms of performance and sustainability, with a high degree of achievement.

2.2.2 SPECIFIC OBJECTIVES

A number of specific objectives were set for this research, which would form the basis of guidelines for further projects of this nature. These six objectives include:

- The creation of a revised readiness baseline for a school to participate in a school network project, in terms of infrastructure and finance (Readiness Objective);
- The development of an optimised network architecture (Architecture Objective);
- The identification of a cost-effective source of high bandwidth Internet access (Internet Objective);
- The establishment of formal system test, soak test and acceptance test procedures, which can be implemented to achieve a high availability of the computer networks installed or to be installed in the participating schools (Availability Objective);
- The establishment of an affordable, effective and sustainable network technical support process (Support Objective); and
- The development of a viable fund raising programme for schools to raise sufficient funds to support the computer networks (Funding Objective).

2.3 RESEARCH METHODOLGY

As part of the execution of the two projects, various reports were written. In addition, a detailed audit of the status of the equipment delivered, installed and commissioned, and other quantitative data on the project utilising refurbished computers was carried out. However none of the information and data contained in these documents had ever been analysed in any depth with respect to the lack of complete success on the i-Learn Project.

[3] Proposal to Thintana for the Implementation of the Thintana Internet 2000n Project, May 1999.

[4] Proposal to Telkom Foundation for the Implementation of the Telkom Super Centre Project, September 2000.

In 2002, an evaluation of the projects was carried out, focusing largely on the training component of the projects. This required extensive field research and data gathering through visits to several of the schools involved in the projects. In order to avoid a repetition of field work and in view of the existence of unanalysed statistics in the audit report, it was decided that the methodology for this research should primarily constitute desk research involving the appraisal of data already collected, ie meta research. This desk research would include the appraisal of reports of other similar projects, and the application of some relevant theory. The desk research would be supported by interviews of relevant persons in Government, donor institutions, industry, and visits to a small number of schools in order to verify some of the data provided in the audit report. In addition, institutions similar to SNSA, in some other African countries, would be visited.

The detailed research plan that was applied is as follows:

- Review the project documentation, interview participants and visit a sample of schools in order to understand how the projects were executed and what developments took place;
- Execute a literature survey on the subject matter to identify relevant documentation on other similar projects and review such documentation, as well as relevant theory;
- Interview central and provincial Government representatives as well as Non-Government Organisation (NGO), academic and industry representatives in order to obtain a greater insight into needs, education policy, norms and standards;
- Visit organisations similar to SNSA in Namibia, Kenya and Mozambique to establish an understanding of the experiences with similar projects in these countries, specifically in the use of refurbished computers;
- Analyse the developments of the two projects with respect to relevant theory and other experiences;
- Draw conclusions in general with respect to the execution of school computer projects;
- Evaluate the specific objectives in the form of guidelines for future projects; and
- Develop recommendations to SNSA and other similar organisations.

2.4 PROJECT DOCUMENTATION

For the purpose of understanding the background to the two projects, and how the projects were executed and what developments took place, the following documents were obtained and studied:

- SchoolNet SA: Annual Report, 1998;
- SchoolNet SA: Proposal to Thintana for the Implementation of the Thintana Internet 2000 Project (Project i-Learn), 1999;
- SchoolNet SA: Proposal to Telkom Foundation for the Implementation of the Telkom Super Centre Project, 2000;
- Project Reports and Minutes of Progress Meetings of both projects;
- SAIDE: Report on the Evaluation of the Telkom SuperCentres Project and the Thintana i-Learn Project, 2002;
- Telkom ITSD: Thintana Schools Audit Report, 2003;
- Business Plans submitted by schools; and
- Miscellaneous project documents.

2.5 PARTICIPANT INTERVIEW

Information obtained from the above-referenced documentation was supplemented with valuable contributions from interviews held with some of the project team members or participants. These interviews took place in Johannesburg, Cape Town and Pietermarizburg in the period from February 2004 until June 2004. The interviews took place with two objectives in mind, firstly as indicated, to obtain project specific information, and secondly, to obtain views and suggestions as to how projects of this nature could be implemented differently.

2.6 SCHOOL VISITS

A small sample of schools was visited in order to gain first hand exposure of school computer networks and the conditions in which these are installed. One school from each of four categories was visited, as follows:

- i-Learn Project (Hybrid thin-client network with new and refurbished computers): Howick Secondary School, Howick, KwaZulu-Natal;
- SuperCentres Project (Fat-client network with new computers): Zamazulu School, Pietermaritzburg, KwaZulu-Natal;
- Independent project (Standalone second-hand relatively new computers): Mpophomeni High School, Mpophomeni, KwaZulu-Natal; and
- Private School (Campus WAN/Fat-client network with a large number of all-new computers): Hilton College, Hilton, KwaZulu-Natal.

3. PROJECT DETAILS

3.1 INTRODUCTION

This Chapter reviews the requirements and details of the two projects and the resulting scope of work which became the contract baseline. Important aspects of the planning decisions and processes applied by SNSA are also reviewed, on a comparative basis relative to the two projects, where applicable.

3.2 SUPERCENTRES PROJECT

The Telkom Foundation SuperCentres Project had its foundation in the Telkom 1000 Schools Internet Project. The purpose of this earlier project was to provide 1000 schools throughout the country with a computer with Internet access. Although the implementation of the project with all new equipment was successful, there were major shortcomings in the project in other respects.[5] Three shortcomings were an inadequate training component in the project make-up, the lack of field support and the lack of a channel of communications between the schools and Telkom. The result of this was that many schools were unable to make use of the donation because of a lack of computer orientation and training, and no channel through which to communicate this situation. Disappointment and disillusionment prevailed within the affected school community.

As a consequence of this situation, Telkom expressed a desire to remedy the situation with a smaller project but one which would overcome the shortcomings of the previous project, and include a training component, field support and a communications channel back to Telkom. As a result of discussions between Telkom and SNSA, the latter prepared and submitted a proposal to Telkom in 2000 for a project to provide computer networks with dial-up Internet access to 100 schools, using all new equipment. In terms of this proposal, SNSA would project manage the supply of educator training and assistance in the schools selection process, whilst Telkom would directly manage the supply of all equipment, installation, commissioning and technical assistance.

In terms of schools selection, SNSA proposed that schools be selected from the previous Telkom 1000 Schools Internet Project, and that an equal number of schools be selected from each province. These criteria were accepted by Telkom with the additional criterion that the selection of schools would be in line with the strategic development objectives of provincial departments of education.

In terms of equipment supply, Telkom would provide 100 schools with 21 new Dell computers each, together with a server, printer, hub, uninterruptible power supply (UPS) and a dial-up modem, ie SNSA would not be involved in the supply, installation and commissioning of equipment at all. All the equipment would be new. In terms of training, SNSA would provide comprehensive training to at least 10 educators per school. In addition, technical training would be provided to 2 educators per school to provide technical network support.

3.3 I-LEARN PROJECT

At roughly the same time as the formation of the Telkom project, Thintana had committed R100m to educational projects as part of its corporate social commitment. Thintana's approach was somewhat different to that of Telkom's in that it wished to benefit as many schools as possible.

[5] Participant Interview.

This commitment was translated into an objective of providing 200 Internet access points for schools, community centres, libraries, and health care facilities, hence the proposed project name of the "Thintana Internet 2000 Project".

In response to this stated requirement, SNSA submitted a proposal to Thintana in 1999, in terms of which, SNSA would provide 200 schools with computer networks with dial-up Internet access, and by using a mixture of new and refurbished computers, would leverage the 2000 new computers into 3000 new and refurbished computers plus 200 new servers, in so-called midi-and maxi- installation configurations.

The training component of the project would comprise the training of 2000 educators in educationally-integrated Computer Literacy and the effective use of computers in education. SNSA would be responsible to project manage the supply of all of the equipment, installation, commissioning, technical training and assistance, educator training and provide assistance in the schools selection process.

In terms of the schools selection process, SNSA proposed the following selection criteria:

- Schools should be equally distributed across all 9 provinces;
- High schools should benefit first but at least 20% of the beneficiary schools should be primary schools;
- Schools should be selected from various lists and databases of the Departments of Education (DoE's) and from previous projects; and
- At least 20% of the beneficiary sites should be non-school sites, ie community centres, libraries and health care facilities.

In reaching a contractual agreement between the parties, some of the project requirements changed, as illustrated here in Table 1:

TABLE 1: Comparison of Proposed Requirements and Contracted Requirements

AS PROPOSED	AS CONTRACTED
EQUIPMENT CRITERIA	
100 Midi (11) sites and 100 Maxi (2) sites, with at least 21 computers for classes >40. Mixture of 2000 refurbished and 1000 new computers.	200 networks each comprising 10 refurbished computers and 4 new computers.
New server, printer, hub, UPS, cabinet and modem.	New server, printer, hub, UPS, cabinet. Donated 3COM modems.
SCHOOLS SELECTION CRITERIA	
Schools should be equally distributed across all 9 provinces.	Schools should be distributed equitably across all 9 provinces.
High schools should benefit first but at least 20% of the beneficiary schools should be primary schools.	Schools should be historically disadvantaged secondary schools.
Schools should be selected from various lists and databases of the DoE's and from previous projects.	There should be historically disadvantaged secondary schools.
At least 20% of the beneficiary sites should be non-school sites, ie community centres, libraries and health care facilities.	The density of computer networks per province and per district should be balanced.

------	There should be flow through from the Thintana MST Project and from national and provincial DoE's.

3.4 THE COMBINED PROJECT

The two projects were combined into one for implementation, initiated in August 2000, with a planned completion date of August 2002.[6] A single SNSA project team was formed. The two projects were run as one but treated separately with respect to the two donors, ie separate progress reports and budgets were prepared and separate progress meetings were convened.

As indicated in Chapter 2, the two key deliverables of both of the projects were a) the provision of educator training in the use of computers, and b) the provision of computers to schools. In order to ensure satisfactory delivery of these two deliverables whilst fulfilling the donor requirements as stated in para's 3.3 and 3.4 above, a combined Statement of Work (SOW) was established as a contract baseline for the projects, as given here in Table 2, showing some of the differences in the contracted requirements between the two projects:

TABLE 2: Combined Statement of Work

TASK	THINTANA i-LEARN PROJECT	TELKOM SUPERCENTRES PROJECT
1	Assist in the schools selection process (although with different selection criteria as identified in **TABLE 1**), ie a total of 300 schools.	
2	Develop effective educational use of the provided computer networks by running a programme of development for educators, using the computers and the Internet in education.	
3	Undertake the training of at least 10 educators per school, ie a total of 3000 educators.	
4	Provide technical training to 2 educators per school, ie a total of 600 educators.	
5	Conduct a monitoring and evaluation process that assesses the qualitative and quantitative impact of the project(s).	
6	Provide telephonic support via a Help Desk to the network administrators, to resolve network, hardware, software and Internet problems.	
7	Refer any specific supplier-related problems to SNSA's contractor for technical on-site support.	Refer any specific supplier-related problems to Telkom's contractor for technical on-site support.
8	Provide computer networks with dial-up Internet access to 200 schools around the country.	(NB: Telkom took direct responsibility for the provision of 100 computer networks).
9	Provide technical on-site support for the duration of the project.	(NB: Telkom took direct responsibility for the provision of technical on-site support).

The contracting models between SNSA and its two customers were therefore similar but differed in terms of responsibilities for the supply of equipment and technical on-site support. It should be remembered that at the time of contracting, SNSA was still an entity within the

[6] Various Project Meeting Minutes.

IDRC organisation, and therefore without its own ability to contract directly with outside organisations. The contracting models therefore were as follows:

FIGURE 1: SNSA/Thintana Contracting Model

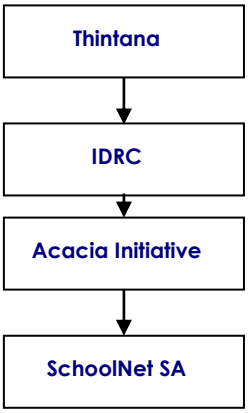
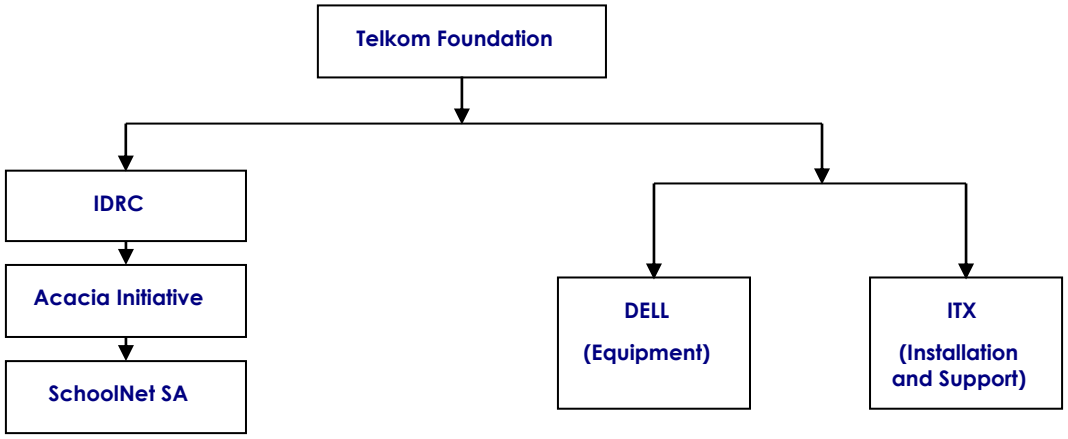


FIGURE 2: SNSA/Telkom Contracting Model



3.5 TASK ALLOCATION

SNSA itself undertook the execution of some of the tasks in the Statement of Work, and contracted the remaining tasks out to other organisations. Contracts between SNSA and other organisations were initially signed by the IDRC until SNSA became a Section 21 company and hence acquired power to contract.

