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How to set up and operate a successful computer refurbishment centre in Africa

A planning and management guide

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EXECUTIVE SUMMARY

Tapping the potential of refurbished computers for Africa

More Africans need to get their hands on computers in order for African countries to tap the potential of information and communications technology (ICT) to improve lives. But the price of new computers puts them beyond the reach of most organisations and individuals in Africa. And the overall lack of technical skills also limits the widespread use of computers across the continent. Locally owned computer refurbishment centres offer some promise to address these issues. But establishing such a business in an African setting may call for more than just a viable refurbishment operation: everybody wins when a related social purpose is embedded in the business plan. When used equipment is donated to refurbishment centres it helps keep costs down, while at the same time solving problems for big companies that have social corporate responsibility obligations and which increasingly face environmental mandates on hardware disposal.

But there are only a few successful computer refurbishment centres in Africa at present, and very little is documented about their experiences for others to learn from. *How to Set Up and Operate a Successful Computer Refurbishment Centre in Africa: A Planning and Management Guide* is the result of a study undertaken by bridges.org in early 2004, which examined the methods and strategies of the computer refurbishment industry, focusing on Africa. This guide describes the steps involved in opening a computer refurbishment centre in Africa and managing it into productivity. It is intended to distill best practices and provide information on proven methods that could be replicated in refurbishment centres across the continent.

Overview of the computer refurbishment industry

A computer refurbishment company specialises in sourcing second-hand computer equipment, and cleaning, testing, repairing, and assembling it for resale. Some refurbishment companies operate strictly on a commercial basis, using large volumes and economies of scale to derive profit from resale. Others integrate a social purpose into their approach, by using the labour-intensive refurbishment process as a training opportunity through which inexperienced volunteers exchange their time for basic technical training. Refurbishment businesses can be positioned merely as vendors of hardware, or designed to deliver a set of services in concert with computer provision, including pre-sales consultation and needs assessment, and after-sales technical support and training. By providing support and skills training, they can help ensure that clients come to rely upon ICT as a tool that can enhance productivity and communication.

The composition and purpose of refurbishment operations differ widely around the world. Globally, the market tends to be influenced by the need -- or perceived need -- among corporate users for newer, faster computers. When corporations renew their computer equipment, large quantities of used machines enter the resale market. Other buyers, motivated by lower prices and what they see as a better return on investment, purchase those used items. This cycle of technology exchange drives the global trade in used computers. In Africa, additional factors drive the market. Because so many computer users lack experience, organisations currently providing refurbished computer in Africa assume a greater responsibility for ensuring their clients use ICT productively. Therefore, consultation and technical support are as much a part of a refurbishment centre's value proposition as are its affordable computers.

Although the global and African refurbishment markets differ in size and demand, the fundamental economics remain the same: costs fall as production scale rises. African computer refurbishment centres can achieve economies of scale by either centralising production or forming a consortium with others to increase collective buying power. But to reap the benefits of large-scale production, effective management processes are needed, and in Africa that means quality in both production and service.

PART I. ORGANISATION AND MANAGEMENT OF A COMPUTER REFURBISHMENT CENTRE IN AFRICA

Outlook on African computer refurbishment centres

There are a number of constraints to the viability of refurbishment operations in Africa. Existing African refurbishment operations tend to lack the appropriate information systems and documented procedures to operate efficiently at large production volumes while maintaining service quality. There are two models for a computer refurbishment centre that are best suited to the African market: centralised refurbishment with distributed support, and purchasing consortium.

Business drivers

Defining a centre's market position, measuring the costs of service provision, and assessing demand to calculate the affordability of its products, are three key business drivers that determine the financial sustainability of a centre. An African computer refurbishment centre can position itself in three main ways: as a service provider to government or donors; enabler of small-scale individualised donations; or provider to local small enterprises, community service organisations and the public at large. Key cost drivers for computers sourced internationally include the costs of delivery, parts and peripherals added to computers, as well as sourcing and installing legally obtained operating systems and applications. The operating costs of the centre, including its Internet connectivity, utilities, labour and other kinds of overhead must also be recouped through product and service pricing in order to sustain the centre over the long term. The demand drivers affect customers' likelihood of purchasing equipment, including measurable factors such as an item's price, the availability of capital and the cost of borrowing, as well as unquantifiable factors, such as personal taste, interest and priorities.

Good management of a refurbishment centre also depends on the ability to design, document and implement standard procedures for carrying out fundamental tasks. A focus on process orientation and documentation formalises knowledge and enables a centre to plan for controlled growth. It ensures that staff members have access to the instructions and procedures necessary to carry out their work; distributes knowledge throughout the work environment; and alleviates demand and time pressures on more experienced workers.

Supply management

Establishing a supply chain and managing it well are two activities that are essential to computer refurbishment centres. Used computers form a part of a large and competitive market that accommodates several different kinds of suppliers. At the same time, the diversity of that market requires a lot of knowledge and familiarity with current pricing in order for purchasing managers to maximise a centre's spending power. The off-lease computer market is also volatile -- prices and quality can change quickly. Ultimately, the procurement practices of local and international companies and governments determine the quality of used computer supplies. As a consequence, the long-term focus of a supply manager should concern the establishment of supplier relationships that can help insure a centre against price swings, fluctuations in availability and demand and the high overheads of the bidding and tendering process. Being able to articulate a centre's needs is central to a centre's ability to forge partnerships with hardware suppliers. It may take some effort and a few well-handled transactions in order to cultivate willing partners, but, in time, it will mean that computers are cheaper to source, that the supply of computers is more integrated into the operation, and that the boom-and-bust cycle of activity in the workshop is eliminated.

Shipping and customs

Shipping computers for import can incur considerable cost and delay, but good preparation and good relationships with suppliers, freight forwarders and customs agencies can reduce some of the frustrations involved. Because shipping can place such strain on an organisation, both in the time that it takes to carry out the transactions and gather necessary documentation and in the financial resources required, it is a job best left to those most experienced. Centres must still carry out much of the work themselves, particularly when assessing the initial feasibility of importing computer equipment into a country. At the same time, the interest, profile and public sentiment about computers and ICT issues may also give the centre a chance to create a network of supportive partners within existing government and industry institutions. That network of goodwill may be able to ease the task of ICT import.

Product profiles

Usability is a consideration central to the design of products. It is important for a centre to produce platforms that its users -- especially novices -- can learn to use quickly and well. Since responsiveness is key to a user-oriented product specification, computers should be fitted with more RAM and higher processor speeds as long as the costs of these extra features keep prices affordable. Since product design must also be matched to the computer's intended use, the products must provide the applications that its users want and need. Standalone computers are suitable for home or office use, where a limited number of people use the computer. These machines should be outfitted with productivity applications, an Internet browser and an email client. Centres may also add other software such as an accounting package, graphics tool or database. Computer labs can be installed with machines that run independently of each other or be equipped with a server and several diskless clients. In each case, the computers' operating system must feature true multi-user functionality in order to protect data and streamline the task of administration. To promote sustainable use of the computers and take measures to ensure their longevity, computer refurbishment centres can include more than hardware and software in their product offerings. While a consideration of the operating system and applications is key to the product, just as important are issues of security and data protection. These safeguards lay the groundwork for a recipient's sustainable use of the PC equipment.

Inventory

An inventory should be able to track volumes of equipment over long periods of time and several locations. By integrating inventory with workflow, it is possible to keep an eye on how many computers are available for installation, and to match future demand with current supply. But most of all, inventory management is a mechanism designed to keep control over a process that comprises many different elements and locations. The different features of various inventory solutions will suit computer refurbishmentcentres at different stages in their development. The early appeal of a spreadsheet's ease of use may fade as volumes in the workshop increase. Likewise, an evaluation or audit may force a centre to be able to produce and track its stock in greater detail, necessitating the migration to a database system. Centres should invest time and effort into finding an inventory that suits their workshop conditions, workflow, and local practicalities.

Staffing

A computer refurbishment centre has complex staffing needs. At the outset, it requires the experience and involvement of a few committed organisers that articulate the vision and direction of the centre. In the early stages, it requires the concentrated effort of a small team of technical and nontechnical staff to pilot the centre through the complicated set-up phase. And to flourish in the long term, it requires the efforts of a dynamic team of skilled technicians. The need for skilled labour creates an opportunity to develop the skills of a workforce in-house. By initiating a volunteer program under which enthusiastic trainees exchange their labour for skills, the centre can meet its labour force needs and nurture the

interests of members of the communities in which it operates. This arrangement demands a workshop take several steps to ensure that both volunteers and the staff see benefits. It requires the removal of barriers to volunteer eligibility, the provision of structured work plans as well as the necessary tools, documentation and work structure that foster skills transfer. This should be combined with a way to monitor the progress of both volunteers' skills acquisition and the production outputs of the workshop. A rotating, team-oriented approach is one method of organising work activities to maximise the opportunities for skill sharing. While testing programmes can enable a centre to monitor the pace of skills acquisition, orienting a centre's training programme toward the attainment of a recognised qualification can improve trainees' employment prospects in the ICT job market at large.

Increasing impact and ensuring sustainability

Computer refurbishment centres have a responsibility to raise awareness about ICT integration issues and to promote ways that computer ownership can bring concrete benefits to organisations and businesses that use ICT. As a consequence, the centre should strive to be regarded not merely as a supplier of computers, but as a place that can help people determine their needs and shape the context within which computers can become effective, productive tools. Readiness and planning tools also help centres remain productive. Since demand for computers can frequently outstrip available supply, a centre providing services to large numbers of clients will inevitably receive more requests for computers than it can meet. If it is focused on social service, it must develop a method of assessing the eligibility of applicants and of ranking the priority of eligible clients. The development of standard ranking tools helps to drive decision-making; if the tool is transparently applied, the method can also defuse criticisms of bias and favouritism in a centre's decisions. Given its role in the community as a trainer of staff and its profile as a dispenser of valuable and often-coveted equipment, a centre's choice to advise its clients as well as provide them with computers will likely bring longer-term benefits to the centre and to its relationship to the community in which it operates. Computer refurbishment centre managers wary of the cost implications of administering a readiness and needs assessment programme may have recourse to follow an emerging trend in the ICT sector in some developed countries and subcontract specialty needs and readiness assessments to a third party. Centres may also be able to levy a service fee for these consulting services, or embed a charge into a service contract.

Technical support

To realise the benefits of ICT, good technical support is key. The presence of technical support engenders trust between a centre and prospective customers who may worry that their own inexperience should discourage them from purchasing a computer and coming to rely upon it. Given the potentially high frequency of problems the combination of new users, older hardware and a harsh environment may produce, the technical support arm of a centre's customer relations service must receive considerable attention. A centre should implement both remote and on-site support systems, carried out with specifically tasked staff and supported by management software. Support systems should be established with a view to training and preparing clients to support themselves as much as possible. Proactive customer support measures such as scheduled service calls and activity monitoring can help bolster a relationship with a client and improve both support levels and quality. Of all measures to improve customer service, the definition, communication and adherence to standards of response and resolution time is paramount.

Facilities and infrastructure

Computer refurbishment centres require three main features in their facilities: size sufficient to store equipment, carry out refurbishment and conduct business; stable electricity to support the infrastructure of the operation; and a form of Internet connectivity to enable communication with suppliers and provide a method for sourcing software. At the same time, facilities can be costly to modify, expensive to furnish and

difficult to find. A centre should turn as much as possible to its partners and other possible donors in order to find premises and equipment as cheaply as possible. While the features of a given facility are important considerations, it is also important to find a location for the centre that gives access to staff and the general public.

Partnerships

Since hardware and technical support comprise only a small part of the broad-based initiatives required to ensure sustainable ICT expansion in Africa, partnerships are key to a centre's success. Foremost among these partnerships is the one the centre develops with its clients, who can give valuable feedback to the centre about its products and services. Given the priority of controlling ongoing costs, refurbishment centres should seek to partner with local telecommunications providers with the purpose of driving down connectivity costs to affordable levels. Given the importance of end-user skill development, a partnership with a training agency can help to satisfy the needs of a centre's user base, including both basic instruction to learn applications and interfaces, as well as specialised training to solve technical problems common to the products the centre distributes. Given the position of government as a source of valuable information, participation with government agencies is vital if long-term programmes are to be planned effectively. Given the responsibility of a centre to dispose of end-of-life equipment responsibly, a partnership with a reputable recycler is also necessary. Finally, given the involvement of SchoolNet Africa in computer supply and service issues in concert with its One Million Computers For Africa initiative, managers should endeavour to familiarise themselves with this programme.

PART II. TECHNICAL PROCEDURES FOR COMPUTER REFURBISHMENT

Efficient computer refurbishment centres require formalised internal technical procedures to produce high-quality products consistently. Supplying a refurbished computer to a client involves five basic steps that will restore a computer to a working state, fit for its next owner:

Cleaning. Before the computers move into the workshop, the cases should be removed for cleaning. Using a vacuum, compressed air or high intensity blower, dust and debris should be extracted from the interior of the computer case. Cases should be cleaned with a light detergent and stripped of any badges, decals or other material that the manufacturer or former owners applied. See the section entitled "Cleaning" for more detail.

Testing. Software is used to identify faults in components. All equipment should be tested before it is used in production in order to eliminate the cost of warehousing material that has no value, and to reduce the rate of replacement for equipment that fails after it has been given to a user.

Assembly, software installation and configuration. Tested equipment is assembled according to a set of specifications defined in the product profile. Technicians should follow a standard procedure for assembling the computers. Once the computers have been assembled, an operating system and applications are installed on the harddrive. Then drivers and any hardware are installed or added to the configuration. Finally, networking is configured and applications are installed. In an environment where large volumes of computers are loaded with software, centres can use a method that installs software on large numbers of computers simultaneously in order to save time and effort. Each of these steps is outlined in the "Assembly, software installation and configuration" section, which describes the steps in more detail and gives instructions and links to sample documentation and reference material.

Quality assurance testing. The hardware configuration is tested using a program called a burn-in test, which stresses the hardware. A technician then verifies that the product complies with quality standards against a checklist. See the section entitled "Quality assurance testing" for more detail.

Packing, shipment and installation. The tested computers are packed together with other necessary equipment and installed in the new location. See the section entitled "Rollout and installation" for more detail.

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ANNEXES (attached separately)

Acknowledgements

This guide was made possible by the generous support of the Catalysing Access to ICT In Africa (CATIA) initiative, a three-year programme of the UK Department for International Development (DFID) in close collaboration with other donors and role players.

We would like to thank the individuals and organisations, including the eight African refurbishment initiatives visited, which agreed to be interviewed and provided the first-hand information upon which this document is based. Their willingness to engage and share experiences enriched this guide immeasurably, and has proven to be a valuable contribution to the field. A full list of those interviewed is included in Annex O. We are also grateful to the many individuals that helped with logistical support.

We would like to give special thanks to SchoolNet Africa for sharing data with us. We urge readers to have a look at SchoolNet Africa's *Integrated training programme to set up technical service centres in support of education in African schools,* at http://www.schoolnetafrica.net/coursepressrelease.0.html.

INTRODUCTION AND BACKGROUND

1 Tapping the potential of refurbished computers for Africa

More Africans need to get their hands on computers in order for African countries to tap the potential of information and communications technology (ICT) to improve lives. But the price of new computers puts them beyond the reach of most organisations and individuals in Africa. And the overall lack of technical skills also limits the widespread use of computers across the continent.

Locally owned computer refurbishment centres offer some promise to address these issues. When refurbishment is done cheaply and efficiently, restored computers can be resold at a low price. But establishing such a business in an African setting may call for more than just a viable refurbishment operation: everybody wins when a related social purpose is embedded in the business plan. Where the refurbishment process is integrated into the local setting, it provides technical training to members of the community -- staff, volunteers and clients -- who can help sustain effective ICT use. And refurbishment centres increase their likelihood of success by offering consultation, technical support and related services along with affordable second-hand equipment, providing needed services that are usually not otherwise available.

When used equipment is donated to refurbishment centres it helps keep costs down, while at the same time solving problems for big companies that have social corporate responsibility obligations and which increasingly face environmental mandates on hardware disposal. A number of international initiatives are underway to bring significant numbers of donated computers to Africa from North America and Europe, and many intend to refurbish the computers at the local destination. Many believe there is much to be gained for refurbishment centres that partner with development efforts, government programmes, and community organisations, because there can be business opportunities in serving underserved markets.

But there are only a few successful computer refurbishment centres in Africa at present, and very little is documented about their experiences for others to learn from. *How to Set Up and Operate a Successful Computer Refurbishment Centre in Africa: A Planning and Management Guide* is the result of a study undertaken by bridges.org in early 2004, which examined the methods and strategies of the computer refurbishment industry, focusing on Africa. This guide describes the steps involved in opening a computer refurbishment centre in Africa and managing it into productivity. It is intended to distill best practices and provide information on proven methods that could be replicated in refurbishment centres across the continent.

Roadmap to this document

This document consists of four parts. First, this *Introduction* section sets the stage for the guide. It gives background on the issues and the study, and an overview of the field more generally.