The tasks which SNSA undertook included:

- Task 1: Assist in the schools selection process;
- Task 2: Develop effective educational use of the provided computer networks; and
- Task 3: Undertake the training of 3000 educators.

National Data Systems (Pty) Ltd (NDS) was contracted to:

- Task 4: Provide technical training to a total of 600 educators.

The South African Institute for Distance Education (SAIDE) was contracted to:

- Task 5: Conduct a monitoring and evaluation process that assesses the qualitative and quantitative impact of the project(s).

The Western Cape Schools Network was contracted to execute the two support tasks of:

- Task 6: Provide telephonic support via a Help Desk to the network administrators; and
- Task 7: Refer any specific supplier-related problems to the respective contractor for on-site support.

The technical tasks, namely:

- Task 8: Provide computer networks with dial-up Internet access to 200 i-Learn schools around the country; and
- Task 9: Provide technical on-site support to the 200 i-Learn schools for the duration of the project,

were contracted out to a single implementation contractor, namely SourceCom Technology Solutions (Pty) Ltd (SourceCom), who in turn contracted out much of the work to other contractors, as given here in Table 3:

TABLE 3: Subcontractor Responsibilities

SUBTASK	SUBCONTRACTOR
Refurbish and supply donated computers (i-Learn)	FreeCom
Provide new computers, servers and other hardware (i-Learn)	Memtek (until its liquidation as part of the Siltek Group, then Sahara)
Deliver equipment to schools (i-Learn)	Memtek
Install and commission networks (i-Learn)	NetDay Associates
Provide technical on-site support (i-Learn)	Memtek (until its liquidation as part of the Siltek Group, then CS IT Solutions (Pty) Ltd (CS ITS)

With SNSA assistance, the provincial DoE's were responsible for the selection of schools, and again, with the assistance of SNSA, the selected schools were responsible for infrastructure requirements such as the availability of a classroom, any modifications to the classroom, electricity, insurance, security, a telephone line and an Internet Service Provider (ISP) contract. The schools alone were responsible for raising funds to finance these infrastructure issues, with the exception that Telkom subsidised both the telephone call charges (to a maximum of R300 per month) and the ISP charges for the SuperCentres schools only.

3.6 TASK 1: SCHOOLS SELECTION PROCESS

In designing a schools selection process which would fulfil the donor criteria as stated above, SNSA took into account the lessons learnt from its previous projects.[7] Experience had shown that, where inappropriate schools had been selected in "supply-driven" processes, the risk of project failure had increased substantially. Problems that could occur include:

- Schools do not take the initiative to sustain and enhance what they have been supplied with, leading to a state of dependency on the donor;
- Schools do not integrate the initiatives into their developmental programmes and day-to-day operations; and

[7] Thintana i-Learn Project: Report on the School Selection Process, February 2001.

- Some do not have an appropriate and enabling environment to support the successful use of ICT's, or have disabling management or staffing problems.

SNSA therefore sought to implement a needs-driven assessment process, in which schools were asked to respond to a comprehensive set of questions examining school leadership, executive and financial management, the teaching and learning environment, community involvement and staff involvement.

As a first step, SNSA presented its proposed process to all the provincial DoE's, in order for them to understand the projects and the process, to indicate a willingness to participate, to table further selection criteria, and to nominate representatives to participate in the school selection panel for their particular province. The panel members consisted of representatives from the provincial DoE head office and from the Regional and District offices.

Once the schools selection panels had identified an initial pool of candidate schools for consideration, the project requirements and the process were communicated to these schools. The process required an interested school to prepare a comprehensive business proposal which included physical details concerning the school as well as a financial plan and a technology plan. Other issues to be addressed in the business proposal included the organisational climate in the school, the likely leadership initiatives to be taken in the school, and the school's community approach to teaching and learning. After proposals were received from schools, these were evaluated by the school selection panels and by SNSA, using an evaluation grid. On the basis of this evaluation, schools were ranked on a shortlist and visited by a team comprising SNSA project staff, panel members and technical service providers, in order to evaluate school management, interview relevant staff, make technical observations, examine any issues raised by the evaluation of the submitted proposal, and collect baseline data for formative evaluation purposes. Thereafter a final selection was made and all schools notified accordingly. Successful schools were also advised of any shortcomings in their infrastructure that had to be rectified before computer network installation could commence.

Makgetse High School in the North West Province was identified as a pilot site for the SuperCentres Project. The purpose of the pilot was to validate the time required to install and cable the computer networks and also to minimise potential technical problems that might arise after the infrastructure had been rolled out. Similarly, a pilot site was established in Cape Town for the i-Learn Project with 10 refurbished computers, a hub, a modem and a server.

3.7 TASKS 2 AND 3: PROVISION OF EDUCATOR TRAINING

The original intention in respect of Educator Training was to provide face-to-face training. However, during project development, it was decided to adopt the mentor-led distance method of training as the most suitable training approach to employ, based on lessons learnt from a range of previous projects in South Africa and abroad. A selection of distance learning modules was made available from which educators could choose, thus making the courses appropriate for a wider range of computer competence and addressing the adult style of learning. The materials and support resources were made available on a compact disk (CD) as well as on-line. The face-to-face Introductory Course provided training in the tools of communication that were required for the remainder of the course. This distance learning course was supported by e-mail and on-line interaction (using the Internet) between approximately fifteen educators, who were on the same course. The groups were facilitated by a mentor who had undergone an intensive training course in the skills of facilitation and the type of mentorship expected.

3.8 TASK 4: PROVISION OF TECHNICAL TRAINING

The intention, as contained in the project proposals, was that schools would become responsible for the sustainability of their networks, and to this end, 2 educators from each school would be provided with technical training covering basic administration skills and technical skills. NDS was contracted to provide this technical training to 600 educators, ie 2 educators from each of 300 schools. The prescription to the schools in terms of selection of these 2 educators was that they should be technically competent. The curriculum for the two-day course included the following:

- Hardware familiarity and basic troubleshooting;
- Basic network familiarity and troubleshooting;
- How to log in, run applications, print and save files;
- How to use and share CD's on the network;
- How to create and delete users on the server, and change passwords;
- How to manage files and disk space on the server;
- How to backup and restore files;
- How to recreate workstations (Ghost/Imagecast) if required;
- Using email (system administration using Taxis Mail);
- Using Internet (system administration with MS Proxy Server);
- Basic Internet troubleshooting;
- Managing Internet access and costs;
- How to get help (Helpdesk, online Help resources); and
- CD and Manual Resources.

A training manual was jointly prepared for the training course. Training commenced at the beginning of July 2001 and went through until February 2002. In the execution of the training, it was found that the first group of educators that had been trained during July and August 2001 had retained very little information and had acquired insufficient skills to carry out their functions. The solution was for SNSA project staff to work together with NDS to amend the technical training materials to make them more specific to the project, and to appraise NDS of the more contextualised teaching approach which was required. A point which NDS stressed in discussions with SNSA was that the educators had to understand clearly that the training course would not be covering the opening and working with the inside of the computers, as many of the educators had this impression.

3.9 TASK 5: MONITORING AND EVALUATION PROCESS

As the title implies, there were two aspects to this task. The first was to monitor the execution of the project. The intention was that SNSA would monitor the following areas:

- Implementation and installation of equipment;
- Management, staffing and administration of school/centre and resources;
- Operational capacity of the facilities;
- Extent of utilisation of the site by schools and community;
- Extent of implementation of a sustainability plan;
- Extent of participation in educator development programme;
- Extent of educational and developmental benefits for community, teachers and learners; and
- Impact assessment.

The second aspect was to contract the South African Institute for Distance Education (SAIDE) to provide research design, to develop an evaluation methodology and to compile a final evaluation report. SNSA would be responsible for collecting most of the research data during the project implementations. The final report was to be completed by the 30th September 2002.

3.10 TASKS 6 AND 7: PROVISION OF TELEPHONIC SUPPORT

The Western Cape Schools Network was contracted to provide ongoing telephonic support to educators tasked with network administration, to resolve network, hardware, software and Internet problems. Where necessary, supplier-specific problems were referred to the respective supplier, and the resolution of the problem was tracked. In the case of the SuperCentres Project, the relevant supplier issues were passed onto ITX (and/or its relevant subcontractor), and in the case of the i-Learn Project, the problems were passed onto Memtek initially and thereafter, to CS ITS.

3.11 TASK 8: PROVISION OF COMPUTER NETWORKS

The provisioning of computer networks for the two projects comprised two entirely separate and different exercises. In the case of the SuperCentres Project, Telkom's ITX Division was tasked by Telkom to procure and install new equipment purchased from Dell. The network configuration was to comprise fat-client architecture with a server, ISDN modem (where feasible), hub, printer and UPS, together with 21 fat-client workstations. The server was to be a Dell Poweredge 2300 550MHz Pentium III machine with 128MB RAM and a 9GB SCSI hard disk drive. The client workstations were to be Dell GX100 Celeron 500MHz Pentium II machines with 128MB RAM and a 6.4GB IDE hard disk drive. Software would include Windows 98 and Office 2000 on the workstations, and Microsoft NT and MS Proxy Server on the server.

In the case of the i-Learn Project, the task was to install networks comprising a new Pentium III server, analogue modem, hub, printer and UPS, together with 4 new computers and 10 refurbished 486/Pentium I computers. The 4 new computers were networked with the server using fat-client architecture. In order to provide an equivalent level of functionality (and near-identical desktop) on the 10 refurbished computers as on the 4 new computers, and to facilitate the use of current versions of operating system and productivity software (Office 2000), thin-client network architecture was chosen in respect of the 10 refurbished computers, by making use of the processing capacity of the server (running Windows Server 2000) to make up for the reduced capacity of the 10 refurbished computers, resulting in a hybrid thin/fat-client architecture.[8] Achieving thin-client architecture implies the application of terminal emulation software. There are two ways to implement this.[9] Firstly, the terminal emulation software can be downloaded from the server to the thin-client upon power-up, and the thin-client then operates very much as if it were a fat-client. In this case "thin"-client is a bit of a misnomer as all the connection management and protocols have to be downloaded into the client, effectively making it a "fatter"-client. Alternatively, the terminal emulation software can run on the server and a small amount of code is downloaded to the client for presentation purposes. The configuration that was selected, based on what was available at the time, was again a form of a hybrid in that the refurbished clients ran an operating system (Windows 95 off the internal hard disk) and accessed the productivity software which ran on the server, over the network using the Terminal Server facility of Windows Server 2000.[10]

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[8] Participant Interview.

[9] Thin Client Applications, Network Designers Ltd, July 2000.

[10] Participant Interview.

3.12 TASK 9: PROVISION OF TECHNICAL ON-SITE SUPPORT

3.12.1 SUPERCENTRES PROJECT

Technical on-site was provided by the ITX Division of Telkom, with support from the regional offices of Telkom.

3.12.2 I-LEARN PROJECT

The four new computers per school site and the servers were purchased from Memtek, a company within the Siltek Group of companies. The computers and servers were supplied with two year on-site warranties. When the Siltek Group went into liquidation, including Memtek in October 2001, SourceCom was obliged to contract another supplier in order for the warranties to be honoured from SNSA's perspective. CS ITS was contracted for this purpose until the expiry dates of the on-site warranties as issued by Memtek. The provision of support by CS ITS encompassed a response to a call from a school, regarding a hardware fault, telephonically, via modem or on-site as required. If a site visit was necessary, then this would take place within 24 business hours provided the site was within a 50km radius of the nearest CS ITS service centre, or 24 hours plus an additional hour for every 60km over and above the first 50km. All call-outs would take place within working hours from Monday to Friday, excluding public holidays.

With respect to the refurbished computers, it was intended that educators would be provided with technical training and would take responsibility for the maintenance and repair of these computers.

4. PROJECT DEVELOPMENTS AND OUTCOMES

4.1 INTRODUCTION

The most significant developments during the execution of the projects were the delays which occurred with respect to the two key deliverables of the projects, namely the provision of educator training in the use of computers, and the provision of computer networks with Internet connectivity to the selected schools.[11] Whilst various actions were taken to overcome these problems, at the end of the 2-year project timeframe, the problems still existed with respect to the i-Learn Project, ie the project which utilised refurbished computers.

The decision early in the project, to change the provision of educator training from face-to-face training to mentor-led distance training, implied that, in terms of the way in which the project was designed, the provision of educator training became dependent upon both the successful completion of the delivery, and the sustainability of the computer networks to the schools, both of which in turn were dependent upon the successful execution of the various tasks of the SOW. Significant developments with respect to the various tasks are described here, on a comparative basis where applicable.

4.2 TASK 5: MONITORING AND EVALUATION PROCESS

During the execution of the two projects, developments on the projects were monitored and reported to the project team and the donors via the Project Progress Reports that were tabled at each project progress meeting. Much reference is made to these progress reports and the project progress meeting minutes in this report.

The objectives of the project as evaluated by SAIDE[12] were to:

- Provide an overview of the conceptualisation, design and aims of the projects;
- Monitor project progress and involvement;
- Document and analyse the experiences of participants in the projects;
- Provide a comprehensive overview of the way in which the projects have been implemented and the opportunities and pitfalls associated with this process; and
- Make judgements, based on empirical evidence, about the success of various components of the projects, and of the success of the projects in totality.

Whilst an extensive evaluation was carried out by SAIDE, it was unfortunately carried out before the projects were completed.

Again, much reference is made to this evaluation report in this research report.

4.3 TASK 1: SCHOOLS SELECTION PROCESS

The Schools Selection Process was an extensive and time-consuming process, and took much longer than originally planned. The first contacts with provincial DoE's were made in September 2000, shortly after project commencement. Although it was intended that the first pre-selected school visits would commence in early November 2000, the first school visits only commenced in the week of 19th February 2001 with schools in the Northern Cape, KwaZulu-Natal, North West and Gauteng. It was only at the i-Learn Project Steering Committee meeting of the 11th May 2001 that it was reported that the selection process for

[11] Various Project Meeting Minutes.

[12] SAIDE Report on the Evaluation of the Telkom SuperCentres Project and the Thintana i-Learn Project, 2002.

the Northern Cape, KwaZulu-Natal, North West and Gauteng provinces was complete and that schools had been advised accordingly. Only by the end of July 2001, was the selection process completed for the Western Cape, Mpumalanga and Northern Province. The process for the Eastern Cape and Free State was completed in August and September 2001 respectively. Delays in the Free State, Eastern Cape and Northern Province were variously ascribed to a lack of proposals from schools and resourcing problems within the respective provincial DoE's. The i-Learn Project Closure Report of the 12th August 2002 reported that a total of 100 and 200 schools had been selected for the SuperCentres and i-Learn projects respectively.

It was intended that the first selected schools would be informed of their successful applications by mid-November 2000, but it was only by April 2001 that this happened. Notified schools were given 20 days to get any shortcomings in their infrastructure rectified before network installation could commence, implying that installations could only start in May 2001 at the earliest.

Delays in the schools selection process of up to five months clearly delayed the implementation of the school networks, which in turn had a knock-on effect on the delivery of educator training in all provinces.

An important distinction between the two projects that was noted by SAIDE, was the fact that whilst there were problems relating to the selection of schools which were to benefit from the i-Learn Project, there were no such reports relating to schools which were to benefit from the SuperCentres Project. This could be attributable to the fact that the latter schools had already taken part in the Telkom 1000 Schools Internet project and therefore knew what was expected of them.

The final task of the schools selection process was to inspect the selected schools in order to verify that all the schools' infrastructure prerequisites in terms of security, electricity, alterations, insurance, telephone line etc were in place, in order that installations could actually commence.

4.4 TASK 8: PROVISION OF COMPUTER NETWORKS

4.4.1 OVERVIEW

Whilst delays in the schools selection process had an impact on the commencement of the installation of computer networks with Internet connectivity in the schools, a number of other problems were experienced with respect to the provision of computer infrastructure, again with different experiences between the two projects.

As indicated earlier, the SuperCentres infrastructure rollout was not managed by SNSA but rather by the Telkom ITX Division, supported by regional Telkom offices. Although rollout delays were experienced, it appears that these delays, with the exception of the theft of equipment from a Telkom warehouse, did not significantly delay the educator training process.

However, the situation with respect to the infrastructure rollout on the i-Learn Project was different and a number of problems were experienced, as discussed here.

4.4.2 I-LEARN COMPUTER NETWORK ROLLOUT

Although it was intended that the first i-Learn computer network installations would commence by mid-January 2001 with the last installation to be competed by the end of April 2001, the tender was awarded to the selected main contractor, SourceCom, only on the 11th April 2001. SourceCom was contracted for the supply of computers, servers and other hardware, and to subcontract NetDay to execute the installation, which then

commenced in June 2001. In executing its allocated tasks, NetDay experienced a number of problems including cases of the following[13]:

- Prerequisites not in place despite apparently having been inspected;
- Difficulties in geographically locating schools;
- Insufficient clustering of schools for installations resulting in installation teams having to return to areas previously visited.
- Equipment not delivered to schools in advance of the installation teams;
- Out of box failures with refurbished computers sourced from FreeCom by SourceCom;
- Out of box failures with new computers sourced from Sahara;
- Packaging problems resulting in monitors arriving smashed; and
- Batching problems where equipment batched by FreeCom for particular schools would unwittingly be unbatched by SourceCom before dispatch.

Overall, the NetDay experience covered the full range of possibilities from perfect installations to situations where only 2 out 10 refurbished computers functioned on arrival. However these were mostly sorted out on site by adjusting loose cables and modules (due to inadequate packaging). All of these developments contributed to delays in the educator training process.

Refurbished computers were purchased with a three month warranty. An attempt to purchase an extended warranty of 12 months was not successful due to the high price quoted by the supplier, FreeCom. Although NetDay did experience a degree of success in commissioning refurbished computers, many did fail after installation and were returned for repair. However repairs were not always expedited due to the lack of suitable spares for the relatively old refurbished computers.

4.4.3 SUBCONTRACTOR LIQUIDATIONS

A development during the execution of the projects which took the larger IT industry by surprise was the liquidation of the Siltek Group, a large and well respected IT group of companies. SourceCom had contracted Memtek, a subsidiary of Siltek to supply new computers and servers, with 2 year onsite warranties for the i-Learn rollout. In October 2001, ie about halfway through the project and only four months after commencement of the infrastructure rollout, the Siltek Group including Memtek, went into liquidation, and warranties became void. The effect of this on the rollouts was threefold:

- Deliveries of equipment for further installations were frozen by the liquidators;
- Equipment which had been returned for warranty repairs was not repaired and returned; and
- Further calls for assistance in terms of onsite warranties were not addressed.

This liquidation delayed the infrastructure rollout in the Free State and Eastern Cape from October 2001 until February 2002 by which time SourceCom had managed to negotiate with the liquidators to release equipment from Memtek, and also to contract Sahara to continue with the supply of further computers.

[13] Participant Interview.

4.4.4 INTERNET CONNECTIVITY

For the SuperCentres schools, new external ISDN modems were provided by Telkom as part of the infrastructure rollout. This ensured the provision of connectivity at 64kb/s (with the exception of those areas where ISDN service was not available).

Within the i-Learn Project, it was agreed between the parties that additional sponsorship to the project would be welcomed. This resulted in a donation from 3Com of internal modems. However these turned out to be end-of-life products with limited or no technical support and were ultimately replaced with new external 56kb/s analogue modems. The problems incurred here with the 3Com modems prevented educators from participating in the distance education part of their training. Even when these problems were overcome, the educators on the i-Learn project still had to contend with the performance of the slower analogue modems compared with the faster and more reliable service provided by the ISDN modems on the SuperCentres Project.

4.4.5 ARCHITECTURE

Whilst the decision on the i-Learn Project to utilise refurbished and new computers in a hybrid fat/thin-client configuration made it possible for more computers to be acquired within the project budget, the major disadvantage of utilising thin-client architecture was that when the server failed then all of the client terminals effectively failed as well. SAIDE has reported on several occurrences of this problem. In addition, due to the inadequate technical training provided (discussed later), the concept of thin-client networking was not clearly understood by many of the educators (and others such as maintainers and the auditors who came later), leading to complaints about not being able to access hard disk drives and floppy disk drives on client workstations, which effectively had been disabled.

The fact that the hard disk on the client workstations was only used to provide an operating system for these workstations, meant that the hard disk was quite under-utilised, and could have been used for local data storage. Because of a lack of appreciation by the learners new to computers, of a structured closing down sequence of a computer, many learners simply switched off computers whilst the operating systems were still running, something which is known to cause Windows 95 operating system to crash. Attempts to reinstate such a failed computer, could have caused computers to be dispatched to the maintenance centre instead of being reinstated locally.[14]

Various possible mechanisms to explain the high failure rate of the hard disk drives of the refurbished computers were investigated but none withstood detailed scrutiny, and it can only be concluded that this high failure rate was due to fact that these hard disk drives were near their end-of-life. As above, with a failed hard disk drive, maintainers were not able to reinstate computers and these were dispatched to the maintenance centre when repairs could have been effected locally (replacement of hard disk drive).

4.4.6 TECHNICAL ASSISTANCE

Problems associated with inadequate on-site support and inadequate technical training, as discussed later, led to a reduced ability of educators to help themselves in terms of technical support when problems occurred with the computers and the network.

4.4.7 THEFTS

As mentioned above the SuperCentres Project suffered from a theft of computer equipment from a Telkom warehouse, resulting in a stoppage in the rollout from August 2000 until November 2000, with a further delay in December 2000 when a shortage of keyboards was

[14] Various Participant and Specialist Interviews.

discovered, all resulting in a knock-on effect on the completion of the educator training programme.

The i-Learn Project Closure Report of 15th August 2002 provides details of thefts at 8 schools with a total of 44 computers and other hardware being stolen. In many cases, insurance companies honoured claims and stolen equipment was replaced. However, in other cases, schools spent the money on other items and there were cases where the insurance policies had been allowed to lapse, all resulting in either delays in educator training or a stoppage in the training.

4.4.8 DELIVERY PERFORMANCE EVALUATION

In addition to the problems discussed above and elsewhere, reports were also received from schools about installations that had not been carried out and equipment was still packed in boxes. In response to all of the problems relating to the i-Learn project, a request was made by Thintana at the end of 2002, to the Telkom ITX Division, to carry out a physical audit of the 200 school computer networks. The audit was carried out using a mixture of ITX staff and subcontractors, and a detailed quantified database of statistics was prepared.[15] The audit was executed largely during the December 2002 holidays, and the audit report published in February 2003. The information obtained from the audit has been analysed to produce a measure of the Technical Delivery Performance of the i-Learn Project. Details of the analysis are provided in Appendix B: Technical Delivery Performance Analysis. This analysis indicates that even with the relaxation of some of the measurement criteria, the technical performance measurement of the project was only 34%, ie in only 69 out of 205 schools which received computer networks (i-Learn), were all the prerequisite infrastructure requirements fulfilled and in which all the requisite computer network elements installed, successfully commissioned and functioning at the time of the audit, with Internet access to facilitate distance training. What is also specifically indicated by this analysis, is that there are only 165 servers functioning, ie only 165 out of 205 networks were functioning at the time of the audit as intended, and only 106 of the schools have Internet access. (This was confirmed in a telephonic survey carried out in February 2004, when it was found that only 109 schools have Internet access with 10 schools not contactable) This implies that at only 52% of the schools can the educators participate in distance education as at the date of the audit. The analysis also indicates that only 65 out of the 205 schools have not registered a complaint about faulty or missing equipment, or 23% of the total.

Even relaxing the criterion of Internet access, ie no distance learning possible, the measurement improves to only 46% (95 schools). Going further, even if the criterion of the number of computers delivered is relaxed from 14 down to just 1 computer delivered and working, and no Internet access, the measurement improves to only 70%.

(Appendix B does point out that the statistic in the Audit regarding the number of cabinets delivered, when tested, was found to be flawed. This may also be the case with other statistics that appear excessively high such as the number of computers never delivered, but have not been tested).

4.5 TASK 4: PROVISION OF TECHNICAL TRAINING

Whilst the curriculum for the technical training included aspects pertinent to network administration, and therefore the first objective of the technical training could be fulfilled (Basic Administration Skills), the curriculum fell far short of achieving the second objective of providing educators with usable technical skills. Even the admonition by NDS in the planning stage that "educators had to understand clearly that the training course would not be covering the opening and working with the inside of the computers ….", would ensure that educators would not acquire the necessary skills from this course that would enable them to

[15] Thintana Schools Audit Report, Telkom Information Technology Service Delivery, February 2003.

ensure the technical sustainability of their networks. Many extreme complaints in this regard were recorded by SAIDE.

The net effect was that educators were not able to help themselves when technical problems occurred with their networks, making them dependent upon outside assistance which, in the case of the i-Learn project, was not forthcoming, resulting in less educator training.

4.6 TASKS 6 AND 7: PROVISION OF TELEPHONIC SUPPORT

Western Cape Schools Network (WCSN) provided telephonic support to the schools benefiting from both projects. In the case of the SuperCentres project, calls requiring onsite support were passed on the ITX Division of Telkom for attention.

In the case of the i-Learn Project, calls requiring onsite support were passed on to Memtek initially and, after its liquidation, to CS ITS. With its unique position in terms observing developments on both projects, WCSN was in a good position to make judgement on the relative performance of the two organisations providing onsite support, namely ITX and CS ITS.[16] Based on WCSN's observations, ITX provided a much higher level of service than CS ITS whose level of service left much to be desired, as discussed later. At the time of interviewing WCSN there were 900 open calls from i-Learn schools as opposed to 10 from SuperCentres schools, with no access to available solutions to close the open i-Learn calls. The low level of support provided by CS ITS led i-Learn educators to consider WCSN as a part of the problem. WCSN was much relieved when their contractual obligation eventually expired in early 2004.