Part I of the guide outlines organisation and management priorities essential to an efficient centre. It looks at each of the key areas that a refurbishment centre must address, including: business drivers, supply management, shipping and customs, product profiles, technical processes, inventory, staffing, technical support, site selection, and partnerships. While considerable emphasis is given to the production and supply chain processes central to the provision of computer equipment, the guide also focuses on services to promote and sustain the effective use of ICT. It closes with a development chart that summarises the key activities involved in establishing a computer refurbishment centre in Africa. This

section is targeted at entrepreneurs and facilitators interested in setting up a computer refurbishment centre, as well as managers of existing centres wishing to improve or expand their businesses. It is also relevant for those with an interest in ICT for development. Donors, prospective sponsors and venture capital firms may find it useful as background for business planning.

Part II of the guide covers the technical details and internal processes required for efficiency, standardisation, and high quality output in a refurbishment environment. It looks in detail at cleaning; testing; assembly, software installation and configuration; quality assurance; and rollout and on-site installation. It is aimed at those responsible for overseeing the actual refurbishment processes.

Finally, the *Annexes* to this document contain detailed information to support the guide, including sources of used computers, taxes and tariffs on computer hardware and software, and a list of online technical guides and resources.

1.1 Issues around refurbished computers in Africa

ICT can reward those who use it well with increased income, better quality of life, and cultural and political advantages. Those who do not use it are left behind, and ICT disparities exacerbate existing inequities. The overall trend is that privileged countries and groups acquire and use ICT more effectively, and because the technology benefits them in an exponential way, they become even more privileged. The full range of ICT is part of the scenario -- from telephones to television, from voice-over-IP to personal digital assistants -- but computers and connections form the foundation. This so-called "digital divide" is a complex problem that manifests itself in different ways across countries and communities. These issues are especially critical in Africa, where the benefits of ICT are limited because so few people have access to computers and Internet connections.

Despite limitations in access, there is tremendous interest in the use of computers in Africa. Companies want to use computers to make their businesses more efficient, and the general pubic hopes that computer training will bring employment opportunities for themselves and their children. Governments, development aid agencies, and community programmes are investing in computers as a tool for socio-economic development. Concerns about the need for equal access to ICT have led to a variety of projects that bring computers to disadvantaged groups. ICT access projects put computer labs in schools, government offices, community centres and other places that the general public visits. Other kinds of initiatives more generally encourage the use of computers by organisations and individuals, to build ICT skills across society, promote access to information, and improve the way they do the things they do.

Computer hardware costs

The cost of computer hardware is a significant obstacle. Purchase prices put new equipment beyond the reach of most small businesses, schools, community initiatives, and households in Africa. And there is reluctance among donors to fund the purchase of new hardware for development programmes. Of the many manifestations of the digital divide, the overall scarcity of computers is among the most visible in Africa. Currently even best estimates put fewer than eight million computers on the continent. In 2002, there were 9.9 computers for every 1,000 Africans south of the Sahara,[1] compared to 311 for every 1,000 citizens in developed countries.[2] The World Bank has estimated that there is only

1 Development Data Group, World Bank. "ICT at a Glance: Central African Republic." *ICT at a Glance tables.* http://www.worldbank.org/data/countrydata/ictglance.htm
2 World Bank 2001. "World Bank Development Report 2000/1" http://www.worldbank.org/poverty/wdrpoverty/

one computer for every 139 African learners at any level,[3] while OECD countries average one computer for every nine students in secondary school alone.[4]

Second-hand computers -- which can be refurbished and resold for a low price -- offer promise to address the cost issue. And plenty of used computers are available. The relatively short lifespan of computers (usually three years in developed countries), means that organisations around the world are producing a near-constant supply of used hardware that has to be disposed of in some way. Recycling is an option being more widely considered, but cost-effective systems may still be a few years away. In the meantime, donations to social programmes offer one of the best options for dealing with used computers, especially for large companies that have social corporate responsibility obligations to fulfill. Moreover, the trend toward environmental laws that require computer owners to take responsibility for the disposal of computer hardware, means that finding ways to extend the useful life of the computer may be cheaper than simply throwing it away.

Lack of local technical skills

The international community has started to respond to the need for low-cost computers in Africa by shipping used computers from the developed world. Total volumes remain small for now, but many predict that will change as environmental mandates take effect. However, research suggests that a distressing portion of the equipment that arrives in Africa is under-utilised. Often this is simply due to a lack of local technical expertise to set up and maintain the equipment. Not only is the African ICT labour force estimated to be smaller, per capita, than on other continents, ICT workers are expensive to hire and likely to be employed already.

Local computer refurbishment centres offer a solution

The establishment of locally owned and run computer refurbishment centres may be the best way to both maximize the value of donated equipment and increase technical skills across the continent. Local refurbishment centres can source computers, equip them for the context in which they are to be used, install them, and provide ongoing technical support to users. At the same time, refurbishment centres can build local capacity through job creation and training schemes. And a single, vertically-integrated provider of used computers and services affords economies of scale unavailable to uncoordinated computer donation programmes. For example, centres could provide technical expertise to help inexperienced computer users make the most of the technology, while at the same time acting as a liaison between donors and beneficiaries. Donors could then leverage their relationship with a local computer refurbishment centre to assist other projects in the area with ICT needs.

The problem is that examples of successful, sustainable computer refurbishment centres are scarce in Africa. And the expertise and innovation of the few that exist are undocumented. For those that want to set up a new refurbishment centre in Africa, it is difficult to get good advice about where to start, which problems to anticipate, and more generally how to tackle this complex task.

1.2 The guide for African computer refurbishment centres

The objective of this guide is to distill best methods and strategies for adoption at African computer refurbishment centres. It is based on a study of current refurbishment operations, focusing on those located in Africa. The study involved desktop research, site

3 World Links South Africa. "Exhibit 2: ICT Availability and use." *South Africa Country Report.* (2001):6. http://www.worldbank.org/worldlinks/english/assets/WorldLinks-SouthAfrica.pdf

4 OECD 2001. "Competing the Foundation for Lifelong Learning: An OECD Survey of Upper Secondary Schools" http://www.oecd.org/document/1/0,2340,en_2649_34515_27443329_119699_1_1_1,00.html

visits, and interviews with individuals either engaged in refurbishment in Africa or interested in expanding an existing ICT project into hardware provision. Over twenty people were interviewed as part of the study, including eight African computer refurbishment centres that were visited. Representatives of two additional centres active in Africa were interviewed at a conference. Two nonprofit organisations and a number of commercial operations were interviewed by email. Questionnaires were tailored to address specific subjects in accordance with an individual's job title and expertise. A complete list of people contacted appears in Annex O. The questionnaire is available from bridges.org on request.

There are many factors that make ICT initiatives in developing countries fail or succeed, which go beyond technology and economics. In most cases it is these peripheral issues -- the so-called "enabling environment" that surrounds ICT use -- that determines whether an ICT-based solution is effective or not. To understand how these kinds of issues affect an African refurbishment centre, this study used bridges.org's *Real Access/Real Impact* approach to frame the research methodology, identify gaps, provide a framework for information collection and interview questions, and structure a broad analysis of the enabling environment for refurbishment in Africa. This approach puts forward the idea that for ICT to have a real impact on society and the economy, people must have real access to it, and it presents a number of key criteria that determine "real access". For more on the *Real Access/Real Impact* framework, see Annex P.

Parameters of the guide

This document is not a feasibility study for the refurbishment industry. Furthermore,it aims to remain neutral on the debate surrounding total cost of ownership of new versus refurbished computers. A separate study on these total cost of ownership issues has been commissioned by the CATIA initiative, and a report will be available in 2004 on the CATIA website, http://www.catia.ws.

Given the context in which African-based centres must operate, this guide focuses on service-oriented business, and as a consequence, some content will be of limited application to readers interested in sales operations alone. Furthermore, the guide gives special attention to purveyors of used equipment; however, the processes and key drivers it outlines apply equally to assemblers of new computers, especially those who import parts from overseas.

2 Overview of the computer refurbishment industry

A computer refurbishment company specialises in sourcing second-hand computer equipment and cleaning, testing, repairing, and assembling it for resale. Some refurbishment companies operate strictly on a commercial basis, using large volumes and economies of scale to derive profit from resale. Others integrate a social purpose into their approach, by using the labour-intensive refurbishment process as a training opportunity through which inexperienced volunteers exchange their time for basic technical skills training. Refurbishment businesses can be positioned merely as vendors of hardware, or designed to deliver a set of services in concert with computer provision, including pre-sales consultation and needs assessment, and after-sales technical support and training. By furnishing support and skills training, they can help ensure that clients come to rely upon ICT as a tool that can enhance productivity and communication.

The composition and purpose of refurbishment operations differ widely around the world. Globally, the market tends to be influenced by the need -- or perceived need -- among corporate users for newer, faster computers. When corporations renew their computer equipment, large quantities of used machines enter the resale market. Other buyers, motivated by lower prices and what they see as a better return on investment, purchase those used items. This cycle of technology exchange drives the global trade in used computers. In Africa, additional factors drive the market. Because so many computer users lack experience, providers of computer equipment in Africa tend to assume a greater responsibility for ensuring their clients use the ICT productively. Therefore, consultation and technical support are as much a part of a refurbishment centre's value proposition as its affordable computers are.

Although the global and African refurbishment markets differ in size and demand, the fundamental economics remain the same: costs fall as production scale rises. African computer refurbishment centres can achieve economies of scale by either centralising production or forming a consortium with others to increase collective buying power. But to reap the benefits of large-scale production, effective management processes are needed, and in Africa that means quality in both production and service.

2.1 Global market trends

Many companies, regardless of the type of business they are in, prefer to use computers for a defined period rather than use them until they fail completely. A typical usage period for desktop computers is three years in a corporate environment in developed countries, and at the end of this period the computers are replaced. Old stock is either sold, thrown out or returned to leasing agents, who in turn try to find another customer for the equipment. This practice, often called "remarketing" or "reselling", has created a large, competitive used computer market.

For example, many companies lease computers to clients for a defined period, and they later sell previously-leased or "off-lease" hardware after it has been returned. Some leasing companies are divisions of computer manufacturers, such as IBM Global Financing and Dell Financial Services. Others, such as GE Capital, are divisions of larger corporations not involved with computer manufacture. Still others specialise in leasing computers, and they vary in size and market scope. Some companies provide computer removal and de-installation services, or other forms of asset management. These outfits work for companies looking to dispose of equipment, or leasing companies that outsource the repossession of leased machines. In exchange for the service, removal companies receive the computers themselves or a portion of profits from computer resale. These bulk buyers sell the used equipment to individual consumers, businesses or other brokers. The number and diversity of participants in the commercial refurbishment, remarketing, off-lease and

resale market impedes any accurate calculation of the total size of this business around the world, but it appears to be growing -- and changing.

This market was formerly dominated by speculators and brokers that sprang into operation in the wake of Internet company bankruptcies in 1999 and 2000. But according to a 2002 article in *CIO Magazine*, the entry of global Tier-1 manufacturers -- IBM, Dell, Hewlett-Packard and Compaq (before its merger with HP) -- altered the dynamics of the resale landscape.[5] Now corporate off-lease reclamation and other equipment buy-back programs contribute significant profits to manufacturers. In 2001, HP Financial Services, the Hewlett-Packard division which runs HP's refurbishment program, attributed 40% of its 2001 earnings to equipment resale. The division reported turnover of US$400 million dollars and profits of US$29million the first quarter of 2004 alone.[6] Dell Financial Services started its refurbishment program in 1999 and by 2001 the business was bringing in US$200 million per year.[7]

Volumes of equipment are also growing. IBM's 20 refurbishment warehouses process 15,000 units a week; HP Financial Services turns over 500,000 pieces of equipment in a year in one refurbishment centre alone. At the same time, brokers remain major participants. General Electric's GE Refurbishment business sells close to US$200 million worth of equipment on the secondary market annually.[8] The majority of these businesses derive the bulk of revenues from the resale of server hardware, although desktop and notebook computers sold both to companies and individuals comprise a solid portion of total turnover. Large operating scales ensure that the cost of overheads are distributed over a high number of products. Online and telephone sales reduce overhead costs even further.

2.2 The African market

A primary goal of any refurbishment company is to obtain large volumes of equipment as uniform and as affordable as possible. Overseas nonprofit suppliers, overseas commercial suppliers, and local corporate donors comprise the three main sources from which an African refurbishment centre draws its supply of used computers. The African refurbishment market is increasingly integrated with the activities of international corporations seeking to dispose of used equipment. In most African computer refurbishment initiatives computers are shipped in bulk from overseas, subjected to local testing and software installation, and then distributed to recipients. Estimates have put the number of internationally sourced, locally refurbished computers in Africa as high as 50% of the speculated 1.25-7.5 million total computers in Africa. For example, South Africa refurbishment company Device Global sourced 90% of the 17,000 used computers that moved through its Johannesburg depot in 2003 from sites in Europe.[9]

Many used computers arrive in Africa courtesy of nonprofit organisations such as Computer Aid International, Digital Links, Close-the-Gap and World Computer Exchange, which receive the used computers as donations overseas and ship them.[10] These organisations resell the second-hand computers at a very low price to applicants who meet a set of criteria, normally based on the recipients' line of work (for example favouring education settings and social programmes).

5 The term "Tier-1 manufacturers" refers to computer manufacturers with their own supply, manufacturing, marketing, retail operations and, importantly, brand equity. Examples include IBM, Dell, HewlettPackard/Compaq.
6 http://www.hp.com/hpinfo/investor/financials/quarters/2004/q2presentation.pdf
7 Scott Berinato. "Good Stuff Cheap." *CIO Magazine,* October 15, 2002. http://www.cio.com/archive/101502/cheap.html
8 Jordan Wolfe, Manager, GE Refurbishment. Phone interview, May 2004.
9 Alan Finlay. "Are we wasting the refurb opportunity?", 1. http://www.catia.ws/Documents/Indexpage/CommentrefurbishedPCs.pdf
10 A more exhaustive list of equipment donors active in Africa appears in Annex A.

Unlike in Europe and North America, the refurbishment process in Africa today is often just one component of a broadly defined business. Refurbishment centres often come to be seen as a locus of expertise as much as a source of hardware. They offer added value to large scale ICT provision programmes by developing tools to assess the readiness of prospective recipients. They also package their expertise with technology planning to encourage organisations and businesses to integrate ICT within their operations and shepherd them through the process. Likewise, the provision of technical support once a client has received a product from the centre is another major aspect of a service-oriented centre. The availability of online, telephone and in-person support to clients is essential to minimising downtime. It is also a key factor in helping clients transform their inhibitions about new technology into positive attitudes about computers.

Examples of education-focused hardware and service providers include SchoolNet Namibia, Computers For Schools Kenya, and the Shuttleworth Foundation's TuXlab programme, active in South Africa's Western Cape Province. These operations provide refurbished computers to schools, along with technical support and training. Much of the labour is carried out by volunteers, including on-site installation for clients.

A number of commercially motivated operations are also active in Africa. In addition to Device Global, South African refurbishers FreeComGroup, DireqLearn, and Asset Disposal Management Africa source computers from corporate dealers, manufacturers, and through end-of-lease service contracts. They refurbish the machines before selling them either to companies or the public through retail stores. As with profit-oriented operations in Europe and North America, competitive pricing is the main appeal of refurbished equipment.

PART I. ORGANISATION AND MANAGEMENT OF A COMPUTER REFURBISHMENT CENTRE IN AFRICA

3 Outlook on African computer refurbishment centres

The core components of a computer refurbishment centre are:

- *Supply management and inventory mechanism* – a means of cost-effective sourcing and importing used computer equipment; tracking movements from intake through to purchase and environmentally sensitive end-of-life decommissioning; and forecasting supply needs and managing inventory levels to optimise costs.
- *Staffing and training* – a group of employees motivated and trained to carry out specific tasks; set of job descriptions; and protocol for nurturing the interests and skills development of staff through a mutually beneficial volunteer development programme.
- *Workshop processes* – a set of documented processes, standards and procedures for tracking inventory, testing disk drives and components, assembling computers from parts according to specifications, installing software, checking products according to quality assurance performance standards, packing, and installation.

Components of centres that also specialise in additional service provision include:

- *Needs assessment and readiness protocol* – a service to assess the readiness of clients to receive equipment, and a process for determining the needs of clients with a view to assisting the integration of ICT into daily routines.
- *Helpdesk function* – a customer service mechanism to solve technical problems; respond to customers' questions; and replace, repair or upgrade equipment and software as necessary.

3.1 Constraints to viability in Africa

Economic and geographic factors constrain the viability of refurbishment operations in Africa. For example, the high cost of inland transportation favours operations in port cities. The limited availability of Internet access supports urban rather than rural headquarters. However, two-thirds of Africans live outside of cities.[11] Experience at existing refurbishment centres indicates that the greater the distance between a supplier and recipient, the lower the frequency of service calls, centre involvement, and overall success in computer use. If rural Africans are to have access to ICT, rural service solutions need to be developed.