4.7 TASK 9: PROVISION OF TECHNICAL ONSITE SUPPORT

As mentioned above, technical onsite support was provided to SuperCentres schools by Telkom's ITX Division. By all accounts the level of service provided was excellent especially with ITX maintaining a close relationship with its schools, even providing software upgrades proactively when these became available.

Two important issues arise out of the low level of service provided by i-Learn schools by CS ITS. Firstly, there appeared to be a critical lack of central accountability within the CS ITS organisation for the service provision, making it necessary for issues to be discussed with each of the different branch managers within the CS ITS organisation. Secondly, and possibly related to the first issue, there was a significant lack of a uniform level of service across the country. In some areas the level was adequate but in other areas the level of service was very poor. This even led to some schools requesting assistance from any technician, preferably an ITX technician but definitely not a CS ITS technician. In some areas the service provision was subcontracted out by CS ITS to other suppliers, resulting in even less control of the level of service provided. The contract, as drawn up between SourceCom and CS ITS did not include any service level agreements and therefore no penalty conditions for poor delivery. The levels of service actually provided were not monitored properly either.

4.8 TASKS 2 AND 3: PROVISION OF EDUCATOR TRAINING

As noted above, the decision early in the project, to change the provision of educator training from face-to-face training to mentor-led distance training, implied that, in terms of the way in which the project was designed, the provision of educator training became dependent upon both the successful completion of the delivery, and the sustainability of the computer networks to the schools.

[16] Participant Interview.

Whilst the provision of educator training experienced its own delays, in terms of recruitment of mentors and trainers, this task was significantly delayed by the other problems on the project of late schools selection, the delayed rollout and the minimal support of computer networks, specifically the i-Learn networks.

At the time of the project closures in August 2002, only about 60% of the educator training for i-Learn schools had been completed, as opposed to 90% of the SuperCentres training. To enable further distance training to take place with i-Learn schools, SNSA contracted CS ITS directly to provide onsite support to the i-Learn schools. This proved to be effective to a degree. Many of the older computers could not be repaired due to a lack of suitable spares.

4.9 SUMMARY

The two projects commenced in August 2000 with a project timescale of 2 years. Although the i-Learn Project ended in August 2002 (at least in terms of network installations), the educator training was far from complete, and so the project continued in terms of onsite support and the provision of educator training. The SuperCentres Project also continued in terms of outstanding educator training until the formal closure of this project took place in December 2003, although ITX continued to provide on-going proactive onsite support to the SuperCentres schools. The i-Learn Project was formally closed in April 2004, even though many computer networks are still not fully functional and educator training is not complete. As of writing, it appears that Telkom will take over the i-Learn Project and address the outstanding issues.

5. LITERATURE SURVEY

5.1 INTRODUCTION

A number of documents were sourced and studied in order to gain an appreciation of the experiences of other similar projects. In addition, various sources were consulted to assist in establishing guidelines for future projects.

The sources consulted include the following:

- Computers for Schools: Enriching the Education of New Generations of Colombians, March 2003, a partial English translation of the original Spanish Report by Maria Isabel Mejia and Pablo Bernal, April 2003;
- Computers in Secondary Schools in Developing Countries: Andy Cawthera, estimated date 2001/2002 ;
- Choosing and Using Open Source Software: NOSI, 2004;
- Evaluation of Swedish Support to SchoolNet Namibia: Peter Ballantyne, December 2003;
- Report on the Use of ICTs in Schools Research Project June 2003 (Draft Research Report): Sue Cohen, June 2003;
- Information and Communications Technologies for Development in Africa, Volumes 1, 2 and 3: IDRC, 2003;
- Strategy for Information and Communication Technology in Education: Departments of Education and Communications, November 2001;
- Draft White Paper on e-Education: Department of Education, September 2003;
- ICT's in African Schools: Workshop Report, 27th April to 2nd May 2003;
- Report on SchoolNet Namibia Wireless Access: Kyle Johnston, December 2002;
- MultiMedia Training Kit: Using Older and Refurbished Computer, 6 Sections: APC, 1st April 2004;
- Unwanted Computer Equipment, A Guide to Re-Use: AEA Technology Environment, May 2001;
- The Internet: Should this [be a] priority in Schools Networking in Africa?: Paper by Ephraim Siluma, Researcher SAIDE;
- Electronic Waste Guide: SECO e-Waste Website: www.ewaste.ch;
- Networking Complete: Sybex, 3rd Edition, 2002;
- Upgrading and Repairing PC's: Scott Mueller, 15th Edition, 2004;
- Lighting up South Africa: National Electricity Regulator, 2002;
- System Engineering Deployment: Jeffrey O. Grady, 2000; and
- Project Management: A Systems Approach to Planning, Scheduling and Controlling: Harold Kerzner, 1979.

5.2 SYSTEM ENGINEERING

There has been much development in the fields of system engineering, project management and risk management. System engineering, as Grady (2003) points out, is characterised by a deep understanding of the interactions between elements in systems and the consequences of these interactions. People in this profession have a broad interest

in systems rather than a narrow domain focus. They look at the system development process in the context of three fundamental steps, namely:

- Defining problems (requirements analysis and specifications);
- Solving problems (design by domain specialists, integration and optimisation); and
- Proving the solution relative to the requirements (verification).

The decision on, for example, the configuration or architecture of a system, should only be based on the results of the analysis of the specific requirements of a particular project and the constraints imposed on that project. The system engineering process can be used to determine the specific requirements of a particular project within the constraints imposed on that project and also to validate proposed solutions against the requirements. At the same time, each design requirement should be paired with a verification requirement so that upon completion, the fulfilment of each requirement can be verified in an agreed upon manner.

This process will assist in determining the ranking of requirements and even the elimination of requirements, which when subjected to analysis turn out not to be firm requirements.

5.3 PROJECT MANAGEMENT

According to Kerzner (1979) project management can best be described as the planning, scheduling, directing and controlling of company resources for a relatively short-term project which has been established for the completion of specific goals and objectives. Furthermore, it utilises the "systems approach" to management through the use of functionally controlled personnel (vertical hierarchy) assigned to a specific project (horizontal hierarchy). The objective of project management can be defined as an attempt to make the most efficient and effective use of the resources of:

- Manpower;
- Equipment;
- Facilities;
- Materials;
- Money; and
- Information/technology,

so that company objectives and goals can be achieved:

- Within budget;
- On schedule; and
- At the desired performance/technology level,

while adhering to the ever-changing environmental input factors of:

- Legal;
- Social;
- Political;
- Economical; and
- Technological.

Risk management can be considered to be a two-step process of identifying possible risk in a project, followed by necessary analysis of those identified risks. The risks to the success of a project need to be identified, in terms of identifying those elements of a project which could fail to meet budget, schedule and performance objectives. The second step then would be

to determine what the possible causes and probabilities of the failures could be, what the consequences could be and what contingency plans should be put in place.

5.4 COMPUTER USAGE LEVELS IN SCHOOLS

As a result of research carried out in 21 schools in North West, KwaZulu-Natal and Western Cape provinces, Cohen (2003) suggests that a continuum of use of computers in schools appears to exist and that it is possible to impose 8 levels of use in this continuum, ranging from school administration tasks down to the level of learning a computer-based subject.

In the case of the school administration, use would relate largely to word-processing, spreadsheets and some accounting tasks. In the case of the educators, the usage would range from the use of a computer for administration purposes and as a word processor for the preparation of tests and worksheets, through their use of the computer to access online resources which they would use to inform their teaching practice and subject knowledge, and which they would thus make available to their learners indirectly through printed handouts and information imparted during a lessons, to their integrating online resources into their classroom practice by setting tasks for learners that required their direct access to online resources during subject class-time. For learners, the continuum ranges from their having no direct access at all to computers, to their having access only for the purposes of learning a computer-based subject such as Computyping or Computer Studies, to their having some exposure to the use of the computer across the curriculum through its application to various studies in an *ad hoc* way in a computer-based subject, to their having access in a more formal way during subject class time.

6. EXPERIENCES IN OTHER COUNTRIES

6.1 INTRODUCTION

The opportunity was provided within Project Refcomp to visit a selection of other African countries to learn at first hand of the experiences there in the provision of computers to schools, and in particular, experiences with regard to the employment of refurbished computers. The purpose of obtaining information pertaining to other countries was to be able to benchmark the experiences of the i-Learn and SuperCentres Projects against projects carried out under totally different economic, political and educational circumstances.

The countries visited comprised Namibia, Kenya and Mozambique. The visits were greatly enriching in that each country presented very different experiences and circumstances. Whilst there is insufficient tangible evidence to support the notion, it was perceptible that the circumstances in each of these three countries could be traced back to the colonial origins of the countries. This could be an important factor in the establishment of guidelines for school computer projects for other countries in Africa. Another important aspect that emerged from the visits to these three countries, is that the specific organisations visited are involved in the provision of computers on an on-going basis and not on a project basis as per SNSA and i-Learn and SuperCentres Projects. A number of schools in Kenya and Mozambique were also visited. Pertinent information obtained during the visits to the three countries is described below.

In addition, reports describing similar projects outside of Africa, namely Colombia and Canada were also studied and relevant points from these reports are also discussed below.

6.2 NAMIBIA

6.2.1 INTRODUCTION

Namibia is a relatively large but sparsely populated country. It has an area about two-thirds the size of South Africa but a population of only 1.95m The official language is English and other spoken languages include Afrikaans, German and 3 indigenous languages.[17] There are about 1520 schools in Namibia of which only about 30% have basic facilities such as proper ablutions, electricity, telephones and libraries.[18] An ICT policy is in place, prepared by the Resource Network Group, at the request of the Ministry of Foreign Affairs, Information and Broadcasting. SchoolNet Namibia (SNN) is recognised in this policy as a key mechanism in the rollout of ICT in education and job creation.

6.2.2 SCHOOLNET NAMIBIA

SNN was constituted as an association not for gain in February 2000 by Mr Joris Komen. Its main objective is to introduce computer technology and Internet access to all schools in Namibia. SNN facilitates the provision of basic connectivity for all schools in Namibia, through computer refurbishment and other low cost, innovative and alternative technologies and training solutions. To date, some 200 schools have benefited from SNN's activities. A typical SNN installation comprises from 2 to 20 diskless workstations in a thin-client network configuration using Linux as an operating system together with open source software. In addition, SNN operates an ISP service and provides this service to schools free of charge together with connectivity subsidised by Telecom Namibia. Organisational staffing is

[17] www.cia.gov/cia/publications/factbook/geos/wa.html

[18] www.schoolnet.na

volunteer-based. SNN also operates a free Internet Café at its premises just outside Windhoek.

6.3 KENYA

6.3.1 INTRODUCTION

Kenya is about half the size of South Africa with three-quarters the population. There is one official language (English) and one national language (Kiswahili), and many regional languages.[19] English is the language of education. There are 3700 public high schools distributed over 8 provinces.[20] At present, there is no national e-Education policy, however the new Government of Kenya is very supportive of the introduction of computers and related training into schools, as it has set itself the target of the introduction of e-Government by 2007. There are many organisations in Kenya involved in some way or other in the provision of computers and computer training to schools. The most prominent organisation directly involved in the provision of computers for schools is Computers for Schools Kenya (CSFK). Because of its target of the introduction of e-Government by 2007, the Government is very supportive of CFSK's activities if only in indirect means such as the relaxation of customs duties, the speedy approval of work permits for foreign volunteers and the provision of Government buildings for training purposes. No direct financial assistance is forthcoming.

Kenya SchoolNet is another organisation in Kenya involved in computer education in schools. This organisation has not reached critical mass yet but there is significant potential for it to collaborate with CFSK in terms of curriculum development.

6.3.2 COMPUTERS FOR SCHOOLS KENYA

CFSK was established in October 2002 as a not-for-profit NGO whose mission is to provide Kenya's youth with access to modern technology through the donation of computers to Kenyan public schools. CFSK came about as a result of a chance meeting between Mr Tom Musili, the current Executive Director of CFSK, and Mr Wayne Tosh, Manager for Computers for Schools Canada. The ultimate objective of CFSK is to provide at least 20 computers to every public secondary school in Kenya.

CFSK has been very successful since commencing its operations in January 2003 with a very simple business model that eliminates many of the problems experienced on the i-Learn project. CFSK acquires donated second-hand computers, refurbishes these in-house and supplies these to schools as a donation. This donation comprises 20 standalone refurbished computers with no Internet connectivity, together with hands-on technical training down to module level and computer training for the IT educators. In return, schools are obliged to pay a small once-off registration fee for each computer and an annual maintenance fee for each computer. Schools are responsible for all transportation of computers between CFSK and the schools. The maintenance fee covers all repairs carried out at CFSK, the supply of replacement modules to schools, as well as preventive maintenance visits to schools every six months. There is no selection process. Schools are made aware of the availability of donated computers and then apply via the CFSK website. A rigorous readiness programme involving the Boards of Governors of the schools and the local Ministry of Education officials, as well as onsite inspections, ensures that schools are adequately prepared for what they are committing themselves to. All training is carried out in Nairobi free of charge (except for accommodation). CFSK also runs a Help Desk and is involved in curriculum development. Most of the staff of CFSK are volunteers looking for work

[19] www.cia.gov/cia/publications/factbook/geos/wa.html

[20] Participant Interview.

experience. CFSK's income is from the fees charged to schools for the donations as well as in kind donation from many large companies.

After only 14 months of operation, (as at May 2004), CFSK has achieved the following:

- The establishment of an efficient organisation of 32 to 35 people with the internal procedures to:
  - Process requests from schools for computers
  - Provide those schools which are ready, with computers
  - Provide training
  - Provide technical training.
- A website (www.cfsk.org) which provides much information regarding its activities and frequently answered questions.[21]
- A simple on-line procedure for schools to register their request to CFSK to be considered for a donation of computers and training.
- A computer refurbishment workshop with a capacity to refurbish 100 computers per week, equivalent to fulfilling the needs of about 250 schools per year. (4 to 5 schools per week).
- The delivery of over 1000 computers to 56 schools and 13 other institutions.
- Installation at the most remote school in Kenya (Mandera, 450km from Nairobi, on the northern border).
- A training centre situated at the Kenya Science Teachers College, for the training of educators, headmasters and others.
- The training of 122 principals, 136 IT educators and 74 non-IT educators.
- A volunteer programme which provides CFSK with the bulk of its 35 staff members.
- Recognition at Ministerial level of the importance of its work and achievements in the field of computer education amongst the Kenyan youth and educationalists.
- A major interest and involvement by parents in the computer education of their children.
- A significant improvement in learner performance in the Science subjects.
- The leading NGO in its field in Kenya.

6.4 MOZAMBIQUE

6.4.1 INTRODUCTION

Mozambique is about two-thirds the size of South Africa with one third the population. There is one official language (Portuguese) and 17 other languages.[22] The war in Mozambique which only ended in 1992 stifled the development of education in the country. Currently, there are about 8500 schools distributed over 10 provinces. Of the 8500, only 200 are secondary schools and of these only 35 offer matriculation. Only 50% of all schools are supplied with electricity. Since the end of the war however, there has been significant development in the education sector, often exceeding planned objectives.

The Policy interventions in the education sector in Mozambique are guided by the Action Plan for the Reduction of Absolute Poverty, adopted by the Government for 2001-2005, and the Education Sector Strategic Plan, 1999-2003; "Combating exclusion, renewing schools". In December 2000, the Government published its National ICT Policy which, in part, seeks to achieve national ICT literacy and the development of ICT human resources. An ICT Policy Implementation Strategy was prepared, and approved by the Government on the 27th June 2002, which includes the development of SchoolNet Mozambique (SNMoz) as a key flagship project and which will see all secondary schools across the country connected to the Internet and effectively using ICT's to enhance education. The Ministry of Education is

[21] www.cfsk.org

[22] www.cia.gov/cia/publications/factbooks/geos/wa.html

currently revising the Education Sector Strategic Plan in all aspects, including the development of ICT's in secondary schools, technical and vocational schools and teacher training colleges. SNMoz will be integrated into the core education sector programme.

6.4.2 SCHOOLNET MOZAMBIQUE

SchoolNet Mozambique (SNMoz) is now an in-house project of the Mozambican Ministry of Education having started out in 1998 as the Internet para as Escolas, a project based at the Informatic Centre of the Eduardo Mondlane University in Maputo. In 2001, this project was handed over to the Ministry of Education, with the assistance of funding from the IDRC. SNMoz is the vehicle through which the Department of ICT's, within the Ministry of Education, is promoting education through ICT's in order to fulfil the mandate by the Government to create a Mozambican information society.

The Internet para as Escolas project acquired a large number of donated second-hand computers from the World Bank, which it refurbished and supplied to schools, on the nominal basis of 10 computers and 1 server to 13 schools. The networks were loaded with Windows 95 and Office. Due to many problems associated with these old computers, this project was not largely successful. The refurbishment process had to be repeated because of equipment failures. Many incompatibility problems were experienced with replacement parts. After the move of the SNMoz to the Ministry of Education, a quantity of 200 new Pentium 4 Dell computers were purchased and supplied to about 20 schools, in a fat-client network configuration, with Internet access, although the provision of connectivity in the rural areas presents major problems. The networks are loaded with Windows XP and Office 2000.[23]

SNMoz is about to embark on a large refurbishment process, commencing with 100 second-hand computers donated by the Italian Government and 200 donated by the German Government. It is planned that there will be 3 refurbishment centres in the country, one each in Maputo, Beira and Nampula. Accommodation is already available in Maputo at a local technical college. The Italian Government has promised to provide more second-hand computers on an ongoing basis.

In terms of schools acquiring donations of computers, schools take the initiative to apply to the Ministry for a donation. Such requests are handled through the provincial educational directorates who confirm the viability of such requests. In Mozambique, text books are provided free of charge to schools. The same Ministry-funded transportation arrangements are used to deliver the computers to schools. Private companies are contracted to carry out installations, through public tender processes. Completed work is inspected by Ministry staff who then issue the contractor with a certificate of satisfactory installation for payment.

6.5 COLUMBIA

6.5.1 INTRODUCTION

Colombia is about the same size as South Africa and has approximately the same size population and one language, namely Spanish.[24] There are approximately 60000 schools and public colleges distributed throughout its 32 departments and the capital district of Bogota. Computadores par Educar (CPE), Spanish for "Computers for School" was founded

[23] Participant Interview

[24] www.cia.gov/cia/publications/factbooks/geos/wa.html

in 2000 by the president of Columbia, and is based on the Canadian Computers for Schools model.[25] CPE functions within the Colombian Ministry for Communications.

6.5.2 COMPUTADORES PARA EDUCAR

In 2001 and 2002, CPE refurbished and delivered 12131 computers to 1433 schools throughout Colombia. Many of the schools that benefited are located in remote areas requiring transportation over rough roads and even by air and river. Armed conflict is still present in some of these areas. Despite these logistical hardships, a failure rate on delivery of the computers of only 3.6% was experienced. Each school was provided with 15 computers as well as Internet access where connectivity was possible, which is not the case with most of the schools. In the Colombian context, the local municipalities ("mayoralties") are responsible for school premises in their areas, and therefore participated on the process by taking responsibility for the prerequisite school infrastructural modifications.

At each school, a committee was formed to handle the introduction of computers into the school. This committee was made up of the school principal, educators and parents. A significant feature of the CPE rollout is the use of graduate students as "delegates" to assist with the introduction of the computers into the schools. Each delegate is assigned 3 schools in an area and spends 5 months in the area, visiting the 3 schools to assist with educational and technical issues.

CPE is refurbishing and supplying computers to schools as an ongoing process. It has established 5 refurbishment centres and has set strict levels of acceptance of second-hand computers. Formal refurbishment processes are in place. The success that CPE has achieved with its processes is used through public promotion to encourage companies to donate their unwanted computers to CPE. Such companies are treated as customers who donate their computers in exchange for the knowledge and publicity that their computers will be successfully refurbished and distributed to schools who will benefit therefrom. The activities of CPE and the opportunity for schools to receive donated computers is well publicised to schools, who then apply to CPE for such a donation. By April 2003, CPE had delivered 19223 refurbished computers to 2117 schools, benefiting approximately 750000 children and youth across the country.

6.6 CANADA

The Canadian Computers for Schools programme, on which some of the above programmes are based, is managed by Industry Canada, a government agency. The programme was launched to connect all Canadian schools and libraries to the Internet. By mid-2003 it had delivered over 425000 refurbished computers to over 16000 schools and 3500 libraries, having commenced 10 years earlier.[26]

[25] Computers for Schools: Enriching the Education of New Generations of Colombians, March 2003

[26] SchoolNet, Fall 2003 p.3.

7. CONCLUSIONS

7.1 INTRODUCTION

It is clear from the developments that took place on the SuperCentres and i-Learn Projects that both projects had their problems, although the i-Learn Project suffered much more than the SuperCentres Project. From the analysis of the developments during the projects, it must be concluded that the planned timescales for the projects were too short, the project team was under-resourced, and certain processes that were put in place were inadequate. In addition, the pressure on the i-Learn Project to provide as many computers as possible within a limited budget led to the use of refurbished computers with near end-of-life hard disk drives (ie a high hard disk drive failure rate was experienced), and which were inadequate for the preferred software, in turn leading to the adoption of a hybrid thin/fat client architecture which in itself, brought in a few more problems. Project participants concur with this conclusion.

The first two tasks on both projects which were critical to the commencement of the network installations, namely the schools selection process and the establishment of supplier contracts took about five to six months longer than the planned four months. The schools selection process turned out to be a much longer process involving protracted engagements with the DoE's. Likewise the tendering process in the case of the i-Learn Project and the Telkom internal contracting process in the case of the SuperCentres Project, were both more involved than anticipated.

The decision to change the educator training from face-to-face to mentor-led distance training (with good reason) made the successful delivery and sustainability of the computer networks, in terms of the way in which the projects were designed, a prerequisite for the provision of educator training. On the SuperCentres Project, the delivery of networks was delayed by large thefts but by and large was completed on time. Full sustainability of these networks was ensured by Telkom's ITX Division. By contrast, the delivery of the i-Learn networks suffered extensive delays and the functioning of these networks became unsustainable. At the time of the Telkom ITX Audit four months after the end of the i-Learn project, and in terms of the audit results, only 81% of the installed networks were functioning (as networks) and at only 52% of the schools could the educators participate in distance training. This contrast between the end-results of the two projects draws focus onto one particular difference in the implementation of the two projects, namely the use of refurbished computers on the i-Learn project.

Conclusions regarding the use of refurbished computers and project processes are discussed in detail below, drawing on the experiences in other countries and concepts from various sources.

7.2 USE OF REFURBISHED COMPUTERS

7.2.1 INTRODUCTION

Whilst the use of refurbished computers on the i-Learn Project did add to the set of problems experienced on this project, these computers were certainly not the root cause of all the problems incurred. As indicated above, the first delays incurred, on both projects, were unrelated to the type of computer utilised. The liquidation of the Siltek Group caused a delay of about five months to the i-Learn Project, but this delay was primarily in the supply of new computers, not refurbished computers (although this supplier also went into liquidation later). In fact, according to various reports, the new Sahara computers which replaced the Siltek-sourced computers gave as much if not more trouble than the refurbished computers. Where refurbished computers did exacerbate the project problems, was in the increased demand for repairs of the refurbished computers due to the large number of hard disk drive failures.

As discussed in the previous Chapter, many organisations in other countries have experienced much success with the use of refurbished computers. In Africa, Kenya and Namibia utilise only refurbished computers as work stations, in their on-going activities. In Canada, over 400000 second-hand computers have been refurbished and put to good use in schools and libraries, over the last ten years. At the same time, many organisations have had unfortunate experiences with these computers. Analysis of these experiences indicates that appropriate selection and refurbishment processes are the key to success. This is discussed further below.

7.2.2 REFURBISHMENT PROCESSES

From the projects investigated, one specific message regarding the bad experiences in the use of refurbished computers is particularly clear; many of the computers donated at the end of the '90's were in such a poor condition, that problems in their re-use were inevitable. Many of these computers had been in use for a long time and had suffered more physical abuse than computers donated in more recent times. As a result, electro-magnetic devices, namely power supplies, hard disk drives, floppy disk drives and, to a lesser extent, CD-ROMs had become over-stressed and lacking in capacity for a new life as a refurbished computer. The age of the older computers, containing 486 and Pentium I processors (as used on the i-Learn project), donated to refurbishment centres, was greater than the age of more recently donated computers, containing Pentium II, Pentium III and Pentium 4 processors. This can be attributed to a number of factors.

Firstly, it is probable that the older computers lay in storage for several years awaiting a decision on their fate, whereas newer computers are timeously dispatched to refurbishment centres, both commercial and non-profit. (Old 286 processor-based computers are still present in some South African school stores, awaiting a decision on their fate). Secondly the first life of newer computers is shorter due to changes in procurement policies in that in large organisations, computers are more often leased than purchased outright and therefore upgraded more readily. The desire to upgrade more readily has been driven by the fairly rapid development of the Microsoft Windows operating system from Windows 95 to the more stable and preferable Windows XP. (Microsoft is currently experiencing its longest ever lag between major Windows releases). Of course, the need to upgrade the operating system more rapidly has also been driven by the marketing decisions of Microsoft in terms of which operating systems it will no longer provide support for (currently none older than Windows 2000).

As the use of and dependence upon computers in all sectors has grown over recent years, so the care of computers has increased with the greater use of UPS's to reduce mains-borne surges and harmonic frequencies thereby reducing the electrical stress to electronic components in the power supplies. Likewise, with the use of UPS's, there is a greater tendency to leave computers switched on overnight, and therefore reduce even more the stressing of components due to on-off power surges.[27]

It is therefore posited that newer used computers, containing Pentium II, Pentium III and Pentium 4 processors, with the appropriate attention given to the electro-magnetic devices, will provide a longer and more reliable second life than that experienced with older used computers. This is supported by reports of positive experiences where (amongst other factors) the policy has been to not use 486 processor-based computers, and to replace Pentium I processor-based computers as expediently as possible.