The economics of supply and logistics management compound the problem of viability in the African context. When planning supplies, managers must pace acquisitions to fit with production output and sales. The lengthy process of shipping, customs clearance and import can impede this supply management goal. Sourcing large volumes of computers at the same time reduces the cost of shipping as a proportion of the total cost of acquisition, and capital investment is maximised by higher production volumes. But greater production volumes require more planning, increased supply chain visibility, more efficiently managed inventories, and considerable management finesse to ensure continuous, high-quality output. Existing refurbishment operations in Africa tend to lack the appropriate information systems and documented procedures to operate efficiently at large production volumes while maintaining service quality.

11 World Bank Group. "Rural Travel and Transport." *Sub-Saharan Transport Policy Program.* http://www.worldbank.org/afr/ssatp/rttp.htm

Most computer refurbishment centres operate in a management environment that relies on employees' undocumented, tacit knowledge, gained by virtue of familiarity with their roles within an organisation rather than by reference to formal standards. At small scales, these informal habits do not impede a workshop's apparent productivity -- workers still carry out testing, quality assurance, and well-executed refurbishment. But their success in managing their output and keeping track of priorities is attributable to the countervailing virtues of small organisations: employees know clients' names, can keep track of outstanding work in their heads, and communicate with colleagues directly. However, these operations do not survive the transition to larger scales, and without formal processes to fall back on, quality suffers. So economic and management priorities seem to be at odds: if operations retain output levels at small scales, a centre's per-computer acquisition costs are higher. If these operations expand to produce computers more affordable to clients, quality suffers, raising the cost of maintenance and service for both client (measured in downtime, frustration, and money), and centre.

3.2 Two models

There are two models for a computer refurbishment centre that are best suited to the African market:

Centralised refurbishment with distributed support

Balancing location, acquisition costs, service range, and productivity points toward a hub-and-spoke model that centralises refurbishment and distributes support. One centrally located, large-volume refurbishment centre in an urban area well serviced by telephony, stable electricity, transportation and other infrastructure would keep costs down. Disbursed rural support through regionally located, small-scale service and maintenance sites means the operation can be responsive to a widely distributed client base. The smaller operations benefit both from the economies of production scale -- by sourcing hardware from the central refurbishment centre -- and the virtues of the intimacy with clients that small-scale operations afford. This is not to say that small operations are exempt from formal procedures and documentation; these will be necessary to comply with expectations of the large-scale partner and to maintain quality assurance standards. But the manageable informality of small scales will allow the small operation to weather problems such as intermittent connectivity and poor electricity that would inhibit the operation of high-volume production scales.

Purchasing consortium

One alternative to the hub-and-spoke solution described above calls for several independent businesses operating in different regions to combine their capital to form a consortium with the purchasing power of a much larger organisation. The thrust of the consortium is to purchase computers in volumes that reduce as much as possible the total acquisition and shipping costs for all parties participating in the bulk acquisition; members can decide if they wish to pursue further benefits.

4 Business drivers

Business drivers are the factors that determine the financial sustainability of a business. Foremost among these is market position. A computer refurbishment centre's must define its market position in terms of identity, purpose and role in the ICT sector of a given region or country. In order for a refurbishment centre to cover costs and produce a positive revenue stream, managers must take into account all expenses involved in providing products and services. And a centre must understand the factors that affect customer demand for its products and services.

Effective management also determines the success or failure of a business venture. Good management of a refurbishment centre depends on the ability to design, document and implement standard procedures for carrying out fundamental tasks. Developing a management culture of process orientation, which focuses as much on work methods as it does on task completion, is paramount if quality is to be maintained while productivity increases. A focus on process orientation formalises knowledge and enables a centre to plan for controlled growth. The cornerstone of process orientation is good documentation. It ensures that staff has access to the instructions and procedures necessary to carry out their work; distributes knowledge throughout the work environment; and alleviates demand and time pressures on more experienced workers. An inventory tracking system further supports these priorities if its use is integrated with formalised procedures.

4.1 Market position

An African computer refurbishment centre can position itself in three main ways: as a service provider to government or donors; enabler of small-scale individualised donations; or provider to local small enterprises, community service organisations and the public at large.

Service provider to government and donor agencies

Many computer refurbishment centres active in Africa today have positioned themselves as service providers to government, corporate social responsibility initiatives or international donors. These bodies contract the refurbishment centre to provide hardware and technical support to clients the institutions wish to serve. For example, NetDay South Africa supplies low-cost computer labs to schools on behalf of Uniforum, the administrator of the .co.za domain. The organisation contracted NetDay for the work as part of its School of the Month initiative. NetDay liaises with the schools; Uniforum pays NetDay for its work. Similarly, Tsunami Networks in Namibia was awarded a contract after it bid on a tender issued by Vanco, an oil and gas company active in Africa, to provide computers to a school of Vanco's choosing.

SchoolNet Namibia and Computers For Schools Kenya (CFSK) are examples of bilateral initiatives to service government schools on a countrywide basis with funding from international donor agencies. SchoolNet Namibia is responsible for providing schools with computers, training, service, and fixed-rate Internet service(in the context of a trust forged in partnership with the national telecommunications provider). But it is answerable to its donor partners -- the biggest of which is the Swedish International Development Agency (SIDA) -- for reaching its targets of service delivery. Likewise, CFSK received start-up funding from the Canadian Government's International Development Research Centre (IDRC), but it focuses on increasing ICT literacy within Kenyan schools according to an ICT curriculum forged in partnership with the Ministry of Education. Each of these contractors has the opportunity to recoup operating costs and levy a fee for its service. Typical fee margins range from 3.5% to 7% of the total value of the contract.

Enabler of individualised donations

For every formal computer-provision programme in place at national or regional levels, there is a host of smaller initiatives, each of which is active on individualised bases. Frequently, embassies, councils or businesses wish to sponsor computers at a nearby clinic, library or school, but they often lack ICT expertise. Similarly, groups brought together through religious affiliations or international service agencies agree to certain kinds of ICT sponsorship or donation schemes. However, inexperience with good practice, sustainable hardware provision, service issues, cost predictions and an array of other factors usually results in the failure of a high percentage of informal donation programmes.

The inability of individual groups to convert their goodwill into sustainable ICT donation creates a sizable market opportunity. Computer refurbishment centres should aim to develop a market profile as an intermediary that specialises in catalysing the good intentions behind small-scale donation initiatives into sustainable ICT provision. By positioning itself as an operation knowledgeable about training, cost, and service issues, and as a vendor well-supplied with affordable hardware, a centre can become the enabling body through which individuals and groups can see their monetary donations produce good outcomes. A centre should encourage the ability of individuals and groups to give to those it chooses to work with, while at the same time striving to become the source of hardware, expertise and execution that wrings maximum benefit from the transaction.

In a majority of cases, a centre positioned as an enabler of donations on small scales will play a consultative role to assess, identify and explain the feasibility of the initiative, suggest an implementation method using the centre's expertise and technical staff, and outline the costs associated with initial and ongoing financial sustainability. Fees for services should be charged at rates slightly higher than formalised, large-scale donation programmes because of the extra overhead of dealing with new situations, needs and the possibility that donors are several thousand kilometers removed from their recipients. A keen eye for forecasting costs, training needs and service liabilities will be key to this business channel.

Provider of affordable ICT to small business, community service organisations and individuals

Centres whose products strike a good balance between a computer's purchase cost and its capabilities can accommodate an entire market segment previously excluded from ICT participation. Corporate ICT equipment providers have for the most part neglected the service requirements of groups with access to limited capital; suppliers of ICT more affordable to small enterprises, community service organisations (CSOs) and homes have a significant opportunity to service their needs by providing affordable, appropriately configured hardware to customers who have not been able to finance the higher initial purchase prices of new computers. The opportunity includes more than sales: a centre should also act as a source of advice about ICT in general, and take steps to enumerate to its recipients the key cost considerations involved in owning computers; to give customers tips for integrating them into the workplace; and to provide assistance managing financial and other resources to make the purchase sustainable. These additional services can cement a centre's profile in the community as an initiative focused on ICT literacy rather than mere computer provision.

4.2 Cost drivers

If a computer refurbishment centre is to ensure it recoups its costs when providing ICT to its partners and clients, managers must consider more than the acquisition costs of materials. The centre must also incorporate into its pricing structure all the activities and variables that affect the total cost of preparing a computer for its next users. For a business to be sustainable, the income from sales must recover all costs of production and operations. Cost drivers are all factors that determine the costs of production and

operation. Key cost drivers for computers sourced internationally include the costs of delivery, parts and peripherals added to computers, as well as sourcing and installing legally obtained operating systems and applications. The operating costs of the centre, including its Internet connectivity, utilities, labour and other kinds of overhead must also be recouped through product and service pricing in order to sustain the centre over the long term.

Computer refurbishment centres, particularly those that have positioned themselves as service providers to large-scale initiatives, may find it useful to develop a document that depicts the centre's total cost of hardware and service provision for a given client. A sample is provided in Annex J. This cost breakdown makes transparent to donors and stakeholders precisely the kinds of factors that determine the cost of giving a computer lab to a school, or installing and supporting a telecentre in a community building. The document can also be used as a marketing tool: managers of corporate social responsibility programmes often express interest in underwriting ICT provision and integration activities, but many do not know where to start. By having a document that outlines the cost of providing hardware, service and support to one representative client, a centre can educate potential donors about the true costs of supporting ICT integration over a defined period and ask that donations reflect the true costs. Calibrating the document to a centre's per-installation cost also enables marketing campaigns such as "Sponsor a School" initiatives, which entreat donors to cover the costs of ICT integration at one site. Letting donors support identifiable groups rather than service providers increases their sense that their contribution has produced tangible outcomes.

A total cost of provision document is particularly applicable to businesses in which service providers pass costs and a service fee onto government and donor agencies as part of a coordinated programme, but the model remains relevant to businesses which have positioned themselves otherwise. Since any form of computer import and sale operation faces similar costs, total cost of provision calculations allow a centre to break down and account for all the cost elements a centre must recoup through its selling price. Keeping track of costs and the overheads involved in sourcing and preparing computers for clients is a critical function for ongoing business feasibility. Cost tracking also enables sales managers to calculate discounts or price adjustments as a centre's own costs fluctuate.

4.3 Demand drivers

An analysis of cost drivers allows managers to calculate the costs that can be recouped through sales. But since prices are affected by buyers as well as sellers, centres should likewise give close attention to the factors that affect customers' likelihood of purchasing equipment. These factors are known as demand drivers, and include measurable factors such as an item's price, the availability of capital and the cost of borrowing. They also include a host of unquantifiable factors, such as personal taste, interest and priorities.

Since a centre can exert more control over quantifiable demand drivers, it should focus on lifting the three primary financial barriers to computer purchase -- price, access to capital and the lending interest rate -- to maximise the number of customers it can serve. Market research can help a centre understand these barriers and determine the price points at which it can sell its products.For example, when FreeComGroup set out to build the retail arm of its refurbishment business, it convened a group of families and individuals who had expressed interest in purchasing a computer. By asking them questions about their needs and finances, interviewers determined that families tended already to have significant credit liabilities, and were not interested in borrowing money to purchase a computer. However, families were prepared to purchase computers outright if they were sold at a price point of ZAR 1500 (about US$240). Using similar reasoning, Tsunami Networks, an importer and hardware service provider in Namibia, aspires to sell computers to individuals at the same price as a high-end mobile phone.

Fantsuam Foundation, in Nigeria, uses a different model for selling its computers to homes and individuals. Having determined that a reasonable price for its refurbished equipment was 50% of the cost of new computers, it established a system that provided layaway credit facilities for its customers. For several months in advance, clients can make payments toward a purchase; as soon as the last payment is made, the client receives the computer. Fantsuam is also considering extending its existing microcredit facility, in which small amounts of capital are loaned to people and repaid over time, to support computer purchases. As microcredit is itself a business requiring close attention, this idea is feasible only for those comfortable and experienced with microcredit management issues.

Volume of demand

Assessing the volume of demand is another important consideration, because the economic impact of high operational costs (such as facilities) can be minimised if they can be distributed across high volumes of sales. To calculate the volume of local demand, a centre may consider inviting prospective clients to attend a short information session about refurbished computers, their benefits, costs and differences from new computers. If a large proportion of prospective clients remain interested after the workshop, centre managers can take this as a good indicator of the presence of demand for refurbished computers in the local market.

4.4 Critical success factor for management: quality through process orientation

Process orientation -- maintaining a focus on production methods -- is the best way for a centre to ensure uniform quality and consistency among its products. Central to the concept of process orientation is defining standard ways of doing things and documenting each of those steps in manuals, flow charts and other forms of instruction. Procedures are most important for technical activities such as hardware diagnostics and software installation. Enumerating every step in a given activity in a workshop document helps to ensure that every employee does the same job in the same way. In the absence of clearly defined procedures, technicians and other employees will each perform their tasks slightly differently. By eliminating variation in the production process and focusing on achieving uniformity in every executed procedure, a centre increases the quality of its products, increases the likelihood that problems in the production cycle can be eliminated, and, if the procedures are appropriate to the task and adhered to by technicians, reduces the burden of technical support once a computer has been installed on a client's premises.

The following anecdotes from currently active computer refurbishment centres demonstrate the problems that arise when procedures are inadequately documented, and the problems that can be averted if technicians orient and discipline themselves to follow protocol:

> **Example 1**
> Newly hired A+-accredited technicians at a refurbishment centre were assigned the task of configuring dial-up Internet access on computers whose operating systems had just been installed. The technical manager, assumed that the employees -- accredited as they were with their diplomas -- knew how to set up the Internet dialler. He gave them the phone number, user ID and passwords and left them to do the job. Some time after the clients had received their computers, they called to complain that their Internet connections did not work. The technical manager made two mistakes that process-orientation would have helped to eliminate: the assumption that new trainees knew what to do, coupled with the absence of documentation, forced them to fumble their way through the assignment. The absence of a rigorous quality assurance process, designed to ensure compliance with a set of performance standards, meant the error went uncorrected until the clients complained.

Example 2
Staff at a supplier of newly assembled computers were responsible for building entire systems from scratch. Technicians often worked alone while fitting all the components together. A separate team of quality controllers verified the assembly. Several times, a short circuit prevented the computers from booting: as soon as the power button was depressed, the lights on the case would flicker and then turn off. The quality controllers managed to trace the fault to a single technician who habitually overtightened the screws that fitted the motherboard to the case. The technical manager alerted the technician to his error and added a warning against overtightening to the procedures manual.

Example 3
At the facilities of another supplier of hardware, technicians copied the operating system, configuration and application software from one harddrive to another using a low-level copying utility. The program did not verify the integrity of the data as it was written from one drive to another. In the first few months under this new protocol, technicians used the same source disk each time data was copied. At some point, this original disk was installed in a computer given to one of the centre's clients. Thereafter, technicians started using different disks as sources, some of which were several generations -- copies of copies -- removed from the original disk. Soon, a number of different, unsolvable and often fatal errors began to appear on computers even before the machines left the assembly workshop. Configuration times began to skyrocket; the technicians grew frustrated at their inability to solve problems and began to copy disks more frequently in hopes of solving the errors. In the absence of a clear procedure, technicians did not know what to do to solve the problem on their own, and the course of action they took only compounded the mistake. A process-oriented workshop could have prevented three crucial errors. First, a set of rules regarding the handling of the original source disk would have prevented its installation in a computer bound for a client. Second, an error tracking system would have alerted technicians to the rise in failure rates traceable to the disappearance of the original media; an audit of procedures would have been able to attribute the failures to the use of a copying utility that failed to verify the integrity of data copied from one drive to another. Third, closer management surveillance could have put an end to the rampant copying and recopying of data that demoralised technicians and stifled their productivity.

Example 4
Technicians, following quality assurance procedures, connected a server to the office's local area network (LAN) to test its mail and web-browsing settings. The procedure deviated from normal quality testing, since the server was destined to access the Internet wirelessly. Most other servers produced in this environment were configured for dial-up access, and hence were tested with a modem. Once the technicians had verified that everything on this specific server worked, the machine was packed and shipped to the client according to procedures. Once the computer was installed in its new location, the server was unable to access the wireless network because technicians had neglected to revert the server to the correct settings. It had been shipped with a configuration still appropriate for the office LAN. A process-oriented management culture could have prevented the mistake by designing special quality-assurance procedures for the new product line before it entered the testing area.

These examples show how an inadequate focus on work methods can affect product quality. Each example touches on the importance of quality assurance procedures applied after the production process. Each scenario also shows that a focus on procedures in the production cycle -- the acts of building, configuring and installing software on computers -- can further reduce error rates, ensure the quality of the products and enable faults in production to be traced to a particular point in the workshop.

A computer refurbishment centre should design and implement standards and processes early, and take measures to enforce those standards. Managers should be encouraged to identify the protocol for disciplining those who deviate from the process and for rectifying problems with a view to creating a work environment where every technician carries out the same activity in the same way.

Documentation

Poor procedures and documentation have been identified as a contributor to poor quality output and high maintenance requirements of computer provision programmes in Africa.[12] Documentation of formal procedures is also the foundation for eligibility for international standards accreditation, a designation that can expand a centre's profile and enhance its reach into the supply market.[13]

Clear writing, good organisation and the use of pictures to enhance meaning are essential to documentation. Procedures should be recorded step-by-step, and written with a voice, tone and vocabulary consistent with the literacy of its intended audience. In most cases, managers should assume a technician's failure to follow documentation is more a consequence of poorly suited documentation than a reluctance on the part of staff to follow it. Where possible, physical demonstrations and examples should accompany written documents.