Not withstanding the above statement, there are some other hardware factors that need to be taken into consideration in the use of second hand computers. Experience in various projects has shown that the use of used peripheral devices such as keyboards and mice is not always warranted and that when future logistic support costs are taken into account, it

[27] The Effect of Power Cycling on Reliability, Internal Study, Ian Braid, 1975

is often wiser to replace such second hand devices with new devices. In addition, used computers sourced from foreign-language countries often have different keyboards which can create unnecessary difficulties for the inexperienced user. Experience has also shown that refurbished brand-name computers can withstand the rigours of school use (and abuse) much more than newly purchased clones (unbranded computers) where keyboards and on/off switches have a tendency to break more easily.

The use of newer versions of the Windows operating system has become imperative in order to run newer applications. In addition it is necessary to move to newer versions because of the marketing decision of Microsoft not to provide support for older versions of Windows. This enforces the use of computers with Pentium II processors and above as the older 486 and Pentium I processor-based computers were not intended to be used with versions of Windows newer than Windows 95 and Windows NT.

It has also been the experience in the refurbishment process of older computers, that where peripherals have had to be replaced, difficulties have been experienced in obtaining suitable drivers for the replacement peripherals

Whilst many basic combinations and permutations of architecture and operating system are possible, three appear to predominate in current projects. Firstly, Microsoft products are generally utilised with standalone computers, and secondly either Microsoft products are used with fat-client networks or open-source software is used with thin-client networks.

The recent decision by Microsoft to provide its products free of licence charges to schools has eliminated this expense, at least for the time being. It is also understood that this financial relief only applies to the older Microsoft products.

In the meantime, the Linux open-source operating system has undergone much development to become a significantly improved platform in terms of stability. With the aim of reducing logistical costs, many organisations have chosen to go the thin-client route in combination with the licence-free application of Linux plus other open-source software. As a result of the bad experiences resulting from the use of disk-based thin client configurations, several organisations have developed the diskless alternative. In this configuration, the moving parts, ie HDD's, FDD's and CD-ROM's are removed from terminals thus reducing the load on the computer power supplies and UPS's and hence, in combination, significantly increasing the reliability of the terminals. Such increased reliability, together with the use of the Linux operating system on the network server, reduces the direct maintenance costs and facilitates remote on-line support. In addition, centralised software upgrades, either server-based or remote, are possible.

It has been reported that where refurbished computers have been used and the original packaging material has been lost, damage has occurred to the computers in transit due to the absence of comparable packaging material.

In addition, problems have occurred with older computers where plug-in modules are a feature of the design, as compared to newer computers which tend to have a single board design. Again in respect of the use of older computers, problems have occurred where in the dispatch of computers to schools, computers and their original monitors have become separated and incompatibility problems with video drivers have occurred.

The above has attempted to indicate that the use of refurbished computers can be successful and that such a decision should not be negatively influenced by past poor experiences. However, as indicated above, such a decision should only be made after a thorough analysis of the specific requirements of a project in hand and with due regard to the constraints applicable to that project. In addition, the decision cannot be made in isolation of the decisions regarding software and the network architecture. It must be emphasised again that certain guidelines should be followed in order to ensure success.

These guidelines include the following:

- Select only Pentium II processor-based computers or newer (some relaxation of this is viable in the case of diskless thin-client Linux-based networks);
- Select only branded computers;
- Standardise on a make and model of computer as much as possible, specifically within one network;
- Replace keyboards and mice with new devices;
- Consider purchasing new monitors if affordable;
- Apply a formalised, structured and consistent refurbishing process which includes adequate functional, compatibility and burn-in testing;
- Build the network for a specific site at the Refurbishment Centre using the actual items intended for that site, and carry out adequate network functional, compatibility and burn-in testing;
- Package the items appropriately for the form of transport;
- Repeat the network functional and burn-in tests on site once the network has been built; and
- Record details of the final network configuration in terms of model numbers, serial numbers, software versions, etc.

7.2.3 CONCLUSIONS

Whilst the ideal situation is to make use of new computers, the financial situation may dictate considering the use of lower cost refurbished computers. The significant successes that have been experienced in other countries together with the adherence to guidelines in the refurbishing process justify the conclusion that refurbished computers, if properly selected and refurbished, are suitable for schools. Refurbished computers can be considered to be just another item in the toolbox of the solution designer. The decision to utilise refurbished computers or new computers is not a simple one and is impacted by other decisions such as the selection of thin-client or fat-client architecture, diskless or disk-based computers and the use of proprietary or open-source software. The decision on refurbished or new computers should only be based on the results of the analysis of the specific requirements of a particular project, the constraints imposed on that particular project, and the intention as to whether to adhere to a number of empirically-derived guidelines or not.

7.3 PROJECT PROCESSES

7.3.1 INTRODUCTION

Formal project processes were applied and adhered to in the execution of the i-Learn and SuperCentres Projects. It can be said that what was achieved (in a positive sense) was due to this adherence, in the light of the various problems that did occur, particularly in the case of the i-Learn Project. Comment on the application of some of the processes is appropriate.

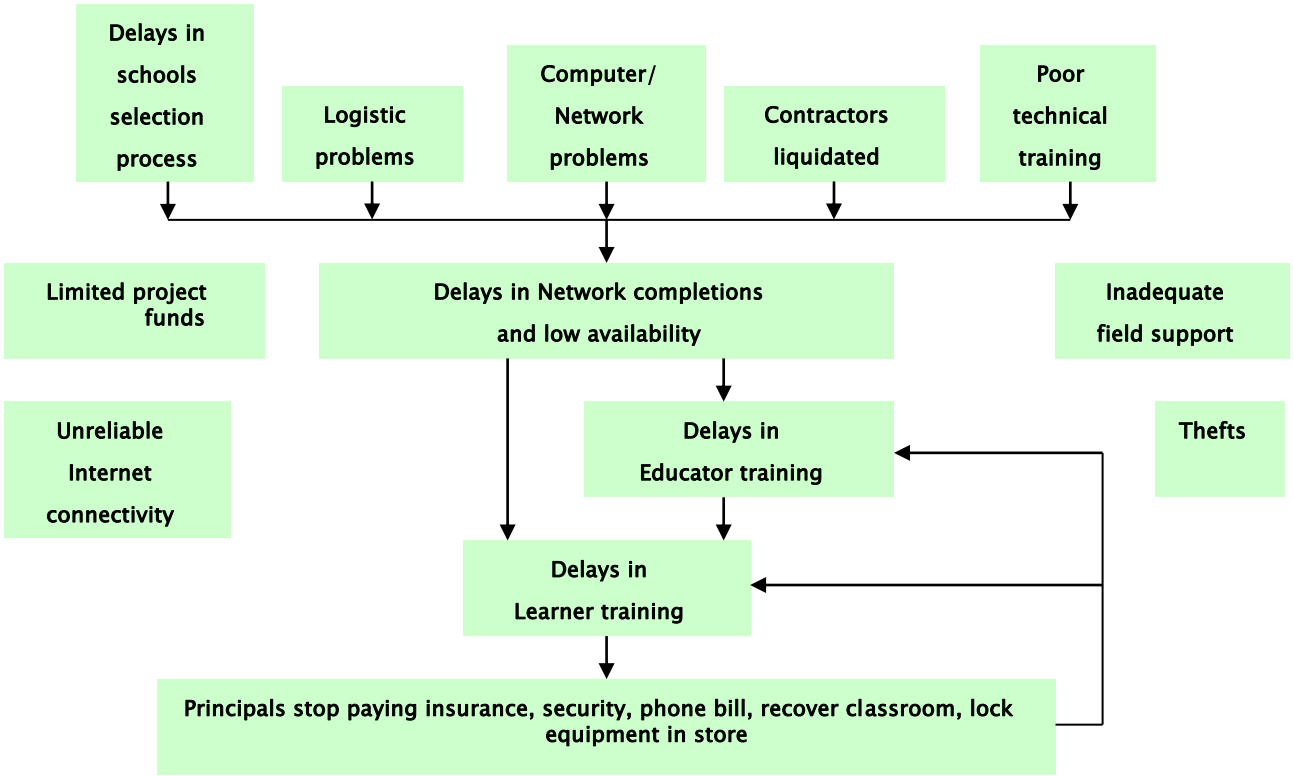
In the execution of the projects there was strict adherence to timescales and budget. When the last network was installed, within the two year period and within the project management budget, the project was closed, notwithstanding the fact that at this stage there were still many i-Learn networks that were not fully working. Within the monitoring task there appears to have been little in the form of verification procedures by a part of the organisation, separate from the implementation team. The final testing of installed networks appears to have been no more than a check that each terminal logged into the server. A formal written acceptance test procedure, carried out by someone in the project but separate from the installation team, ie someone from SNSA but not from NetDay, would have brought out problems before the network was handed over to a school. This is

especially true if the acceptance test was carried out after a soak test in which the network was left running for a few hours or even days, whilst being used by educators and learners.

SNSA chose to contract out the implementation of the projects largely to a single contractor namely SourceCom, because of a lack of project management and execution resources within SNSA. As it happened, many of the problems that were experienced, occurred in the environment of the subcontractors of SourceCom, and because of a lack of attention and involvement by SourceCom management, SNSA staff were forced to become involved in subcontractor issues anyway. It is possible that if SNSA had retained direct control of more of the project activities itself, even by temporarily increasing its resources, some of the problems experienced could have been resolved more expediently.

One particular issue that has become very apparent in the execution of projects of this nature, and is of great importance to future projects, is that **once a project of this nature commences, and schools become enthusiastic about the pending arrival of computers and new skills, the implementation teams have only a very narrow window of opportunity to get to a school and successfully install and commission a network, no matter what its complexity is.** The reason for this is two-fold. Firstly, if the school's expectations are not fulfilled in a short period of time, enthusiasm wanes rapidly, and secondly, from the time that it is confirmed that a school will receive a network, it has to absorb a large number of costs in terms of security, insurance, training, building modifications, telephone lines, as well as the loss of a major resource, namely a classroom. It is quite apparent on the i-Learn project that when expected results were not forthcoming due to the numerous problems experienced, disillusionment set in very quickly. Unfortunately this scenario begins to feed itself until principals take the matter into their own hands and shut down the computer classrooms, as happened at many schools. This process is illustrated here in Figure 1:

Figure 1: Effect of Delays on Educator Training



Further analysis of the processes applied in the projects is given below, structured in terms of the six specific objectives set for this research.

7.3.2 READINESS

An extensive schools selection process was adopted to select schools to receive computer networks from the two projects. The process led to protracted engagements with some of the provincial DoE's, and as reported, some disagreement in terms selection criteria to be applied.

In contrast, CFSK has chosen a much simpler schools-driven process in which schools take the initiative to register an interest in receiving a donation of computers by applying online (via private or other computers) via the CFSK website. CFSK's concept is that schools must have a want to acquire computers, and an understanding of the implications of this want. Schools are encouraged to decide for themselves when they are ready and can afford to go ahead with the acquisition of computers. This is to ensure that schools become committed to the acquisition process and will follow through with the financial and other commitments which the process will impose on the schools.