Tip: Supplementing documentation with examples

Tsunami Networks, a computer assembler in Namibia that works with inexperienced technicians, leaves a sample product, with its case removed, in the workshop at all times as a model to which its technicians refer while they are working on their own tasks.

Additional advantages of process orientation

Document-driven process orientation increases the likelihood that the workshop turns out high-quality products because it lays the foundation for tasks to be carried out the same way by every staff member every time. It also brings three additional advantages: it helps to formalise knowledge within an organisation; enables a centre to plan its operations with a view to sustainable production growth; and permits centres to engage in those monitoring and evaluation activities that allow a centre to improve its services.

Formalising knowledge

Procedures also help to formalise knowledge within an organisation. In many production environments, the distinction between workshop roles and individuals becomes blurred: certain tasks become tied to certain individuals, with the consequence that a given skill is unevenly distributed among staff in the workshop. Formalised procedures and good documentation help to disseminate knowledge much more broadly.

Documentation also helps to alleviate the strain on certain staff members. In many ICT environments, more experienced workers face greater pressures and demands on their time. The presence of documentation eases the burden on these key people by allowing the centre to distribute responsibilities to different parties. This also protects those with specialised skills so that they can concentrate on the tasks that are unique to their role.

12 Ian Braid and Geoffrey Daniells. *Project Refcomp: Project Overview*. Unpublished, shared via email. Also Terence Sibiya, founding Executive Director, Computer Education Trust. Phone interview, February 2004; and Holger Oberprieler, management consultant. Interview, March 2004.

13 See "ISO 9002 Translated into Plain English", http://www.connect.ab.ca/~praxiom/9002.htm

A corollary of this problem is turnover: when key staff members leave, their knowledge about the way things are done can leave with them. If there was no role-individual distinction at the centre before the departure, it can take months for a replacement to learn all the tasks and responsibilities of the post. Closely followed procedures, manifested in documentation, are a centre's best hedge against this threat.

Planning for scalability

A problem endemic to hardware and technical support providers working at small production scales is a lack of anticipation and preparation for their growth. The early implementation of standards, even when supply and support volumes appear manageable, can prevent the emergence of problems as the demands on a centre grow.

Most problems seem manageable when a centre is in its infancy. When scales are small, technicians know who has received what kinds of equipment, the names of their clients, the kinds of problems commonly encountered and the solutions commonly required. It is a much different story when refurbishment centres are supporting fifty or more installations. At larger scales, a centre must rely more heavily on documentation for information about hardware profiles, contact details and other information. Over a longer period, staff changes, promotions and turnover can disrupt informally forged relationships between clients and representatives of the centre. By introducing comprehensive documentation procedures for production, client relationship and support, as well as using software to help manage that information, a centre stands a better chance of weathering the burdens of increased demand on its resources.[14]

Nascent operations tend to undervalue the priority of process orientation because the scales at which they produce, install and solve technical support questions mask disadvantages of informal and ad hoc solutions. But once support and production pressures rise to a certain threshold, informal procedures begin to break down. Individuals can no longer be expected to remember the kinds of products a given client received, or recall what kinds of service needs a certain customer has expressed. The informality with which agendas, schedules, requirements and priorities were tracked ceases to become effective as the volume of planning requirements grows.

There is also a danger that refurbishment centre managers feel they can wait for a certain threshold to come about before a centre should dispense with their informal procedures and implement documented ones. But formal procedures and planning tools bring a long-term benefit that justifies the cost and time involved in their creation. And since it requires significant management talent to shepherd a shift from an informal to formalised work environment, most centres with aspirations of supporting large volumes of clients have no choice but to formalise their systems at the outset. It is better and easier to create good habits from the beginning than to try to rehabilitate poor ones later.

A key driver for ensuring sustainable growth is the elimination of informal activities in favour of the creation of formal procedures. Determining, evaluating and documenting a set of standard procedures that technicians, helpdesk representatives and on-site repair personnel must follow will be a key factor in a maintaining a centre's success even as production volumes and technical support requirements grow over time.

Monitoring and evaluation

Developing a culture that attends to detail, follows procedures and reviews its standards brings indirect benefits alongside the direct returns of quality and scalability. Processes give managers something to measure and control. In the absence of processes, errors are untraceable and apparently random. Problems can creep into a production environment unnoticed. To combat this, centres should develop a method of identifying which technicians have worked on what equipment -- mechanisms as simple as signing off on a

14 See the sections on "Technical support" and "Inventory" for a discussion of management software.

work order or maintaining a record of daily assignments will suffice -- and a system in which managers audit reported errors, refine processes and enhance documentation. The presence of traceable assignments enables errors to be isolated either to employees or to process design. The introduction of rewards for technicians who produce error-free work can engender positive attitudes about compliance. Together these two initiatives can comprise an accountability programme that will increase the likelihood of uniformity and quality in the products that leave a centre's workshop.

Not just workshop activities should be tracked. An operation that keeps good records of installation dates, inventory and production volumes also makes the job of internal and external performance evaluation easier. Any operation answerable to equity shareholders or subject to accounting standards applied to publicly financed entities should expect to be evaluated regularly. By maintaining formal records and following formal procedures that update and enhance those records, centres are more transparent to their stakeholders and outside auditors.

These process monitoring tools may include more than records of site visits, installations, service calls and hardware production volumes. They could also include mechanisms to measure clients' ongoing use of ICT. For instance, centres can build a pro-active technical support structure around the data kept in Internet connection logs, which record the time a client connects to the Internet and signs off again. A client's computer can be configured to email these logs to the centre on a regular basis, and design a system to calculate the frequency by which users access the internet. Changes in the frequency can be used, for example, to measure the impact of a recent training session on a client's use of ICT or to highlight the need for financial or other kinds of support to promote greater use of the Internet. Sudden stops in Internet access can prompt a technical support call or visit.

Internet service providers (ISPs) also log the times that its clients access the Internet. Centres may be able to forge a special relationship with an ISP that grants the centre access to the ISP's logs about the frequency of Internet use among customers of the centre. In the majority of cases, however, such collaboration will be difficult to arrange because of the kinds of data involved.

No matter how it is collected, this data must be used only with clients' permission. Crucial to the agreement between the centre and its client (and the ISP, if applicable) is securing the user's informed consent about monitoring details. Users must be briefed about the kind of information being shared and must also be given an option to refuse monitoring on their computers and to cancel the activity at any time, without penalty. The centre must also guarantee that the information will be used only by the centre for the purposes clients agree to. As well, the centre must promise not to sell or divulge information for commercial purposes. Sample privacy policies available on the Internet should be able to provide a starting point for the centre's own user agreement and for the methods it can use to inform its users before they grant or withhold consent.

A centre may also wish to package its ongoing monitoring activities as a feature service to which its clients can choose to subscribe. The separation of the programme from the core product offering may also underscore its optional nature, and put an emphasis on the balance between giving access to private data in exchange for enhanced services. If used well, the monitoring can provide quicker, more responsive and pre-emptive service. But the service requires trust to make worthwhile the compromise about one's rights to privacy.

In the absence of formal data collection programmes tied to ongoing monitoring initiatives, centres may wish simply to survey their clients' impressions of the quality of the centre's service and solicit recommendations for improvement. In the same survey, the centre can ask clients to describe their Internet and application usage.

Summary

- ➔ Defining a centre's market position, measuring the costs of service provision and assessing demand to calculate the affordability of its products are three key business drivers that determine the financial sustainability of a centre.
- ➔ At the same time, internal management priorities comprise another set of critical success factors. A process-oriented production culture allows a centre to measure performance according to the extent of its compliance with standards. When coupled with good documentation, it also formalises knowledge in a work environment.
- ➔ A focus on work methods is also the surest way by which a centre can maintain high quality among the products that leave the workshop. Process orientation also affords managers an ability to measure employee performance and gives them a way to introduce changes in production methods and, importantly, oversee that employees adopt those changes, if errors arise.
- ➔ Process orientation also helps to ensure a smooth transition as the refurbishment centre raises its productivity. Since informal, ad hoc solutions appear effective in making problems disappear when staff and production is small, managers should expend considerable effort to implement formal procedures and processes as early as possible.
- ➔ Finally, monitoring and evaluating clients' use of ICT, in concert with their informed consent, can provide insight into the way that the centre's products are being used and can provide feedback about the stability of the hardware and software. This data can also highlight training needs and begin to indicate the kinds of ongoing support and direction clients require in order to derive maximum benefits from their ICT.

5 Supply management

A centre can draw its supply of used computer equipment from three general categories: overseas nonprofit suppliers, overseas commercial suppliers, and local corporate donors. Each potential branch of supply carries advantages and disadvantages. Establishing a supply of used computer equipment involves obtaining access to the computer market at large, finding ways to evaluate the worth of goods for sale, and determining which products and prices suit a centre's interests best. A centre manager must not only cultivate relationships with suppliers, but also develop the tools and familiarity with the market to appraise the value of offers.

5.1 Types of suppliers

Nonprofit suppliers

Several international nonprofit agencies focus on supplying used computers and other ICT equipment to computer refurbishment centres as well as individual customers in Africa and other continents. These outfits acquire computers primarily from donations sourced in the United Kingdom, Europe and the United States, the regions where donors appear to be most active. In some cases, the computers gathered are loaded and shipped overseas without refurbishment. Other agencies submit their supply to a refurbishment process in the developed world before the equipment is sent to recipient partners in developing countries. The computers are not provided free of charge. Recipients must cover the costs of local collection, warehousing and refurbishment, as well as shipping costs. Costs are typically fixed by the organisation for a set period.

The majority of computers donated to these operations come from corporations as they renew their ICT infrastructure and get rid of old computers. Companies' large volumes of identical or similar equipment are desirable for the relative ease with which they can be refurbished and maintained. Some agencies still collect donations from home users, but the practice is fading as a consequence of the highly varied stock this method produces.[15] Some higher-profile participants in donated supply include Computer Aid International, World Computer Exchange and the Digital Partnership. A more complete list of donor suppliers of used equipment appears in Annex A.

Commercial suppliers

Commercial suppliers are in the business of buying and selling computers for a profit. While their operational size and market strategies may differ, each commercial enterprise sources used computers from the turnover created by the widely-followed business practice of renewing ICT equipment outlined in the section entitled "Overview of the computer refurbishment industry".

Some suppliers refurbish equipment before reselling their stock; others specialise in sales only. Most suppliers post details of their current stock on their websites, or email price sheets and other information in regularly updated circulars and flyers. Sometimes the prices appear fixed; in other cases, computers are bundled into lots and auctioned in a closed or open bidding process. A list of many commercial suppliers of used equipment appears in Annex A.

15 Computers 4 Africa. "FAQ: How we ship computers to Africa." http://www.computers4africa.org/faq.htm#faq6

5.2 Considerations for choosing between suppliers: corporate or donor?

Several considerations should be taken into account when deciding whether to source computers from donor or commercial sources.

Eligibility

Foremost among these issues is eligibility. Most international donors will only supply computers to nonprofit organisations without the financial resources to pay for or secure computers themselves. In many cases, it is essential that these organisations be registered as nonprofits in the countries where they operate.

Several commercial vendors may also place restrictions on who can purchase used equipment from them. In most cases, the restrictions are in place because the company wishes to protect its brand. Some Tier-1 computer corporations worry that unscrupulous or careless resellers might tarnish the manufacturer's reputation by allowing lax refurbishment standards to affect the quality of the refurbished product, and, as a consequence, affect a consumer's experience and opinion of the manufacturer.[16]

IBM, for instance, controls access to its main used equipment supply channel, the Private Trading Exchange (PTX), by mandating that suppliers be in business for two years, be profitable, have established premises, and bring some sort of incentive or added value to IBM -- a market it does not have access to, or a specialisation such as education.[17] The PTX is an auction and catalogue run by Global Asset Recovery Services, a division of IBM Global Financing. Registered dealers can browse and bid on large quantities of off-lease equipment, as well as purchase used goods at fixed prices from an online catalogue. Applications for permission to access the PTX are available online.[18] A sample offer of goods distributed through the PTX is available in Annex H.

Price

Another consideration is price. Donor suppliers, perhaps because they have fewer eligible customers and, as a result, lower turnover, tend to have higher prices than commercial suppliers.

Sample prices (Quotes collected 2Q/2004. Excludes shipping.)			
Computer Aid International*	PII US$71 complete (independent of quantity) PIII –US$198		
World Computer Exchange	PI US$57.50 complete (at volumes of 225 and 450)		
Ace Traders	PII US$10-15	Monitor US$15-30	MSE/KBD US$5
GMCUK*	PI US$5-36	Monitor US$32-55	MSE/KBD US$2 new
GMCUK complete systems*	PII US$58 complete (at volumes of one pallet/15 units)		
GE	PII 350–US$30 (at volumes of 200+)		
*original quotation given in British Pounds. Converted GBP£1=US$1.82			

16 Heywood Rose, iCommunities Manager, Hewlett-Packard South Africa. Interview, March 2004.
17 Mark Owens, Business Development Manager, Global Asset Recovery Services, IBM Global Financing. Email interview, March 2004.
18 https://www-1.ibm.com/financing/gars/ptx/logon/LogonServlet.wss

The single biggest influence on the price of used equipment is availability. The market is driven by the quantity of supply to the extent that if several large companies get rid of their old computers at the same time, the price of computers falls across the board.[19] A flood of Pentium III machines not only creates low prices for Pentium IIIs already on the market, but it also shatters the price floor for computers with lower specifications. Because commercial suppliers are exposed to this market, their prices are adjusted frequently, and mostly in one direction: downward.

5.3 Price comparison

Commercial prices are not immediately comparable with those of donors, but careful analysis does permit overall costs to be compared. Donor suppliers typically include display, keyboard and mouse in their prices; these items are typically purchased separately from commercial suppliers. Computer Aid International also includes modems with volume purchases of Pentium II, as well as a number of boxes of untested supplementary equipment such as printers and networking devices.[20] World Computer Exchange and Computers For Africa often offer to supplement their orders with printers, software, documentation and networking devices on an ad hoc basis. Donor suppliers also tend to include a number of computers (from 3% to 10% of the volume) at no extra charge, either to compensate for so-called Dead-on-Arrival rates, the term given to computers that develop failures during shipment or to assist with the satisfaction of warranty claims from end-users.[21] Commercial vendors ship only what has been paid for, but sometimes include a warranty (often no longer than 30 days).

Cost advantages of homogeneous shipments

Even if they come with extra equipment, heterogeneous shipment may present hidden costs. While each organisation acknowledges that ideal shipments comprise large volumes of identical computers, none guarantees that a given shipment will contain only one make and model of computer. Computer Aid International, for example, states clearly that the composition of its stock at the time the order is filled determines the composition of the order.[22] Customers of commercial suppliers have greater recourse either to stipulate that their orders be uniform or to bid on only those lots that are; suppliers that operate at larger volumes are also in a better position to satisfy such requests.

It is difficult to quantify the value homogeneity can add to a shipment, but a supply of identical computers brings three main advantages:

(1) Large volumes reduce the per-computer configuration time technicians require to refurbish a machine, and cut down enormously on maintenance overhead during troubleshooting.

(2) The ability to exchange parts between models extends the total life of the supply since technicians can extract working parts from otherwise failed machines, and build one working computer from two or three failed ones.

19 Jason Karaian. "Getting Rid of IT". *CFO Europe,* February 2004. http://www.cfoeurope.com/displayStory.cfm/2383076

20 Tony Roberts. "aa Technical Queries FAQs - all P2 or above.rtf". No longer available online. Metadata shows that the document was created on 08 January 2004. Accessed from http://www.computer-aid.org in February 2004.

21 Close-the-gap. "Configurations". http://www.close-the-gap.org/mainFrame.cfm?ID=102

22 "If we have 5% PIIIs in stock all orders will receive 5% PIIIs. If we have 20% PIIIs in stock all orders will receive 20% PIIIs. It is not possible to provide higher specifications (or higher percentages) to you from the machines donated to us as people do not donate higher specifications (or higher percentages) to us. For us to reserve PIIIs just for you would be unfair to somebody else so we never do this." Tony Roberts. "aa Technical Queries FAQs - all P2 or above.rtf". No longer available. Metadata shows that the document was created on 08 January 2004. Accessed from http://www.computer-aid.org in February 2004.

(3) Finally, clients prefer cosmetically uniform equipment, and novices may infer or project performance differences onto computers that look different.

Analysis in business environments has shown the value of the homogeneity within computer fleets, but most of these gains are measured as a savings in labour cost, which, in a volunteer environment, has limited application.[23] These ICT-industry cost projections also operate under the assumption that replacement parts for different computers are equally easy to source, as is often the case in the developed world. A metric more applicable to refurbishment centres is the impact that increased labour requirements can have on productivity, weighed against the opportunity cost of learning and repeating the process of sourcing drivers, building hardware profiles and troubleshooting problems characteristic of a given product line. Even more pertinent to a refurbishment operation is the availability of replacement parts. In most cases the only viable source of excess parts will be the shipment itself. As the shipment's diversity increases, the centre's ability to satisfy its replacement needs diminishes. Computer obsolescence rates climb as a result. These issues highlight the fact that shipments composed of different computers bring extra costs and, likely, other kinds of problems, not immediately visible on appraisal.