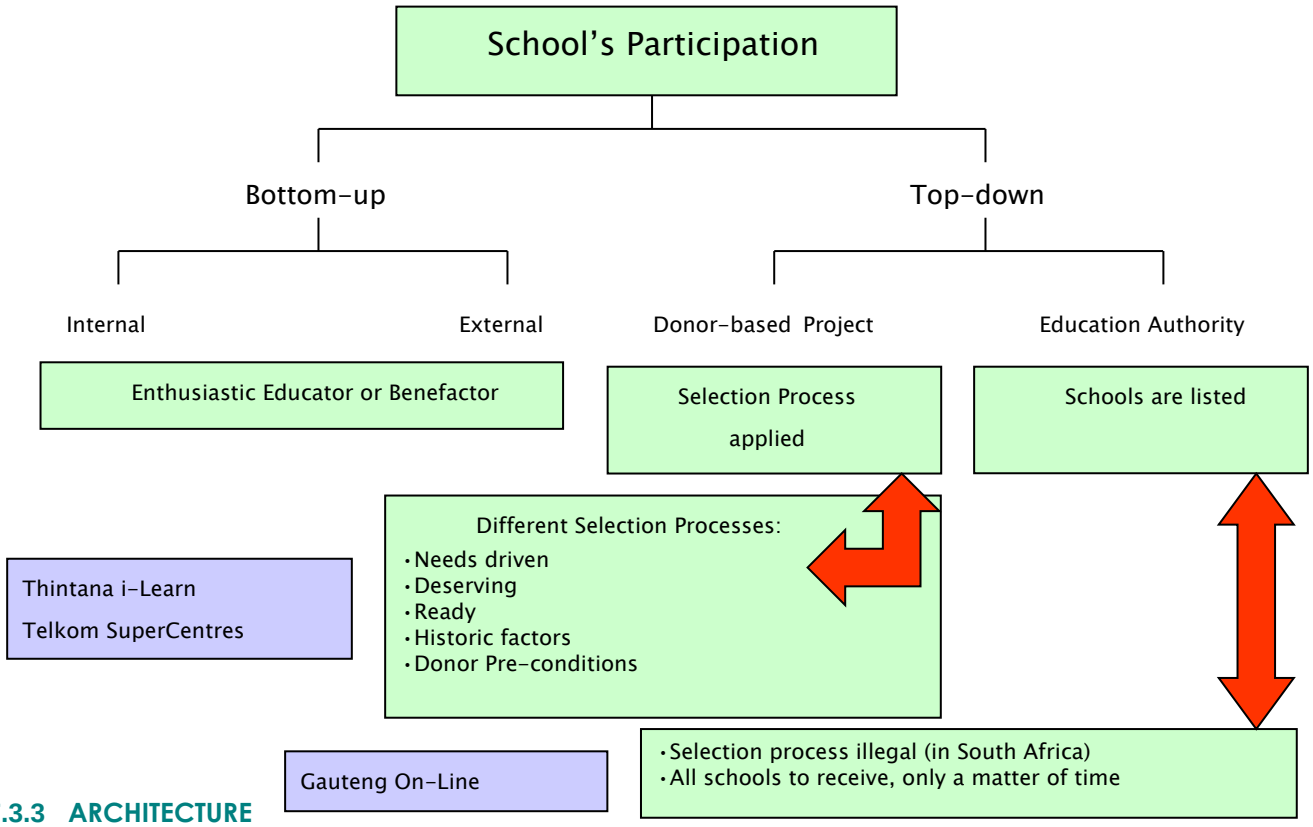
The onus is therefore on the school to prove that it fulfils certain criteria including educator/governor/parent buy-in as well as support from the District Education Officer, all in the form of written minutes and letters. Computers are not made available until such documentation is received and validated, educators, school administrators and parents (members of Parent/Teacher Associations and Boards of Governors) have been on training and sensitisation courses (at their own travel and accommodation costs), school prerequisites (electricity, security, etc) have been confirmed, a trained IT educator is in place, and prescribed fees have been paid. Whilst some details may appear the same between the two approaches, in the CFSK approach, much more tangible commitment is extracted from the school and its community, than can ever be achieved via the writing of a business plan which may never be consulted again after the selection process is over.

The fundamental difference between the two approaches is that in Kenya the schools are effectively selecting themselves, as opposed to being selected as in the i-Learn and SuperCentres projects. It must have been extremely disheartening for a South African school to be preselected, spend time creating enthusiasm within the school community and preparing a business plan, only to be informed that it had not been selected. Suspicions must have been aroused regarding the motives of the donors and DoE officials. In contrast, in Kenya if a school did not succeed through the process, it only had itself to blame or it was based on a logical decision due to a lack of funds or similar.

It is suggested that in the ultimate scenario, the provision of computer infrastructure to schools is no different to the provision of books or science laboratories to schools today, that is, it becomes a DoE responsibility and eventually every school will receive computer infrastructure. In this scenario, there is no selection process, only a verification process that the school is ready. It is then reasonable to state that the current situation is one of transition and this is illustrated in the following Figure 2: Schools' Participation Model. Here the transition from a bottom-up enthusiastic educator or benefactor driven process through to the ultimate education authority driven process is illustrated. Many of the early schools networks referred to in para. 2.1 fit the enthusiastic educator/benefactor part of the model, whereas the current Gauteng On-Line project of the Gauteng Provincial Government (GPG) fits the education authority-driven part of the model. In fact the Gauteng Department of Education (GDE) has taken the approach that it is illegal for it, as a public authority, to apply a selection process which benefits one school over another, and hence is now providing all schools within its jurisdiction with computers.

The general notion therefore is that, having made it known that computers are available to schools, schools should effectively select themselves to receive such computers by convincing the relevant organisation or authority that the school is ready in terms of commitment, community buy-in, prerequisites in place, training completed and the availability of funds. When it comes to ensuring that the school is physically ready to receive computer infrastructure, there is no alternative to the discipline of actually visiting and inspecting the necessary facilities at the school.

Figure 2: Schools' Participation Model



7.3.3 ARCHITECTURE

Whilst the SuperCentres computer networks utilised the commercially popular fat-client architecture with new computers running proprietary Microsoft Windows operating system and Microsoft Office applications, the i-Learn networks utilised a combination of new and disk-based refurbished computers in a hybrid thin/fat-client architecture running Microsoft Windows and Office applications. Both configurations included Internet access. Whilst the use of the thin-client architecture has been justified on an economic basis (more refurbished computers within a limited budget), this did create additional availability and support problems in that when an i-Learn server failed so did the whole network effectively, secondly because of inadequate technical training, the concept of thin-client networking was not clearly understood by many of the educators (and those who carried out the audit) leading to complaints about not being able to access hard disk drives and floppy disk drives which effectively had been disabled, and thirdly because of the increased vulnerability of the disk-based computers.

The decision to change the educator training from face-to-face to mentor-led distance training made the provision of Internet access critical to the provision of distance training. It was observed by SAIDE during the evaluation that it was found that in many schools, there was evidence to suggest that the educators and learners were not making use of the Internet because of a lack of the necessary skills, or because of a lack of policy regarding the use of the Internet. Siluma argues that, based on research carried out in 45 schools, there is little use, if any, made of the Internet for a variety of reasons but mainly because of costs and lack of skills.[28]

[28] The Internet: Should this [be a] priority in Schools Networking in Africa?: Paper by Ephraim Siluma, Researcher SAIDE

The full application of the system engineering process forces network architects to address all requirements fully, and in the context of the constraints imposed on a project. In the i-Learn Project, the critical provision of Internet access for the educator training programme could have been addressed initially with the supply of only one computer and the modem, giving more time for the remainder of the network to be built and the opportunity to address the ensuing problems that occurred with less pressure.

In contrast to the i-Learn and SuperCentres networks, CFSK provides Kenyan schools with standalone computers only and with no Internet access (because of the prohibitive costs involved). This solution simplifies many aspects in terms of costs, implementation, technical training and support. SNN is providing networks to schools in Namibia which comprise a new server with refurbished diskless computers running open source Linux operating system and other open source software in a thin-client configuration. Because the workstations are diskless running in a Linux environment, the power consumption is lower and there are no moving parts resulting in greater reliability.

Cohen (2003) suggests that a continuum of use of computers in schools appears to exist and that it is possible to impose 8 levels of use in this continuum.[29] What is also possible is, through the application of the system engineering process, to analyse the requirements of each level and to predetermine the optimum system architecture and related performance and support issues for each solution for each level, thereby creating a matrix of school needs with matching technical solutions. These technical solutions could be structured to include various proprietary offerings, not just those of Microsoft but others such as Sun Microsystems and Apple Macintosh, as well as open source solutions and various network configurations including fat-client, thin-client, hybrid thin/fat-client, disk-based and diskless computers.

It is also possible to double the number of options by taking into account the feasibility of Internet access. In addition, a financial model can be attached providing the costs associated with each selected level. Then, as needs arise, implementing organisations can consult the matrix to determine to optimum solution for the circumstances or needs, as well as the associated costs. As technologies change and educational needs expand, so the matrix of needs and matching solutions can be adjusted or expanded.

7.3.4 AVAILABILITY

From the study of reports and from direct discussions with educators and schools both in South Africa and in other countries, it is quite clear that once a computer network (or set of standalone computers) is installed in a school, and is suitably supported, it quickly acquires the status of "mission critical". A successful installation fuels its own success and the school, educators and learners quickly become reliant upon the network, even if only to quench a thirst for learning. Educators report a marked improvement in classroom discipline, if only for the class period, whilst learners are using computers. This implies that networks need to be designed, implemented and supported to such a degree that a high availability is achieved. It appears from discussions with educators, that no more than one 24 hour network failure per term can be tolerated before planned lessons become seriously disrupted. This implies a system availability of 98.9% and a service level agreement of repair before the end of the next business day. This also implies a system mean time between failures of about 2158 hours. This determination is somewhat simplistic as a system failure is not defined and there is much redundancy in a network, ie one or more failed computers do not constitute a system failure. However it does illustrate the level of importance that should be attached to network design.

7.3.5 FUND RAISING

[29] Report on the Use of ICTs in Schools Research Project June 2003 (Draft Research Report): Sue Cohen, June 2003

On the i-Learn Project, it was the intention that schools would take on the responsibility for the support of their networks and would either undertake or pay external parties for the maintenance of their networks. Whilst there may be many novel ideas regarding the ways in which school communities can raise funds, it is clear that the communities who are generally the beneficiaries of donated computers are poor, to the extent that any form of fundraising will be unsuccessful. The possible exception to this is the running of skills development courses utilising the donated computers, such as in the development of tourism industry workers. It is therefore essential that in projects of this nature, adequate provision is made within the project budget to accommodate the costs associated with network maintenance for a period of time until the performance of networks has stabilised and there is a clear appreciation of the level of costs involved. The situation can be alleviated by negotiating the longest possible warranty periods still at a reasonable cost. This was attempted on the i-Learn Project by requesting FreeCom to quote for an extension of the warranty period of from three months to one year. FreeCom quoted R1m, the equivalent of another 500 refurbished computers. If a reasonable extended warranty cannot be negotiated, then an alternative is to obtain an undertaking by the supplier to repair at a reasonable price for at least 3 years any equipment supplied. (In the professional telecommunications world this period is typically 10 years).

Overall, it is out of the question to burden poor schools with the issue of sustainability of their networks. Poor schools have so many other items to finance, specifically salaries of temporary teachers. Such schools are caught in a Catch 22 situation or having either a high learner-educator ratio and a lower level of performance, or to self-fund additional educators and have less funding available for other items.

7.3.6 INTERNET

i-Learn schools were provided with analogue 56kb/s Internet connectivity, whilst SuperCentres schools were fortunate to be provided with 64kb/s ISDN connectivity. The latter option is a digital solution and therefore a much higher grade of service is achieved, although this service has a limited range compared to the analogue 56kb/s solution. Another major advantage of ISDN is that the infrastructure actually provides two 64kb/s channels, allowing one channel to be used for data and the other for a telephone in the computer room, or for the second channel to also be used as a data channel also at 64kb/s. Current Telkom SA rates for these services are R79.00/month for 56kb/s, R114.00/month for 64kb/s ISDN and R198.00/month for 128kb/s ISDN.[30]

Various always-on broadband services are also available but at much higher prices.

In determining which form of Internet connectivity to select, it is best to analyse the requirements, rather than just assume analogue dialup or 64kb/s ISDN. The additional cost from the beginning may outweigh the frustration caused to a large group of users who are expected to make significant concurrent use of the Internet. Analogue connectivity can handle between 5 and 10 users browsing the Internet at the same time without becoming too slow. 64kb/s ISDN can accommodate up to 20 users and 128kb/s double that quantity.

Likewise, it is best to verify the requirements for Internet access where high email or high web browsing traffic can be expected to determine whether a separate server is required or whether the main file server can handle the traffic without slowing down the network to any significant degree.

7.3.7 SUPPORT

Clearly the type of technical training that was provided on the two projects was network administrator type training and not technical training. This implies that if educators were expected to take on the responsibility for technical maintenance of their networks they

[30] www.telkomsa.net

were going to have to do it without any training, notwithstanding the additional complexities of the hybrid thin-client architecture in the case of the i-Learn networks. CFSK addressed the problem of support by firstly providing standalone computers without the complexities of a network, and secondly by training the IT educators to fault-find and repair computers down to module level. This is an ideal solution for where standalone computers are utilised and should be given serious consideration when designing new projects. However where it is decided that networked computers are required, then it is imperative to include ongoing field support as a part of the delivery in a project, certainly until a skilled person is available within the school community.

Whilst it may seem to conflict with what is stated in para 7.3.5 above, it is worth considering charging schools up front for the maintenance for the year ahead and receiving the payment in advance. This will ensure that funds are available to pay for local maintenance, and also that a school fully understands what it costs to acquire a computer network. This approach is taken in Kenya by CFSK.

7.3.8 CONCLUSIONS

Formal project processes were applied and adhered to in the execution of the i-Learn and SuperCentres Projects. It can be said that what was achieved (in a positive sense) was due to this adherence, in the light of the various problems that did occur, particularly in the case of the i-Learn Project. There is scope on future projects to expand on the processes used and to apply a more systematic approach when it comes to requirements analysis, system design and verification processes.

8. RECOMMENDATIONS

8.1 INTRODUCTION

Many ideas, concepts and suggestions have been made in the preceding Chapter in terms of the provision of computer to schools, and the provision of educator training in the use of computers. All these points are summarised here, with further points, structured in terms of 3 levels, namely the Implementation Level, the Organisation Level and the National Level.

8.2 IMPLEMENTATION LEVEL

In terms of future fixed term projects of the nature of the i-Learn and SuperCentres Projects, several ideas and concepts have been discussed in the previous Chapter, based on developments in the two projects and supported by ideas and experiences from other countries and some theoretical ideas based on empirical data. For completeness, a summary is provided here of the main recommendations that are made at the Implementation Level:

Readiness

Schools should effectively select themselves to receive such computers by convincing the relevant organisation or authority that the school is ready in terms of commitment, community buy-in, prerequisites in place, training completed and the availability of funds. When it comes to ensuring that the school is physically ready to receive computer infrastructure, there is no alternative to the discipline of actually visiting and inspecting the necessary facilities at the school.