Business motives and knowledge of local conditions

Donors and commercial suppliers also have different motivations for working with African partners. A commitment to helping Africans address problems with access and supply of ICT typically features in donor suppliers' mission statements. As a consequence of their intentions, many donor agencies are willing to answer more questions and provide more advice about procurement and shipping than are commercial suppliers. World Computer Exchange, for example, assigns programme officers to certain regions, who become the primary point of contact for importers. At the same time, donor agencies, attentive to their profiles both at home and internationally, are sensitive to their exposure to accusations that they just help wealthy corporations dispose their obsolescent equipment by dumping it cheaply on African nations, and that they fail to ensure that their donations form part of a sustainable ICT programme. So the majority of donors use an application procedure to ensure that the equipment will be well used when it arrives, out of both genuine concern for sustainability and as a means to help them answer their critics' contentions. It is now a standard expectation among nonprofit computer agencies that applicants will be able to specify the intended use of the computers, explain a centre's plan for technical support, and demonstrate that a training plan is in place. These applications can be accessed from donors' websites.

Commercial vendors have no reservations about sustainability or programme integration, but the steps required to get the attention of a business culture unaccustomed to dealing with African partners creates what amounts to an application process anyway. Representatives at GE Refurbishment, the ICT remarketing division of conglomerate General Electric, for example, will require potential African partners to call sales representatives early in the stages of negotiating a sale -- probably after the first email contact. Jordan Wolfe, GE's general sales manager and a board member of Association of Service & Computer Dealers International, an industry association for businesses involved in computer leasing and remarketing, explained that "shenanigans" with previous African clients created a preference for using phone interviews to build trust with potential clients prior to reaching a sales agreement.[24] But this extra barrier should not be taken as an indicator of a broad-based reluctance to sell used computers to Africans. With reported sales of more than US$150 million (server and desktop equipment) in 2003 and capacity to grow, Wolfe said, sales managers at GE Refurbishment are always looking for new market opportunities. In America, African markets are receiving more official attention, as a consequence of the US Government's African Growth and Opportunity Act (AGOA)

23 This is true if the operating system differs as well. Gartner. "The Cost of Client-OS Diversity." March 25 2003. http://www4.gartner.com/DisplayDocument?doc_cd=113896

24 Jordan Wolfe, Manager, GE Capital - Refurbishment. Phone interview, May 2004.

programme, and appear to be receiving more informal attention as well, as sensitivity about African development issues becomes more widespread.

Commercial vendors will also insist that financial transactions, including letters of credit or escrow services, be handled through internationally recognised banks, and perhaps only at banks with facilities major financial centres such as New York or London.[25] This consideration should influence a centre's choice of bank in the country in which it operates. In addition, most vendors require up-front payment via a wire transfer. The majority of international commercial vendors responded with interest to queries about supplying African markets with ICT, but expressed hesitation because they could not quantify the risk it might present to their investment. Personal contact that annihilates the apparent anonymity and potential fraudulence of email, as well as financial transparency in which trusted third parties such as international banks participate, can together reduce these preliminary barriers.

All the same, commercial vendors may be less conversant with the connectivity and communications problems characteristic of African environments than are donors, and they may need to be briefed more about these issues, lest a communication breakdown such as a missed phone call or late email spoil a deal. They may also be less tolerant of delays in the arrangement of credit approval and funds transfers endemic to economies with poorly serviced banking sectors. Full and early disclosure can reduce these misunderstandings or eliminate them altogether.

Speed and flexibility of service

Commercial vendors may provide greater speed and flexibility with supply arrangements on account of the volumes they have access to, but only if financial arrangements are in order. Bidding, invoicing and up-front payment can happen in about five to ten working days. Donor suppliers, on the other hand, may have access to fundraising initiatives that prolong the procurement process but offset some of the strain on a centre's capital. World Computer Exchange, for instance, works on a four-month timeframe from the acceptance of the application to the receipt of the computers, and provides guidelines and support about securing donations to help pay for the shipment.[26]

The language of sales also complicates matters. Sometimes, computer brokers will sell used machines directly off-lease, and charge a premium if the computers have been refurbished. It is difficult to affix a value to the service. While "used" is a term that permits of little ambiguity, "refurbishment" remains nebulous. With some vendors, it means verifying the presence of certain parts, and perhaps seeing if computers boot. In others it means submission to an appropriate suite of diagnostic tests. Independent of a vendor's claims or conscientiousness, travel over long distances exerts a punishing force on even well-packed computers, to the extent that everything must be retested once it arrives. So a vendor's pledge of refurbishment -- unless it confers on the shipment a warranty that the vendor is prepared to honour overseas with cash in lieu or replacement for each failure -- adds little value to a quantity of computers.

With some vendors it is impossible to buy computers before they enter the refurbishment process. In other cases, it may be possible to request that computers be shipped in the condition in which they arrive at the vendor at further reduced prices. Key in these deals is ensuring that at least rudimentary testing is performed on units before they are shipped in order to reduce the amount of computers that are dead on arrival.

Different business cultures

Essentially, charity computer suppliers and commercial vendors are in the same business; only their business cultures differ. Donor suppliers offer clients more support in the

25 Letters of credit and other shipping forms are discussed in the section entitled "Shipping and Customs".
26 See "Draft Partner Process", http://www.worldcomputerexchange.org/toolkit_english/process.html

application process and likely have more understanding of issues relevant to ICT and the nonprofit sector. But unlike commercial suppliers, they do not allow their clients to determine the composition of their own shipments. Business operators offer little or no support, but allow clients to bid on different compositions of equipment at flexible prices. A centre operator's market position, confidence, experience, access to capital and the time pressures of the centre's production schedule will together determine which supplier is preferable.

Operators of newly founded centres may at first wish to consider taking advantage of the support donor suppliers provide if they have registered as nonprofit enterprises. The lessons learned from the process of securing one shipment with the support of the charity can then be applied to the procurement process on the open market commercial vendors provide. A long-term goal may be to qualify as a partner able to access IBM's PTX, or other vendors' commercial resale operations.

5.4 What to buy: evaluating offers

Supplies should be sourced in volumes determined by quantities that are cost-effective to ship (see Shipping for a complete discussion), which typically means 200 or more computers at once. Many suppliers compete to market such large volumes of computers, but their size, average specification, age, brand and model type can vary greatly from shipment to shipment, to the extent that it is improbable that two allotments will permit direct price comparison. Instead, prospective buyers will have to apply a number of considerations to assess the relative value of one shipment against another. Purchasers of used equipment should factor at least two questions into their evaluation of a supply of computers: how long will these computers work, and how much will it cost to keep them running?

These two considerations, insofar as they are core to the set of considerations involved in what is called the total cost of ownership of a computer, are highly complicated, difficult to forecast -- especially in African contexts -- and the subject of much debate.[27] This discussion is not intended to address all the questions relevant to an assessment of the total cost of ownership of a fleet of computers; rather, it is intended to apply some instruments developed within the total cost of ownership framework to the task of evaluation for the purposes of procurement.

Standardisation

Just about the only rule about volume purchasing is that it is cheaper and easier over the long term to support large quantities of standardised equipment than it is to maintain a fleet of computers of varying brand and configuration. The best way to minimise effort and cost over the long term is to acquire computers not just on the basis of their initial per unit price, but also according to the forecast cost of maintenance for each item within that shipment. By including anticipated costs into an evaluation of computers not yet bought, a centre can control some costs up front.

It is clear that uniform shipments should be valued at a premium. In spite of the established best practice of procuring only identical computers, the market does not always provide what purchasers would demand. Many suppliers, especially brokers of off-lease equipment not affiliated with a single manufacturer, will offer shipments of mixed brands more frequently than they offer a consignment of computers of the same make and model. A shipment of 200 computers might contain unequal volumes of 5 different types of computers or more, with a range of processor speeds. The composition and price of these shipments deserve careful consideration.

27 For an in-depth discussion of the total cost of ownership, see Open Research's "Total Cost of Ownership Calculator", a CATIA 2a project.

A batch of 200 computers of mixed brand and chip speed is worth less than a consignment of 200 identical machines because it will take more work to configure each different computer within that shipment. How much more work, and at what cost, is difficult to quantify, especially, as discussed above, when labour and productivity costs have to be weighed against the opportunity cost of technicians learning about different configurations and support issues. But some direct and indirect costs can be roughly projected.

How much is uniformity worth?

One direct cost heterogeneous stock presents, is the cost of the bandwidth required to download drivers and BIOS updates or to use the Internet to research which problems are characteristic to a make and model of computer.[28] If the average technician requires, for example, three hours of research and three megabytes of downloaded material to restore a computer to working order, and if those costs can be spread over 50 or 200 computers, the average cost per unit is lower.

Another direct cost is parts: as discussed above, in most cases, only the supply itself will provide a pool of replacement parts through a practice often called "cannibalising". Cannibalising is the process of reclaiming working parts from otherwise failed machines and installing them on compatible computers that have suffered different failures. For instance, a computer with a failed power supply can still be used to provide RAM, a harddrive or motherboard to a computer with one of these failures.

If only ten units have interchangeable parts, managers have less recourse, first, to choose to install every one of those ten units, because one or two should be kept behind for spares. Second, the centre will have fewer options about where to install the computers: given clients' preference for cosmetic uniformity, it will be difficult to maintain client satisfaction by mixing eight or ten of one model with those of another make. Finally, small quantities of computers increase the risk that faults will require replacement with another computer rather than a repair sourced from parts found in matching computers: if eight of ten computers are deployed to clients, and two are kept behind for repair, as soon as the third similar failure occurs (if the power supply fails on three of these computers, for instance), there will be no more parts with which to repair the failure, and that machine, and every computer with that failure thereafter, will have to be replaced.

By the same token, large volumes of identical equipment present a danger of being overvalued. A shipment of identical computers is prized because of the low configuration and maintenance overhead and because of its immunity to problems in cannibalising parts from a small supply stream. However, cannibalising is only effective as long as failures are complementary -- that is, if the union of good parts from two otherwise faulty computers can together produce one functional unit.

However, the likelihood of using cannibalisation to reduce the total number of nonworking machines depends on the difference in the failure rates of independent parts. If, for example, a power supply has a 30% probability of failure in a given period, and a harddrive has a 10% probability of failing over the same period, only a third of computers with failed power supplies will be able to be restored to working condition by harvesting the power supplies from machines where the harddrive has failed. The other two-thirds of the failures will require new power suppliers or genuine repair in order to be restored. So while the recourse to cannibalisation does confer extra value on a shipment, its benefits are constrained by the rates of complementary failures.

The value of uniformity is a product of distributing direct costs such as the time and bandwidth required for configuration over a number of computers, and of avoiding or minimising indirect costs such as client preference and the necessity of maintaining a pool of replacement parts. Valuation is more art than science, but it is important, from the

28 BIOS and drivers are discussed in the section entitled "Assembly, software installation and configuration" in Part II of this guide.

perspective of a computer refurbishment centre responsible for after-sales maintenance, to strive to keep shipments as uniform in specification and brand as possible. In the end, only experience will provide accurate forecasts for anticipated costs.

By contrast, there are not many good guidelines about putting a price on heterogeneity in a shipment. The most important thing to avoid in large shipments is very small numbers of a make and model of machine buried among large quantities of other computers. Three or five computers of one kind present almost nothing but cost to a centre. (Then again, it may be worthwhile to purchase five worthless computers if the other 195 are great value). An allotment of ten or even twenty computers is equally problematic. Some practitioners agree that the threshold for cost effective volumes is likely to be as low as any amount that would allow for at least three laboratory-type installations of identical computers, including 10-20% for spares. This allows direct configuration costs to be spread over a reasonable number of units. It also permits a degree of flexibility about where these computers can be installed, and increases the number of clients to whom a supply of replacements is useful. Larger volumes -- up to 200 or more -- are always preferable, but it is difficult to affix a premium to their value. A complicating factor is that the nominal premium paid for uniformity might be very low (perhaps US$5 per computer) when the proportional cost of that US$5 premium (33% of what might be a US$15 item, for example) seems very high. The cost may be measured differently. Depending on the supplier, premiums for uniform shipments may not present a per unit cost, but an administrative cost to cover the extra labour of building a custom shipment. In any case, prospective bidders should endeavour to get as much information as possible about a bulk shipment before agreeing to a purchase. Most suppliers will be able to comply with requests for more detail; if they cannot, it may be a sign that something about the shipment is being misrepresented.

A different cost consideration for uniformity: the local market

The experience of ICT providers at Fantsuam Foundation, which acquired a mixture of Pentium I-, II-, and III-class machines from World Computer Exchange in 2003, presents a case that illustrates the pitfalls of non-uniform shipments. It also shows how local market demands should affect a centre's acquisitions. Fantsuam Foundation sells some of its internationally-sourced used computers to home users in Nigeria. According to one of the senior technicians at the foundation, when the first shipment of computers came from WCE, the computers were all sold at the same price -- 50% of the cost of a new computer -- regardless of their specifications. The entire supply sold out quickly. It did not take long before customers began to realise that the computers some people had received were faster and more responsive than the ones others had received. Some complained. When the next shipment arrived, Fantsuam introduced a pricing structure that differentiated machines according to their processor class. Pentium IIIs sold for about 60% more than Pentium-Is; Pentium-IIs were priced in-between. The shipment sold out again. But by the time the foundation received its third shipment, it faced a different problem: the market had become so savvy about the relationship between chip speed and performance that customers had developed a preference for faster machines. Pentium-II and –III class machines continued to sell out quickly, but some customers, when they approached the centre to buy a computer and were told that only Pentium-Is remained, said they would prefer to wait for the next shipment rather than buy a Pentium I. The foundation was unable to sell its low-end computers to its free-market customers, and had to bear the dollar cost of acquisition and shipment, as well as the sunk cost of warehousing on its own. Had the computers arrived in a different sequence or had the shipments been more uniform, the foundation may have avoided the situation.

Longevity

In addition, a refurbishment centre, if it acquires used equipment, should also seek to optimise the longevity of hardware against its cost. Brand and chip speed are two

properties most highly correlated with the anticipated useful life of a computer[29]. Experiences with refurbished computers show that Tier-1 computers -- the brands IBM, Dell, Compaq and Hewlett Packard -- give the greatest likelihood, on average, to continue to function for two or three years beyond the initial three-year life cycle their original owners planned for. Second-tier manufacturers such as Mecer, Acer and others, perhaps because of lower standards in manufacturing or in their parts supply, do not tend to last as long. "White boxes", the term the computer industry uses to refer to unbranded machines assembled one-by-one or in small batches by stores and other small supply operations, are even less reliable over periods of three years or longer.[30] Another strong indicator of longevity is a computer chip's clock speed: the greater the speed, the younger the chip, and, as a consequence, the greater the likelihood it and the computer in which it is installed will last further into the future.[31]

5.5 Recommended minimum specifications

Longevity indicators permit the formulation of a recommended minimum specification for determining which computers should be acquired. In 2004, consensus among African buyers of used computers seems to suggest 233-266mhz machines, both in the Pentium, but preferably in the Pentium II-class, to be the lowest-specification computers that present an acceptable likelihood of producing another two or three years of useful operation, in most cases, only as thin clients.[32] Lower specification machines, such as 486s and Pentium chips with speed ratings lower than 233mhz, generally do not justify the cost of acquisition (even at prices as low as US$5 per machine) as a consequence of the higher probability that the hardware will require replacement significantly sooner than other equipment. It is also a consensus view that brands of computers other than Tier-1 should be avoided on three grounds: the absence of fixed part specifications among models complicates the task of sourcing drivers;[33] the price difference that makes second-tier brands attractive has for the most part disappeared once they are remarketed. Finally, preliminary quantitative research is beginning to justify the perception that second-tier brand computers tend to be shorter-lived than top-tier branded computers.[34]

5.6 Purchasing thin clients

Those centres seeking to import suitable thin clients for use in a thin-client environment (see Product Development) must incorporate some extra criteria into their evaluations of offers.[35] Thin clients require neither a harddrive nor, under current versions of Linux terminal server software, any more than 64 MB of RAM to operate with optimum efficiency, but the majority of suppliers package their offers so that the computers can work as standalone machines with harddrives and sufficient memory. When bidding on existing lots it may be cheaper to purchase the unneeded but already installed harddrives than to pay a service fee for each one to be removed; if a supplier is preparing a custom shipment, buyers should specify that harddrives are unnecessary.

Purchasers should also give extra attention to the client's compatibility with network interface cards (NICs) to avoid purchasing clients it cannot use. For instance, TuxLab, a computers-for-schools programme run in the Western Cape by the Shuttleworth Foundation, gave its supplier a sample of the standard NIC and eeprom (Electrically

29 "Refurbished Computers meeting", organized by Tactical Technology Collective. Okahandja, Namibia, March 2004; and "Are Refurbs Worth It?", Open Research Workshop. Johannesburg, South Africa. April 2004.
30 Ibid.
31 Open Research Workshop, April 2004.
32 For greater detail about thin clients, and other considerations of matching chip speed and software, see the section entitled "Product Profiles".
33 A device driver is a piece of software used to control a hardware component or peripheral device of a computer. Discussed in detail in the section entitled "Assembly, software installation and configuration".
34 Open Research Workshop, April 2004.
35 See the section entitled "Product Profiles" for a full discussion.

erasable programmable read-only memory) it uses in its labs, and mandates that the supplier verify that every computer destined to become a thin client be tested to ensure it works with the network card and the chip affixed to it.[36] It is best practice in LTSP labs to standardise the kind of network card installed on clients.

5.7 Monitors, keyboards and mice

Even if the computers being produced are refurbished, some computer refurbishment centres opt to source new peripherals. For example, for reasons of cosmetics and cost, SchoolNet Namibia has chosen to source its monitors, keyboards and mice locally instead of from overseas donors. Because older monitors were perceived to have failed more frequently than was acceptable, it was decided that new monitors, sourced locally for about US$100 apiece, were preferable to refurbished displays, whose prices vary from US$15 to US$70 depending on age and size.

Sample Price trends for Monitors by Age and Size - (prices in US$)[37]

Size	1996	1997	1998	1999	2000
15"	$ 20.00	$ 21.00	$ 21.00	$ 22.00	$ 25.00
17"	$ 26.00	$ 27.00	$ 28.00	$ 30.00	$ 32.00
19"	$ 48.00	$ 50.00	$ 55.00	$ 55.00	$ 65.00

New keyboards and mice, available locally for about US$7 each, were also sourced from a national branch of a wholesaler operating in the region. Only the presence of a local supplier with competitive pricing on new equipment and a capacity to deliver in large volumes enabled this decision. SchoolNet Namibia is also considering approaching monitor manufacturers overseas to acquire new displays in large quantities. It hopes to save 20-30% by sourcing equipment direct from the manufacturer.[38]

5.8 Supplementary ICT equipment

If a locally affordable source does not exist, centres will also have to source peripherals and supplementary equipment such as uninterruptable power supplies, networking gear or printers from overseas as well. (A list of the supplementary equipment that should be included with products appears in the section entitled "Product profiles"). Sales channels for new and used peripherals remain similar to those for computer hardware. See the directory of sources listed Annex A for links to sites that sell peripherals and other equipment in bulk.

Tip: Becoming familiar with the international off-lease market

The best way to build confidence about what computers are worth, both in bulk and individually, is through familiarity with the market. Several suppliers post their deals online, as well as allow prospective buyers to subscribe to an announcement service. High turnover rates at auction sites allow observers to track price changes from the opening through to closing bids. By actively

36 See Annex H for more detail.
37 Sourced from http://www.acetraders.com/dimen2.htm
38 Anthony Bessinger, partner, Tsunami Networks. Interview, March 2004. Tsunami Networks has handled overseas purchasing on behalf of SchoolNet Namibia.

observing deal size and price, and watching the changes in quantities and qualities of computers changing hands, it is possible to demystify some of the vagaries of the used ICT market. It is a good idea to spend at least a month watching the market, subscribing to frequently mailed pricing lists and otherwise building relationships with suppliers before beginning to bid on equipment.

5.9 Local donation

Several existing refurbishment centres secure a supply of computers from local donations. Computadores Para Educar, in Colombia, for example, initiated a government-sponsored donation solicitation programme, which urged companies to donate their used computer equipment to its computers-for-schools programme.[39] With the support of tax breaks for donations and a highly visible campaign targeted at the social responsibility programmes within corporations, the programme has managed to secure the donation of 20,000 computers, each of which was refurbished and installed in a school environment. Similar models have been put in place in Kenya although the scale of the operation is, so far, much smaller. Each of these two programmes is a localised model of the corporate donation scheme spearheaded by Computers For Schools Canada, which has processed more than 150,000 computers since the 1990s.

Locally sourced corporate donations are not guaranteed to be without problems as SchoolNet Namibia's less-positive experience with informal donations shows. Many times over its four years of operation, the computers SchoolNet received were either beyond their useful life, or came in such small quantities that the donations required intensive labour to return them to working state. The original manufacturers of the equipment, in some cases, no longer produced computers, or no longer supported the model donated to the workshop, complicating the search for the software needed to return the computers to a fully working state. In other cases, the computers required extra memory and a new network card in order to be deployed as thin clients, but because of the age of the equipment, parts were impossible or difficult to source. Most items were so old they presented a high probability of failure within a short period. As a result, even if the computers could be refurbished, it made little sense to install them in a classroom. Other components gave problems as well. Monitors received by SchoolNet tended to be smaller than those in its active stock; many could not support full colour; some older parts were not compatible with the software SchoolNet installed. Most monitors had to be scrapped. In the majority of cases, the donations resulted in a direct cost to SchoolNet, either in labour or parts, or, in the majority of cases, in disposal. In the end, SchoolNet's director stopped welcoming locally sourced donations.

Elements of successful local donation campaigns

The absence of a formal solicitation campaign may well have contributed to the limited feasibility of those sporadic donations that SchoolNet did receive. The most important part about a donation campaign is defining to potential donors and to the public what can and cannot be accepted, and at what cost. FreeGeek, a volunteer-driven refurbishment centre in Portland, Oregon, on the west coast of the USA, for example, accepts all kinds of computers, but charges a fee for monitors. It also accepts some hardware even though the centre has no intention of using it. For instance, all Compaq machines are immediately disposed of because of some proprietary memory. But it makes clear the centre does not accept televisions, photocopiers or microwave ovens. It also urges people to bring as little packaging as possible, likely because it found itself swamped with cardboard and

39 Computadores Para Educar. "Que es CPE." http://www.computadoresparaeducar.gov.co/que_es.html and "Donantes." http://www.computadoresparaeducar.gov.co/donantes.html (in Spanish). Translated with Google.com's "translate this page" function.

Styrofoam packaging by well-meaning donors.[40] These kinds of rules were instituted not merely up-front, but by hard-earned lesson as well.

Donation programmes require a lot of work beyond communications strategy. Not only do a centre's donation specifications have to be measured, decided upon and justified, managers must also prepare for a campaign's success: valuable local donations, unlike container shipments, come in steady but small streams, and will put a different strain on storage space and inventory methods. They will likely require a lot of parts and technical effort to convert a standard product from disparate donations. They will also test the breadth of hardware operating systems can run on. Increased hardware traffic will inevitably result in increased disposal rates over both the short and long term.

All of these considerations must also be clearly communicated to the donor pool so that it can appreciate some of the hidden costs incurred through hardware donation. It may be possible to mandate that each donation in kind also be supported by a donation in cash in order to maximise the utility of the gift and minimise the centre's cost of supporting it for another specified period.

More than any single factor, the quality of the local computer supply in the places where centres operate will determine the feasibility of a local corporate donation programme. Unless the donors themselves have paid heed to best practices in procurement and maintenance, chances are high that the computers offered to the centre will be closer to their end-of-life than computers sourced through the off-lease market. It is also likely that volumes of similar hardware will be considerably smaller than is optimal. Many computers may already have faults; some may have been unused for long periods of time before being packaged for donation. It may be worthwhile to verify the age and specification of the donation before accepting it, or to assert a right of refusal within the terms of a donation programme.

Another method of securing a local resource pool is to examine the feasibility of contracting to undertake the removal and de-installation process that some remarketing businesses use as their source. As described earlier in this document, some used equipment brokers subcontract a company's task of removing computers from their original user's premises when the computers are being replaced. In exchange, brokers secure the right to sell the computers on the used market, and share the profits from sales of refurbished computers with the leasing company. Instead of profit-sharing, it may be possible to be paid for this work in hardware, which the centre itself can refurbish and pass on to its clients.

5.10 Supply management

As explained above, a major component of establishing a computer supply is finding ways to evaluate and compare the relative worth of different sales offers. But effective pricing techniques are not the only source of savings to a centre: managers can also reduce the total costs of procurement by scheduling arrivals of equipment effectively and by improving supplier relationships.

These methods can only be used advantageously if the centre's own installation, sales and distribution plan have already been articulated in detail. This requires the definition of the centre's supply chain: the set of sales targets, installation forecasts and distribution plans, coupled with a set of estimates about the average amount of time, cost and labour consumed in refurbishment, procurement and shipping, that are each involved in preparing a computer for its next user. Managing the whole supply chain, can help to reduce a centre's exposure to two common problems: downtime and elongated negotiation.

40 FreeGeek.org. "FREEGEEK: DONATING EQUIPMENT." http://www.freegeek.org/computers.php

Reducing downtime

One chronic problem within refurbishment centres is downtime. A flurry of activity follows every arrival of a shipment of computers, but once the computers have been inventoried, tested, refurbished and either installed or packaged for distribution, much of the workshop descends into idleness. When shipments are sporadic or ill-timed, capacity goes to waste and the need for activity fades. It is not only boring for technicians; it is expensive to maintain an infrastructure that is not being used to its fullest. The problem is widespread: every African refurbishment centre interviewed in the course of research reported it was operating at less than capacity -- in some cases, at a rate about 4-5 times less than its envisioned maximum.

Supply chain managers can help to eliminate workshop idleness by scheduling movements in the supply chain to suit the pace of production and installation. The procurement side of supply chain comprises just the beginning of the elongated process of equipping clients with computers. The key to managing the whole supply chain is pacing each activity to coincide with each other activity in the chain. The slowest process in the entire chain, called the bottleneck, should determine the pace at which the supply chain moves. Once the whole chain moves at the pace of its slowest process, the boom-and-bust cycle of activity at other places in the chain should disappear.

A good example of managing the supply chain to suit its slowest process is in use at Computers For Schools Kenya (CFSK). CFSK is mandated with installing computer labs at Kenyan schools in partnership with the national government. It has been operational since 2003, after its founder spent close to two years planning the organisation and its processes. Early on, CFSK determined that training was the key to ensuring that schools seized ownership of the computers and the CFSK programme once the machines had been installed at a school.[41] So it introduced an eligibility requirement that mandated that a principal, teacher and board member at a school receive training and sensitisation about the CFSK operational model before the school they represented was to receive computers.

It also determined that training could only be given during the school holidays, which occurred three times a year and lasted for three to four weeks. The training programme for each of the school representatives was a week long. Its only training facility had twenty seats.

CFSK realised that its bottleneck was the number of school representatives it could train during the holiday; since its training facility could only accommodate twenty people at a time, it was clear that the programme could only install twenty computer labs per term. With its bottleneck identified, CFSK could begin to calculate all the consequences of its supply chain design: 20 installations of 20 computers each required 400 computers to be sourced, delivered and refurbished in time for the beginning of the school term, the dates of which are known at least a year in advance. From calculations about the amount of work required to test and refurbish computers, CFSK could work out how many weeks it would take to process 400 computers. Working backward from the date of the beginning of term, it could figure out when it needed a supply of computers to arrive, probably within a margin of error of a week or two. If everything stayed the same in the supply chain -- especially if the training capacity never increased -- these dates would be as true for the first term in the first year of operation as for the first term in five years' time.

Reducing negotiation time

Another common problem with regard to supply is the amount of time and effort consumed by dealing with suppliers. It is commonly believed among procurement managers that the interests of buyer and seller are fundamentally at odds. Bidding is essentially viewed as a competition between the supplier and purchaser over the most

41 Tom Musili, Director, Computers For Schools Kenya. Interview, March 2004.

unilaterally advantageous price. When the seller is taken to be an adversary rather than an ally, negotiation over price becomes time consuming.[42]

By believing that the supplier's prices should be driven down at all costs, a purchaser focuses only on maximising the value and optimising the volume of a given shipment. The quest to drive prices down involves multiple rounds of asking for pricing, bidding, and then demanding better pricing with reference to the competition. In turn, the supplier, worn down by quotation, bargaining and re-quotation, loses profit margin in the sales contract because of the added overhead of this process. The supplier's ability to reduce prices also becomes constrained by the bidding itself: the longer the bidding process, the harder it becomes to quote better prices because the administrative overhead of nursing the deal adds to the supplier's cost of doing business. And since work-intensive deals are less profitable, sellers lose their willingness to work with buyers who have reputations for elongating the deal-making process. In turn, buyers must seek new suppliers for each procurement cycle, which plunges the centre into the same drawn-out negotiating process once again.

Extended negotiations affect productivity and profit. An elongated, adversarial procurement process impedes a centre's ability to time its shipments to ensure that its staff always have a supply of computers to work with. The high turnover of suppliers also constrains a centre's ability to forecast the cost, quality, quantity or heritage of its supply beyond the current shipment, possibly disrupting product lines and leading to higher other costs. If supplier and purchaser can dispense with rivalries and instead develop a strong relationship, the two parties can focus on eliminating the chronic and expensive habit of cyclical quotation, supply and disbursement that halts production and leaves workers idle.

Key to this relationship is the articulation of a supply chain forecast. The more a centre can plan its installation schedule and assess its equipment requirements in advance, the better able a supplier, or a group of suppliers, is able to meet those needs, often at better prices. To make the procurement process more efficient, trusted sales agents should be taken on as preferred equipment providers and be made privy to a centre's plans as far ahead as managers themselves have articulated them. By allowing partners to understand what kind of supply will be needed at what periods, partners can help to eliminate the expensive lag between the arrivals of new supply and diminish the costs of uncertainty, bidding and overcapacity in refurbishment.

These partnerships will require an agreement about terms and contact volumes based on projected business, as well as clauses that allow purchaser or supply to break the contract if certain expectations fail to materialise. The precise contractual needs of suppliers will vary from business to business, but a standing letter of credit, demonstrating a buyer's ability to pay, will likely be a standard minimum. As well, an annual review process, which allows suppliers and purchasers to re-examine their business relationship, should also be instituted. Important also is allowing more than one supplier preferred status: it enhances competition and defuses charges of favouritism or exclusion.

Summary

- ➔ Establishing a supply chain and managing it well are two activities that are essential to computer refurbishment centres.
- ➔ Used computers form a part of a large and competitive market that accommodates several different kinds of suppliers. At the same time, the diversity of that market requires a lot of knowledge and familiarity with current pricing in order for purchasing managers to maximise a centre's spending power.

42 Holger Oberprieler, management consultant. Interview. March 2004. The seven subsequent paragraphs comprise a précis of Oberprieler's argument in favour of forging partnerships with suppliers.

- ➔ The off-lease computer market is also volatile -- prices and quality can change quickly. Ultimately, the procurement practices of local and international companies and governments determine the quality of used computer supplies. As a consequence, the long-term focus of a supply manager should concern the establishment of supplier relationships that can help insure a centre against price swings, fluctuations in availability and demand and the high overheads of the bidding and tendering process.
- ➔ Being able to articulate a centre's needs is central to a centre's ability to forge partnerships with hardware suppliers. It may take some effort and a few well-handled transactions in order to cultivate willing partners, but, in time, it will mean that computers are cheaper to source, that the supply of computers is more integrated into the operation, and that the boom-and-bust cycle of activity in the workshop is eliminated.

6 Shipping and customs

Importing computers and computer parts can be a lengthy process that involves a number of different parties, regulations, governments and banks. It can also be expensive. For every item that changes hands between businesses in different countries, approximately seven per cent of the value of the transaction has been used to cover the cost of transportation.[43] Shipping is financially risky too: delays in shipment and customs can quickly add to the cost of import.

Moreover, for the most part, arranging for the transport and import of goods from another continent can be bewildering. Fortunately, suppliers will be able to assist with the most difficult logistical legwork by finding their own agents to forward the freight from their premises to the computer refurbishment centre. Nevertheless, importers themselves must become as familiar as possible with the local processes and people involved in the government ministry responsible for international trade.

6.1 Importing: assessing local conditions

Of primary concern is finding out about locally levied tax and tariff rates as well as the necessity of securing permission to import goods, often in the form of an import license. Before purchasing any goods, it is essential that a prospective importer determine the following to establish the feasibility of import:

- Is an import license required to import computers, computer parts, peripherals and computer software? A license to import computer equipment is necessary only in some countries; in some cases it is necessary when the value of goods imported exceeds a given threshold.
- What are the cost, procedure and eligibility criteria to apply for an import license? Which ministry is responsible for trade?
- What value or amount of goods is the holder of an import license entitled to bring into the country, and how frequently? Does an import quota exist for all goods?
- Are tariffs applied on computers, computer parts or accessories. Are they levied on software? At what rates?
- Do opportunities exist for tariffs and other fees to be waived? Are certain businesses -- those who service educational institutions, for example -- exempt from import levies?
- What are the costs of clearance surcharges at customs and shipping ports? Many customs offices levy a fee for their services calculated according to the value of the goods; they also charge for demurrage, the fee assessed for warehousing equipment at customs should delays prevent clearance. Many customs houses levy a first-day demurrage rate several times higher than the fee levied for subsequent days; each day of delay incurs a cost passed directly to the importer.
- Which countries have favourable import laws or quotas? Do any embargoes forbid import from certain countries?
- Which freight forwarding companies operate in the country? Do they operate a bonded or otherwise insured warehouse where goods can be stored while awaiting customs clearance?
- Which clearing agents or other experts in the operation of customs do business in the destination country?