Architecture

The system engineering process should be utilised to establish the project requirements fully within the context of the constraints imposed on a project. A matrix of school needs and optimum technical solutions with costs can be used to design a particular project.

Availability

It should be recognised that a successful school computer network installation quickly becomes mission critical. A system down-time not exceeding one day per term is acceptable and a failed system needs to be restored before the end of the next business day.

Fund Raising

It is essential to budget for network maintenance as poor schools will not be able to finance such costs. In addition it is necessary to negotiate for the longest equipment warranty possible without an inordinate increase in costs.

Internet

Careful analysis of the Internet connectivity requirements is necessary before deciding on the form of Internet connectivity to be provided, and whether a separate server is possibly required or not.

Support

Where standalone computers are to be used then technical training should be provided down to module level. However where it is decided that networked computers are required, then it is imperative to include ongoing field support as a part of the delivery in a project, certainly until a skilled person is available within the school community.

8.3 ORGANISATIONAL LEVEL

With respect to SNSA itself and future projects, what stands out is the preferred situation of on-going implementation in terms of delivering computer infrastructure and training to schools, rather than fixed term projects such as the i-Learn and SuperCentres Projects. The benefits of this business model can be seen in the successes which CFSK, SNN and others have and are experiencing. This would enable SNSA to develop in-house skills and resources for large scale implementation of school computer networks, rather than rely on external resources which, as experienced here, actually require additional project management skills and resources.

8.4 NATIONAL LEVEL

On a national level, it has been suggested earlier that the ultimate scenario is one which is no different to the provision of text books or the provision of science laboratories to schools and is led and directed by the National DoE through the provincial DoE's. This is not to suggest that all implementation and donor-based organisations will disappear to be replaced by DoE-based implementation departments. On the contrary, it is possible for a service and supply industry to be established to support the provision of computer infrastructure and training, but functioning within a framework as set out by the National DoE and governed by the provincial DoE's. At this stage the White Paper on e-Education is in the process of being approved and will provide a national policy within which such a framework could be established.[31]

There are currently many organisations in South Africa involved in the supply of computers and computer training to schools and community centres, sponsored by large local companies and multinational corporates, keen to fulfil their corporate social responsibilities. Unfortunately many of these projects rapidly become unsustainable. Much could be gained from a degree of co-ordination between such projects, in order to address this problem. Unfortunately this is not always in line with the objectives of the large corporates who are typically keen to spend some money and gain exposure in as short a time as possible. Further, the aspect of on-going financial support to provide for maintenance and ongoing training as well as hardware and software upgrades is also not always an attractive proposition to the corporates. Notwithstanding these points, it is recommended that steps be taken to encourage the development of a service and supply industry to support the provision of computer infrastructure and training.

8.5 RECOMMENDATIONS FOR FURTHER RESEARCH

8.5.1 COMPUTER USAGE IN SCHOOLS MODEL

Cohen (2003) suggests that a continuum of use of computers in schools appears to exist and that it is possible to impose 8 levels of use in this continuum. What is also possible is, through the application of the system engineering process, to analyse the requirements of each level and to predetermine the optimum system architecture and related performance and support issues for each solution for each level, thereby creating a matrix of school needs with matching technical solutions. These technical solutions could be structured to include various proprietary offerings, not just those of Microsoft but others such as Sun Microsystems and Apple Macintosh, as well as open source solutions and various network configurations including fat-client, thin-client, hybrid thin/fat-client, disk-based and diskless computers. In addition, a financial model can be attached providing the costs associated with each selected level.

[31] Draft White Paper on e-Education: Department of Education, September 2003

It would be useful to all future projects to develop this model further in terms of the levels of use, the optimum system solutions and the associated financial model.

8.5.2 ELECTRIFICATION OF SCHOOLS

One critical prerequisite to the provision of computer infrastructure to schools, specifically rural schools in disadvantaged areas, that appears to receive little attention, primarily because it is outside of the scope of delivery of the DoE's, is the electrification of these schools. According to the latest official published statistics on the distribution of electricity in South Africa, only 44% of South African schools are provided with electricity, including both grid and non-grid sources.[32] This implies that nearly 14000 schools need to be connected and it can be safely assumed that the majority of these schools must be in rural disadvantaged areas. If South Africa wishes to proceed with the improvement in the provision of education in South African schools by supplementing existing educational processes with technology as the delivery platform, on an equitable basis, then this issue requires urgent attention.

The provision of grid electricity in rural areas is unfortunately an expensive undertaking and is also unfortunately not just a simple matter of raising the requisite finance. Distributing electricity over long distances, even just a few kilometres has technical implications in terms of the stability of supply, particularly with such a low load that a school would present. This suggests that the electrification of schools should be carried out in conjunction with the electrification of other more significant users in the same area. This does however suggest the situation of " the tail wagging the dog".

Various forms of non-grid electricity are possible but none can as yet be described as sustainable or economically viable. Solar electricity is in use in some instances but is very expensive, requires regular maintenance and the on-going replacement of batteries, and is prone to theft. On a current Government-funded project to provide solar power to 1150 schools, the cost per school is over R100000 per school, about the same as a computer network. After three months, not a single school has been electrified yet. On two earlier projects intended to benefit 2340 schools, about 90% of the solar systems are no longer functional. Small portable and fixed petrol or diesel generators are also expensive to run, require a high level of maintenance, have environmental implications and are subject to theft and abuse. There is however still scope for other novel sources of electricity.

Whatever the source of electricity, what is important is to obtain a clear understanding of how these 14000 schools will receive electricity, if at all, and how this provision will be funded and over what timescales, even if the solution requires drastic action such as moving the schools to the electricity rather than the other way round. Whilst it can be argued that rural disadvantaged schools have greater needs than electricity, eg drinking water, sanitation, etc, it is suggested that the provision of electricity to these schools and their communities will act as a catalyst to the fulfilment of these other needs.

[32] Lighting up South Africa: National Electricity Regulator, 2002

9. APPENDICES

9.1 APPENDIX A: ABBREVIATIONS

CD	Compact Disk
CD-ROM	Compact Disk Read Only Memory
CFSK	Computers for Schools Kenya
CPE	Computadore para Educar
DoE	Department of Education
FDD	Floppy Disk Drive (known as a Stiffy Disk Drive in South Africa)
GB	Gigabyte
GDE	Gauteng Department of Education
GPG	Gauteng Provincial Government
HDD	Hard Disk Drive
ICT	Information and Communication Technologies
IDRC	International Development Research Centre
IICD	International Institute for Communication and Development
ISP	Internet Service Provider
IT	Information Technology
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
kb/s	Kilobits per second
LAN	Local Area Network
MB	Megabyte
MHz	MegaHerz
MS	Microsoft
MST	Mathematics, Science and Technology
NDS	National Data Systems
NGO	Non-Government Organisation
OSF	Open Society Foundation
para	Paragraph
SAIDE	South African Institute for Distance Education
SNMoz	SchoolNet Mozambique
SNN	SchoolNet Namibia
SNSA	SchoolNet SA
SOW	Statement of Work
UPS	Uninterruptible Power Supply
WCSN	Western Cape Schools Network

WorLD World Links for Development

9.2 APPENDIX B: TECHNICAL DELIVERY PERFORMANCE ANALYSIS

A physical audit of the 200 computer networks delivered in terms of the i-Learn Project was carried out by the Telkom ITX Division (Telkom's IT Service Delivery Division prepared the report) at the end of 2002, at the request of Thintana. The audit was carried out using a mixture of ITX staff and subcontractors, and a detailed quantified database of statistics was prepared. The information gathered included the following, on a per school basis:

- Physical address and contact names and numbers;
- Infrastructure prerequisites in order (ie security, insurance, etc);
- Quantities of equipment delivered;
- Quantities of equipment present, installed and available for use;
- Quantities of equipment stolen, faulty, not returned from repairs;
- Working Internet access; and
- Degree of lightning activity in the area.

The technical delivery objective of the i-Learn Project can be stated as the provision of 200 schools with computer networks with dial-up Internet access, using a mixture of new and refurbished computers, and the confirmation that schools had electricity, security, insurance cover and a telephone line in place.

This can be disaggregated into:

a) Confirmation of the presence of:
    - Insurance
    - A security system
    - Burglar bars
    - Electricity

and

b) The supply, installation, commissioning and current functioning (at the time of the audit) of the following network items:
    - 14 computers
    - 1 server
    - 1 printer
    - 1 cabinet
    - Cabling
    - 1 UPS

The ultimate success of execution of this technical delivery objective can be measured in terms of the proportion of the complete provision of all of these items that were actually provided to the total number of schools involved in the project. In other words, if 14 computers were actually delivered, installed, successfully commissioned and currently still functioning in only 180 out of 200 schools, then the Technical Delivery Performance would be rated as 90% for this item. Taking the total number of schools at which all the requirements were completely fulfilled as a ratio of 200 would give the overall Technical Delivery Performance for the whole project.

Although the overall project plan was to provide 200 schools with computer networks, by the time the audit was carried out, there were actually 205 schools that had benefited from the

project. Using data obtained from the audit, the following Table B1indicates the Technical Delivery Performance for complete confirmation/supply of each of the items as indicated above, as well as overall performance of the project:

TABLE B1: Technical Delivery Performance, All Criteria

ITEM	QUANTITY	%
Insurance	161	79
Security Alarm	187	91
Security Bars	195	95
Electricity	202	99
14 Networked working computers	121	59
1 Server	165	81
1 Printer	180	88
1 Cabinet installed	75	37
1 UPS	150	73
Cabling	187	91
Working Internet access	106	52
All in place (out of 205 schools)	14	7

These figures indicate that only in 14 schools were all the prerequisite infrastructure requirements fulfilled and in which all the requisite computer network elements installed, successfully commissioned, and still functioning at the time of the audit, or 7% of the total of 205 schools. This measurement is based directly on the information obtained from the audit. In a subsequent discussion with NetDay, for the purpose of validating this result, NetDay confirmed that all Cabinets have been installed. On further inspection of the audit figures it emerged that in some of the provinces, the Cabinets had not been enumerated, due to possibly poor communication with the audit process, as to what constituted a Cabinet. Therefore, the above overall performance measurement is invalid.

This measurement could also be regarded as overly stringent, as some of the items can be regarded as not absolutely essential to the provision of computer education. By taking out the measurement for Insurance, measuring the presence of the Security Alarm and/or Security Bars plus excluding the delivery and installation of the Cabinet and the UPS, the result is as follows:

TABLE B2: Technical Delivery Performance, Reduced Criteria 1

ITEM	QUANTITY	%
Insurance	-	-
Security Alarm	-	-
Security Bars or Alarms	195	95
Electricity	202	99
14 Networked working computers	121	59

1 Server	165	81
1 Printer	180	88
1 Cabinet installed	-	-
1 UPS	-	-
Cabling	187	91
Working Internet access	106	52
All in place (out of 205 schools)	69	34

The Technical Delivery Performance figure improves to 34%. What this means in practical terms is that there are only 165 servers functioning, ie only 165 out of 205 networks function as intended and only 106 of the schools have Internet access. This implies that at only 52% of the schools can the educators participate in distance education as at the date of the audit. From a visual inspection of the comments recorded against the entry for each school it emerges that only 65 out of the 205 schools have not registered a complaint about faulty or missing equipment, or 32%.

The following Table indicates the performance figure if the requirement for Internet access is removed, ie distance learning is not a requirement:

TABLE B3: Technical Delivery Performance, No Internet Access

ITEM	QUANTITY	%
Insurance	-	-
Security Alarm	-	-
Security Bars	195	95
Electricity	185	90
14 Networked working computers	121	59
1 Server	177	86
1 Printer	180	88
1 Cabinet installed	-	-
1 UPS	-	-
Cabling	187	91
Working Internet access	-	-
All in place (out of 205 schools)	95	46

The Technical Delivery Performance figure improves to only 46%.

It can be argued even further that not all 14 computers are absolutely necessary for the provision of computer education. The following Table B4 reviews the Technical Delivery Performance with decreasing number of computers delivered, but with and without Internet Access available:

TABLE B4: Technical Delivery Performance, Reducing Number of Computers

No. of Computers with other Items except Insurance, Cabinet, UPS but with Security Bars and/or Alarm	Internet Access a Requirement		Internet Access not a Requirement	
	Quantity	%	Quantity	%
14	69	34	96	47
13	81	40	111	54
12	85	42	116	57
11	85	42	120	59
10	86	42	123	60
9	87	42	124	60
8	87	42	124	61
7	88	43	126	62
6	89	43	127	62
5	89	43	127	63
4	89	43	130	63
3	89	43	130	63
2	89	43	130	63
1	89	43	144	70

An analysis of the different network items missing from the schools at the time of the audit is as follows:

TABLE B5: Analysis of Missing equipment

ITEM	Never Delivered	Not Installed	Never Returned	Faulty	Stolen
Computers	177	419	15	133	23
Server	4	24	1	18	3
Printer	5	15	1	3	1
Cabinet	8	8	0	0	2
UPS	18	54	1	0	1
Cabling	3	3	0	9	0
Modem	18	57	2	16	1