43 Asycuda. "UNCTAD Technical Assistance in Trade Facilitation." http://www.asycuda.org/pdf%20docs/UNCTADTechnAssi.pdf

- If the country is landlocked, which port in a neighbouring country is a most efficient point of entry?
- Which transnational trade communities does the country belong to? What are the implications of membership?

Each of these steps can be time-intensive. Three possible starting points may shorten the process of finding out about the details and intricacies of import.

- It may be fruitful to approach clearing agents or freight forwarders for answers first. Since they are in the business of shepherding shipments of goods through customs both at home and abroad, they make it a priority to know the mechanisms, people and bureaucracy involved in import and export in the countries in which they operate. An introductory meeting with a clearing agent or freight forwarder will likely provide answers to most questions about import, registration procedures, the names of key people in the ministry responsible for trade and perhaps even those who work at the customs quay itself. A consultation should be free of charge.
- Another option is to approach another company that already imports goods (What type of goods is virtually unimportant, as the procedures for import are independent of the type of item being brought into the country). Chances are high that one or two people are solely responsible for import, and will already be familiar with the way things work locally. A representative at another company, even if she or he bears little chance of perceiving the computer refurbishment centre a business competitor, may be less inclined to agree to a meeting than the freight forwarder, who might see in the meeting an opportunity to forge a business relationship.
- A third option involves approaching the ministry responsible for trade. In some cases, a government-sponsored business development agency may be able to provide some answers about local import procedures. The ministry itself should be able to provide the paperwork for registering as an importer and securing an import license, a process that can take anywhere from a week to three months. It will also be able to provide information about incorporation procedures.

Tip: Finding out about import

If an Internet or telephone directory produces no good contacts for clearing agents or import businesses, managers may consider approaching an auto dealer or the proprietor of an electronics shop, or asking a local mobile phone salesperson who supplies the store with its phones, and approaching that individual.

A good resource for general guidelines on importing goods into specific African countries is the Muslim Trade Network (http://www.muslimtrade.net). The site lists the addresses and telephone numbers of relevant government offices and outlines some of the specific criteria and paperwork local customs agents require to clear shipments. Some of the information about specific tariffs may be outdated, but the site's most valuable content is its directory of government offices, the addresses of which do not change with great frequency.

Exhaustive tariff and import information for African countries appears in Annex B. A full discussion follows in the subsection "Customs and Duties" later in this section.

In most cases, a supplier will be able to arrange for shipping or at least supply a quotation for the cost of shipping goods into the destination country. The experience of suppliers is a valuable resource. For at least the first shipment, it may be worthwhile to rely on their expertise for solving the problem of arranging shipment; thereafter, importers' familiarity with the process may allow them to find cheaper or otherwise more suitable shipping carriers.

6.2 Shipping volumes

The international shipping industry depends on standardisation for its efficiency. Ships sail standard routes at scheduled times; goods on those ships are packed on standard-size pallets inside containers of standard dimension and capacity.

Containers come in two sizes: 20-foot and 40-foot. A good description of different containers and types is available at Kuehne + Nagel's website:

> KN Container Guide,
> http://www.kn-portal.com/ocean/information/index.html?meta=7232&type=News

Suppliers typically sell items by the pallet load, or according to a volume that fits on a pallet or inside a 20- or 40-foot container. A 20-foot container holds ten pallets; a 40-foot container holds 20. If computers and monitors are packed separately, about 60 computers can be placed on one pallet; the size of the screen constrains the number of monitors that can fit on a single slab. If computers are packed together with monitors, about 16-20 computers can fit on one standard 48-inch by 40-inch pallet. (120cm by 100cm)

Pallet Dimensions and Capacity 1" = 2.5cm. 1 lb = 454g			
Monitor Type	# Monitors	Dimension	Weight Per Pallet (lbs)
14"	45	83"(H) X 40"(W)X 48"(L)	900
15"	45	90"(H) X 40"(W)X 48"(L)	1200
17"	30	80"(H) X 40''(W)X 48''(L)	1200
19"	20	90"(H) X 40''(W)X 48''(L)	1140
20"	18	83"(H) X 40''(W)X 48''(L)	1200
21"	16	90"(H) X 40''(W)X 48''(L)	1160
Computers	50-60	75''(H) X 40''(W)X 48''(L)	1200

6.3 Shipping costs

It typically costs US$3,000 to ship a 20-foot container from North America to a port in Africa, and about US$1,600-2,200 to do so from Europe or Asia, excluding insurance. Pricing fluctuates on the basis of precise origin and destination. A 40-foot container costs about twice the amount quoted for 20-foot containers. Transporting containers inland by road in Africa costs much more per kilometer than shipping by sea; for example, it costs the same to ship between Rotterdam in the Netherlands and Mombasa, Kenya as it does to forward the same container from Mombasa inland to Kigali, Rwanda.[44]

Some shipping companies also offer rates on volumes that are less than a container load (LCL). These amounts can sometimes result in cheaper pricing but may present longer overall shipping times.

Shipping quotations can be obtained online. Typically, users fill out a form on a website; a sales representative emails a quotation a few hours later. For more accurate quotes, those inquiring about prices should gather as much detail beforehand -- the number of pallets or containers, the anticipated mass, the point of origin (if the origin is in the US, logistics

44 Brian Robertson, Managing Director, Roberston Freight. Interview, June 2004.

companies require the postal code for calculation), and the destination. Most inland destinations in Africa will not appear on the online quotation engine; users should specify the closest port, or the capital city instead.

Online Shipping Quotation Services

Kuhne + Nagel,
http://www.kn-portal.com/ocean/

Cargo Info Africa: African Freight Information (requires free registration),
http://www.cargoinfo.co.za/

Shipping Rates & Schedules. FreightQuote.com (requires login & registration),
http://www.freightquote.com/Rating.asp

Maersk Sealand (requires login; site requires Internet Explorer),
http://www.maersksealand.com/

P&O Nedlloyd – Trade Lane Schedules,
http://www.ponl.com/

Most suppliers quote the price of equipment and shipping separately, but some prices for equipment are quoted FOB, or free on board. (Nonprofit ICT provider Close-the-Gap, for instance, quotes prices this way). This means that the price of the equipment includes the cost of transferring the shipment from the supplier's premises to the shipyard and onto whichever vessel the buyer or freight forwarder has arranged. The recipient must then only pay for transportation from the point of departure onwards.

When comparing shipping quotations, managers should ensure that the prices under comparison provide similar levels of service. While insurance, for instance, will almost always be included, some suppliers or freight forwarders may not arrange for full door-to-door service. Some quotes may include shipment from the supplier's door only to the port nearest the centre, but not to the centre itself. Other quotations may assume that the supplier will take responsibility for transferring the goods to their exit port, as in the case above. On international shipments, insurance is mandatory, and is calculated on the value of the goods being shipped. Most shipping quotations will include insurance cost as a matter of course. Rates start at two percent of the total freight cost, but some shippers classify computers as fragile goods and charge higher insurance fees.

6.4 Shipping procedures

Experienced importers say that it takes, on average, two to three months for goods to travel from the seller's offices to the importer's premises, but the process is liable to several delays, especially as goods await customs clearance in the country into which the goods are being imported.[45]

Importation is driven by documentation. Each step in the process -- payment, inspection, shipping, customs levy and clearance as well as final delivery -- is enabled by a change in paperwork. The central piece of documentation is the bill of lading. The holder of a negotiable bill of lading and the negotiable insurance policy is, for legal purposes, the owner of the goods being shipped. As the freight moves from origin, out to sea, and into port, the titleholder of the document changes hands from supplier to the freight forwarder, and, finally, to the recipient. Key documents, as well as a description of the process by which documentation drives the process, is included in Annex N.

45 Anthony Bessinger, partner, Tsunami Networks. Interview, March 2004. Brian Robertson, Managing Director, Robertson Freight. Interview, June 2004.

6.5 Freight forwarders and clearing agents

Freight forwarders can be contracted to arrange pickup from the supplier to the shipyard and book onward passage to the destination. Clearing agents as well as forwarders can liaise with local customs agents when the goods arrive, pay any duties and arrange for the removal of goods once they have cleared customs. Some can also house shipments in the interim between a ship's offloading and the arrival of a truck for inland transportation. Freight forwarders and clearing agents typically levy a commission calculated at 3%-10% of the total cost of the segment of the voyage they were responsible for, including any VAT payment, customs fees and other incidentals incurred and paid for by the freight forwarder. All costs are passed on to the client.

6.6 Customs and duties

All goods destined for import and export are classified for customs purposes according to standard codes known as the Harmonized Standard code, or HS code. The harmonized system is used worldwide, and is designed to universalise the procedure of assigning customs categories to goods independent of their origin.[46]

These standardised categories carry the consequence that computer parts, peripherals and computers themselves can be subject to different tariffs. According to data last updated in August 2003, at least ten African countries levy duties on parts at rates different from the computers themselves.[47] Only eight countries waive duties on computers; of these only Ethiopia, Niger and Uganda lie outside the Southern African Customs Union (SACU), where neither parts nor computers incur duty beyond VAT. Tariff schedules do not appear to discriminate between new and used equipment, but only SACU has confirmed this outright.[48] The difference in tariff rates for computers and their parts can determine the feasibility of different businesses.

> **Example**
> Mecer, a manufacturer of branded personal computers, opened a computer assembly plant in an export processing zone in Mombasa, Kenya in 2003.[49] In March, 2004, just six months after opening the plant, Mecer began to reconsider its business position. The government had eliminated tariffs on computers, but retained the 16% duty on the import of computer parts. Mecer complained that it was not clear how parts were classified. Mecer felt its competitive advantage was eliminated, as computers could be imported wholesale at costs lower than the cost of local assembly and production. Its hoped-for local market came under threat.

Knowledge of local tariff rates may allow a centre to alter the composition of its supply in order to minimise its exposure to levies. In some cases it may prove cost effective to import disassembled computers if parts are subject to lower tariffs than computers

46 The harmonized system consists of 22 sections, divided into 97 chapters. The first two numbers of a six-digit HS Code (HS codes can be as long as ten digits, but only the first six are standard worldwide) refer to the chapter under which the good is classified. Computer equipment falls under chapter 84, entitled, "Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof". Computer hardware falls under HS headings 84.71 ("units of automatic data processing machines"), or in 84.73 ("parts thereof"). Computer software falls under HS heading 85.24 ("records, tapes, and other recorded media…"). Manuals fall under HS heading 49.01. Source: Export-Assistance. "Export Education." http://www.exportassistance.com/export_education.html

47 International Trade Administration. "Africa: Tariffs and Taxes on Computer Hardware and Software." http://web.ita.doc.gov/ITI/itiHome.nsf/9b2cb14bda00318585256cc40068ca69/3383d207e223fd3485256d83006f3aa6!OpenDocument. The chart is reprinted in Annex B.

48 International Trade Administration."South Africa Update 2004. Section. E. Refurbished, Used or Repaired Computer Imports." http://web.ita.doc.gov/ITI/itiHome.nsf/9b2cb14bda00318585256cc40068ca69/ea630cc025fa7c8385256d1a00779871%21OpenDocument

49 Daily Nation. "Computer Assembler Says Duty Is Too High." March 30, 2004. Republished by the Computer Society of Kenya at http://www.csk-online.org/html/mecerEastAfrica.htm

themselves; if the converse is true, the threshold for the premium payable for homogeneous shipments (preferably pre-installed with appropriate or excess RAM, harddrives and network cards) rises in proportion to the levies avoided by reducing one's dependence on a stream of replacement parts. When tariffs are unfavourable to an importer, planning and finding ways to reduce fees incurred becomes more important.

A table of tariff and tax schedules on computer hardware and software in African countries appears in Annex B.

6.7 Keys to reducing shipping costs

The three highest avoidable costs of shipping computer equipment internationally are the costs from damage, delay and duties. They are not easily defrayed, but some actions can minimise them.

Damage

Rates of computers that are inoperable at the time the shipment arrives -- colloquially called DOA, or dead-on-arrival-- are highly variable. As discussed in the section on supply, some vendors will either include surplus equipment ranging from 3-10% of total volumes to cover the cost of failures incurred during transport, or include a 30-day warranty on equipment. Those who offer such warranties are more likely to take greater care in packing their shipments to reduce their liability to customer claims. Suppliers who make no such offers should probably be avoided, as they may take less care in ensuring the safe passage of equipment. It is essential to define the terms of settlement -- either replacement or reimbursement -- for 30-day warranties before agreeing to the purchase.

Delays

Delays in customs and shipping can be chronic. They can also be costly, as demurrage rates can amount to hundreds of dollars per week. The customs house in Cape Town, for example, charges R1500 (US$230) for the first day a container sits on its premises and R200 (US$30) for each subsequent day. Importers are liable to pay those costs even if unpredictable problems such as power failures or computer troubles prevent the processing of shipments.

A close affiliation with customs representatives as well as a good relationship with experienced customs clearing agents can assist greatly in reducing the likelihood of delays. Precise, clear, original and stamped documentation can also reduce frustrations in customs. Importers should be sure to consult with the ministry responsible for trade about its paperwork requirements and obtain a written description of the necessary documents from the relevant trade office before agreeing to any international sale. Importers should be sure to communicate these requirements to the supplier so that its office can comply with a ministry's demands.

When seeking help from government, importers should consider the benefits of cultivating ministers and government representatives as local champions, and seek their involvement to facilitate the clearance process. An African nonprofit computer importer, for instance, whose shipment of computers was to be installed in schools and community centres, invited the Minister of Trade to appear at a container opening ceremony covered by the national media. The shipment cleared customs without delay.

Duties

Duties and taxes can be levied at such high rates that they may present the largest obstacle to the economic feasibility of importing computer equipment. Sensitising trade bodies and governments to these issues on an individual and collective basis may enable importers to gain exemptions on computer equipment. A continent-wide initiative to normalise or eliminate tariffs on ICT equipment is currently being spearheaded by SchoolNet Africa. See the section entitled "Partnerships" for more detail.

6.8 Policy issues

Observers have pointed out that some of the administrative and financial barriers to import are a consequence of policies that fail to place any trust in the profitability of businesses. It is also argued that the policies are overly motivated by the preference to regard import as a revenue opportunity rather than a means by which governments can foster business development. As one frustrated computer importer active in Ecuador pointed out:

> It is easier for the government to collect tariff and taxes at the front end to insure revenue than to assume that if it becomes a profitable business the owners will pay taxes later. We have found that some Finance Ministry officials understand the nature of the equation and are creating several policy solutions.[50]

Policy reform, at both national and international level, may improve import conditions and reduce barriers to participation in the market.

Summary

- ➔ Shipping computers for import can incur considerable cost and delay, but good preparation and good relationships with suppliers, freight forwarders and customs agencies can reduce some of the frustrations involved.
- ➔ Because shipping can place such strain on an organisation, both in the time that it takes to carry out the transactions and gather necessary documentation and in the financial resources required, it is a job best left to those most experienced.
- ➔ Centres must still carry out much of the work themselves, particularly when assessing the initial feasibility of importing computer equipment into a country. At the same time, the interest, profile and public sentiment about computers and ICT issues may also give the centre a chance to create a network of supportive partners within existing government and industry institutions. That network of goodwill may be able to ease the task of ICT import.

50 InfoNet. "Hardware Technology Issues - Lessons Learned [InfoNet CyberCaffes]." http://www.infocaffe.net/ShowArticle.asp?ArticleID=1&PageNum=4

7 Product profiles

A computer's features and performance should be tailored for the needs of core target markets. African computer refurbishment operations typically have two kinds of clients. One type of client has a site where computers are used by large groups (such as in schools). The other type of client seeks a computer that will be used by fewer people in an office or home environment. These clients have different needs and appropriate bundles of hardware, software and peripherals should be developed as products tailored for them.

At the same time, for a centre to be able to provide efficient service, it is important to limit the range of products it provides, since as the diversity of products grows, the more difficult it becomes to service and support each different configuration. As a result, a centre should distribute no more than two kinds of products. One platform should be designed to accommodate many users at once and aimed to service computer labs, telecentres, or other places with high volumes of users. Another platform will be designed for offices and homes, where frequently only the same person or set of people will be using the computer most of the time.

The specific configurations of the centre's products depend on a variety of factors. One technical design consideration is the fit between hardware and software. Usability, among novices especially, is highly correlated with a program's responsiveness. A long gap between user's action and a change in the interface can frustrate and alienate cautious and new users. As a result it is better for computers to exceed their required specifications than to meet them. Design priorities include more than technical considerations. Other factors include the reliability of the product and the need for ongoing maintenance and technical support; the presence of relevant applications and content; and the need for and availability of training in both basic use and troubleshooting. Design should also take into account the existing skills of its intended users. An overriding concern should be the products' costs: a centre's products must remain affordable to clients at the same time as their selling prices allow the business to recoup the costs of producing them.

The products a centre develops can feature more than software and hardware. A centre also has the opportunity to package its products with devices that help to protect PCs. The inclusion of extra measures such as power protection, data security and backup facilities can help lay the groundwork for the sustainable use of ICT by increasing uptime, network availability, and, as a consequence, users' trust in the reliability of their technology. Centres can bundle items that address longevity and security issues into a single product tailored as best as possible for the specific needs and priorities of clients. The incorporation of peripherals also helps to inform novice users about measures necessary protect a PC from dangers that those not well-acquainted with PCs can overlook.[51]

7.1 Standalone computer: possible specifications

Standalone computers also require a hard disk large enough to load the operating system and applications. Generally speaking, the capacity of harddrives already available on the international second-hand market -- sizes of 4GB and larger -- suffice for most kinds of operating systems appropriate for standalone computers configured for general use. Disks with capacity as low as a few hundred megabytes will be able to run some, but not all operating systems. The number of applications installed on the computer also determines how much disk space is appropriate.

51 **Note:** This discussion is intended to outline the kinds of products computer refurbishment centres may wish to consider implementing in their programs. It neither compares nor intends to discuss any merits, costs of ownership, or feature of any piece of software against any other. For an in-depth and quantitative analysis of software choice in community access computer labs, refer to bridges.org's "Comparison of free/open source and proprietary software: implementation and policy-making to optimise public access to ICT". http://www.bridges.org/software_comparison

If users intend to access the Internet, a modem -- either internal or external -- should also be included with the product. Since a network interface card (NIC) is relatively easy to install at the time of refurbishment, it should also be installed in standalone computers by default. The presence of a NIC, even if initially unused, will facilitate a client's upgrade to a networked environment in the future. If clients wish, a printer can also be incorporated into the product bundle.

Popular operating system choices for standalone computers include:

Microsoft Windows:
Windows 98 – http://www.microsoft.com/Windows98
Windows 2000 – http://www.microsoft.com/Windows2000**
Windows XP - http://www.microsoft.com/XP**

Linux distributions**:
Fedora - http://fedora.redhat.com
SuSE – http://www.suse.com
Mandrakelinux - http://www.mandrakelinux.com
Damn Small Linux - http://www.damnsmalllinux.org*
Rule - http://www.rule-project.org*

*Designed particularly for lower-specification hardware
**True multi-user operating systems

7.2 Computer laboratory: Possible products

Existing computer refurbishment centres have typically chosen one of two possible approaches to supplying a laboratory environment with computers. In each case, cables physically connect lab computers to one another.[52] The remaining differences hinge on the selection of the laboratory's design: either computers will be able to run independently of each other, or clients will depend on a server for functionality.

Option one: networked standalone clients

With a few modifications, standalone desktop machines can be used in a laboratory environment. If network interface cards (NICs) are present, the computers used as standalones need only be physically connected to each other via network cabling and subjected to a small configuration change in order to be deployed in a lab environment.

Utilities such as shared Internet access, filesharing and printing can be configured on one of the clients in a lab or can be dedicated to a server used only by a trained administrator. In this scenario, the server can be stored in a separate room and run an operating system different from the one on its clients. The versatility of a dedicated server can be used to enhance the kinds of services available to lab users, such as locally cached web content.

The range of operating systems appropriate to networked standalone machines is similar to those appropriate for office or home environment. But given that they are installed in a publicly accessible place, the likelihood that these machines will be used by larger numbers of people calls for a few changes. Lab computers should be installed with an operating system that features complete multi-user functionality, which authorises different users to perform different tasks, allows users to maintain different configurations and protects certain files from unauthorised users. This helps to protect the data stored on the computers from users who may delete files and change configurations maliciously or unwittingly, a problem common to many computer labs.

52 Devices that allow computers to communicate wirelessly are gaining in popularity, but their initial costs remain significantly higher than those needed in conventionally cabled networks.

Option two: server and thin clients

Another option suitable for laboratory installations makes use of diskless thin clients. Under this model, computers use one central server not just to supply an Internet connection, but also to provide an operating system and applications for all the computers in the lab.

The slower processors of refurbished computers, even those available at the lowest-end of the market's price spectrum, are well suited to deployment as thin clients. While all computers are fully functional, the clients do not have any moving parts. The only harddrive required is installed in the server; all the clients share access to it. Since harddrives are among the components most likely to fail in a lab, reducing the total number of harddrives should make the lab cheaper to run. Since the amount of memory and the speed of the processor to run a thin client are each lower than the specifications a traditional, stand-alone computer requires, older computers can be made to run with a degree of performance they would otherwise not achieve.

Thin client implementations may also reduce maintenance requirements. Because clients have few or no moving parts, they do not need to be protected from dust, dirt and other environmental hazards with the same rigour as standalone clients. Since all the work is being done by a server, the clients might also withstand the rougher use -- being turned off abruptly, being rebooted several times -- that novice and casual users can sometimes inflict.

At the same time, thin client solutions also present a moderately higher risk to data availability. Since all the clients depend on the server to function, a failure on the server implies a failure of all the computers in the lab. Consequently, effort and investment should be focussed on the server to increase the lab's overall uptime and performance and to reduce the likelihood of problems on the server. Several distributors of thin client laboratory products choose to use new servers in combination with refurbished clients. The number of clients a server supports determines its specifications. In labs with five or ten clients, a server may require a processor of at least 1GHz. Labs with 20 clients may require 2GHz processors or more. Servers require a baseline amount of about 512 MB of RAM, and about 50-60 MB of RAM for every client it supports.

Thin client implementations may also lower a lab's security risks. As mentioned above, a server need not be in the same room as the clients, so it is possible to dedicate more resources to making sure the server is in a safe place. It is not necessary to fortify the whole room to the same degree as one might if all computers had to be protected to the same degree. Since the clients do not work independently of the server, they also have less value to potential thieves. One supplier of a thin client product urges lab operators to post a sign in the window of the computer room warning that the computers will not work if they are removed from their environment. That fact alone can be a deterrent to thieves.

Enthusiasm for thin clients

Thin client technology is in use by a number of organisations that supply computers to schools. Kakinda Daniel, Executive Director of SchoolNet Uganda, describes the advantages of the system this way:

> The thin-client model is an alternative to the traditional approach of expensive workstations. Under a traditional (fat-client) model, applications run on the individual workstations[...]Under a thin-client model, the applications run on a network server and the local clients (workstations) are used only to provide a keyboard, mouse and display! What makes a computer obsolete is low memory (RAM), low processor speed and low hard disk space. Thin clients have no hard disks, their processing speed & RAM are irrelevant.
>
> One of the biggest problems schools have is that of software

> maintenance because kids sometimes "mess" up the computers. Most school technology coordinators spend the majority of their time just providing software maintenance support. But with these dumb terminals, there is literally nothing students can do to them!!
>
> Only the network server needs to be upgraded to cope with increasing performance demands of both new software and a greater number of users. If you've ever had to deal with the problems and costs of keeping your desktop systems hardware up-to-date so that you can run the latest software, you can see the potential benefits of only needing to update one PC and observe the effects on all the others! [...]
>
> We want to help schools access technology but keep their costs down. Schools can now connect to the Internet using very old machines that would have never have the capacity to access the Internet otherwise. Thin-client technology brings back to life old computers which the schools had labeled obsolete.[53]

Operating system options

Possible operating system options for thin client solutions include:

K12-LTSP – http://www.k12ltsp.org
Citrix Metaframe Access Suite - http://www.citrix.com
Thin Soft Inc. - http://www.thinsoftinc.com/
Linux Terminal Server Project – http://www.ltsp.org

The most common implementations of thin clients by organisations in Africa are based on the Linux Terminal Server Project (LTSP). Annex H lists resources for this solution.

7.3 Applications

End-users interact with applications far more often than they work with the operating system, so it is imperative to ensure that the mix of applications on a computer suits the client who receives it. What users expect to do with their computers should determine what applications are installed on it. Telecentres and other high-volume user environments typically anticipate that users will expect to be able to use computers for writing letters and other documents; sending and receiving email; using spreadsheet calculation applications; browsing the Internet for information; creating slide presentations; creating greeting cards and other announcements; printing documents, forms, and other material; and, in some cases, creating websites to be posted on the Internet or run locally within the lab. The requirements of an office environment are similar, although some users may also require an accounting package, a database application and a publishing programme.

Given these uses, the applications users will most likely expect and request are productivity software such as a word processor, a presentation generator and a spreadsheet program, as well as an email client and a web browser. The table on the subsequent page lists a few options for these applications. It also lists other useful pieces of software such as database, accounting and graphics manipulation software that might meet the needs of higher.

53 Kakinda Daniel. "A mail from SchoolNet Uganda." http://www.tacticaltech.org/africasource
Kakinda Daniel is the Executive Director of SchoolNet Uganda.

Productivity Applications			
Name	Description	Platform	Site
Microsoft Office	Word processor, spreadsheet program, HTML editor and presentation software.	Windows	http://www.microsoft.com/office
OpenOffice	Word processor, spreadsheet program, HTML editor and presentation software.	Windows and Linux	http://www.openoffice.org
Internet Applications			
Name	Description	Platform	Site
Mozilla Thunderbird	Email client	Windows and Linux	http://www.mozilla.org/products/thunderbird
Mozilla Firefox	Web browser	Windows and Linux	http://www.mozilla.org/products/firefox
Internet Explorer	Web browser	Windows	http://www.microsoft.com/windows/ie/default.mspx
Outlook Express	Email client	Windows	http://www.microsoft.com/outlookexpress
Other Applications			
Name	Description	Platform	Site
QuickBooks	Accounting	Windows	http://www.quickbooks.com
Gnu Cash	Accounting	Linux and Windows	http://www.gnucash.org
Pastel	Accounting	Windows	http://www.pastel.co.za/
Adobe Acrobat	Publishing	Windows	http://www.adobe.com
Scribus	Publishing	Linux	http://www.scribus.net
GIMP (The Gnu Image ManiPulator)	Photo and graphics editing software	Linux and Windows	http://www.gimp.org
Adobe Photoshop	Photo and graphics editing software	Windows	http://www.adobe.com
MySQL	Relational database	Windows and Linux	http://www.mysql.org
Microsoft Access	User database	Windows	http://www.microsoft.com/office

A comprehensive table of equivalents of proprietary and open source software is available at the website:

> The table of equivalents / replacements / analogs of Windows software in Linux, http://linuxshop.ru/linuxbegin/win-lin-soft-en/table.shtml

7.4 Security issues

Security concerns can be divided into three categories: the physical security of the installation environment, the security measures that to protect the computer hardware from environmental damage such as lightning and other forms of power fluctuation, and the security of the data stored on a computer. Measures to protect computers from typical hazards should be bundled as part of the products a centre distributes.

Physical security

Just about everyone who deals with computers in Africa is sensitive to the value they represent, and the measures it requires to protect computers from theft. In most cases, the security of the premises is regarded as the client's responsibility. But suppliers should advise their clients about the kind and extent of security -- usually burglar bars, a lockable gate and a metal door and doorframe -- they need to install before receiving computers.

Environmental security

Computers work best in cool, dry and dust-free conditions. Africa's often hot, dusty or humid climate puts a lot of stress on hardware components. Moving parts get clogged with dust; magnetic parts lose their sensitivity; parts that require cooling overheat. As a consequence, computers should be used in rooms where windows can be tightly closed and in places as free of dust as possible. Many rural computer users cover their computers with cloth when not in use.

The stability and reliability of electricity is another consideration: computers need to be protected from power spikes that are the result either of poorly fused circuits, occasional surges on the electricity grid or atmospheric conditions such as lightning. A good way to maximise the reliability of the hardware is to protect it from surges with items such as uninterruptible power supplies (UPS) and surge protectors. A UPS is a large battery and power regulator that allows a computer to continue to run for a short period in the event of a power failure; the extra few minutes of power give users the chance to turn off computers properly and avoid the sudden shutdown an electrical failure precipitates. A UPS can also regulate small surges in power and supplement drops in voltage known as brownouts. Since power surges can travel along phone lines as well as electrical ones, many UPS also contain a conventional phone input and output jack (known as RJ-11 connectors) to regulate voltage fluctuations on phone lines. Phone line power surge suppression is a key measure for protecting modems.

Since a UPS is essential for any server or standalone client, centres should certainly recommend that their clients use them. Some sales managers may wish to bundle a UPS into the product offering.

The minimum specification for a UPS is 650mVa. A good resource about everything pertaining to UPS is available at:

> Uninterruptible Power Supply (UPS) FAQ, http://www.jetcafe.org/~npc/doc/ups-faq.html

Data security

The integrity and privacy of data stored on computers is threatened by two main risks: viruses, which are typically received via email, and intrusion, which occurs when an unauthorised user gains access to a computer.

Users can protect themselves against viruses by means of virus scanning software. Computers can be protected from intrusion by installing a firewall, which controls network access to the computer. These two software applications should be installed on the computers a centre distributes.

Two good, stable, and simply installed firewalls are listed below. They are well documented and come with sample configurations and detailed instructions.

> Shorewall, for Linux operating systems, is available at:
> http://www.shorewall.net
>
> ZoneAlarm, for Windows operating systems, is available at:
> http://zonealarm.com

Since private data can also be compromised by unauthorised users who have physical access to a person's computer, clients should also be briefed on the correct use of passwords and logins.

7.5 Data backup

A computer refurbishment centre should also take responsibility for assisting its clients with the protection of their data. Data can be lost when harddrives fail or when operating systems become corrupted. The best measure to protect against loss is by instituting a practice of backing up (copying) essential files such as configuration files, documents and email archives to separate disks or other media.

One backup option involves the installation of a second harddrive. A computer can be set so that it automatically copies certain directories from one drive to another on a regular basis. Most operating systems have a utility that allows users to specify that the computer execute tasks at pre-appointed times.

> **Tip: Setting backups automatically**
>
> Windows operating systems use an application called Scheduled Tasks, available under the Control Panel. Unix and Linux distributions use what is called a cron daemon to run tasks.

Another option for backup relies on removable data storage devices. A compact disk writer may allow organisations to copy their crucial data on writable or rewritable compact disks as a means of backup. Memory sticks and compact flash cards, which attach via the USB port on a computer, can provide a cheaper alternative, but the most affordable memory sticks offer significantly less capacity than a compact disk. Since these devices are temporarily attached to a computer, backup using these devices (generically known as flash RAM devices) will most likely need to be handled either manually or via a manually executed batch file. Removable media have two advantages over the use of fixed backup drives: harddrives that contain backup data are more likely than compact disks to fail without warning. As well, removable media can be stored in a location separate from the computer, giving users an extra measure of protection in the event of theft or fire.

7.6 Licensing Windows: Microsoft Authorised Refurbishment Scheme

Windows operating systems are a highly popular choice. Recent studies have shown that Microsoft products are installed in 96% of all desktop computers.[54] While Windows may be the most widely used software worldwide, licensing costs put its legal use out of reach for most residents in developing countries. A single license for Windows 2000 Professional, for instance, costs US$319.[55] Analyst Rishab Ayer Ghosh has shown that disparities in purchasing power in developing countries are a key reason that Microsoft products are unaffordable.

> [I]n developing countries, even after software price discounts, the price tag for proprietary software is enormous in purchasing power terms. The price of a typical, basic proprietary toolset required for any ICT infrastructure, Windows XP together with Office XP, is US$560 in the U.S. This is over 2.5 months of GDP/capita in South Africa and over 16 months of GDP/capita in Vietnam. This is the equivalent of charging a single-user licence fee in the U.S. of US$7,541 and US$48,011 respectively.[56]

Microsoft has launched an initiative intended to reduce the costs of using Windows legally for some users. It is specially suited to refurbishment centres that supply computers to schools, nonprofit institutions and other specially defined recipients. The Microsoft Authorised Refurbishment Programme (MAR) allows two of its products, Windows 98 and Windows 2000, to be installed on donated and refurbished computers. Licenses for these programmes are free, but the initiative levies a US$5 administration fee for each license issued.

Computer refurbishment centres must apply for the MAR designation via Microsoft's website. Since the application asks for references of previous recipients, the organisation's contact details and other specific information, it seems unlikely that refurbishment centres that have not yet begun to operate will be granted the designation. A full description of the application process is available at:

http://www.microsoft.com/emea/refurbishers/en/joiningTheMARProgramme.mspx

The MAR programme may institute several restrictions on a refurbishment centre's operations. First, only certain organisations may receive operating system licenses under the program. Eligible recipients include schools, teaching hospitals, research institutions, community service organisations, libraries and others, but any for-profit enterprise such as a small business is forbidden from obtaining a license through MAR discount programmes. Computers must be given to clients on a cost recovery basis, but a MAR designation does not preclude charging fees for services.

Second, a MAR designation may prevent a centre from offering certain kinds of software solutions. It appears, for example, that a school may not be allowed to receive a thin-client lab if the donated computers were distributed by a MAR-approved centre. Its designation would forbid anything but the installation of Windows 98 or Windows 2000.[57] It appears

54 Access Global Knowledge. "Access Global Knowledge - Article." http://access.globalknowledge.com/article.asp?ID=5757

55 Microsoft Corporation. "Windows 2000 Pricing and Licensing." http://www.microsoft.com/windows2000/professional/howtobuy/pricing/default.asp

56 Rishab Aiyer Ghosh. "License Fees and GDP per capita: The case for open source in developing countries." First Monday, Vol. 8, Number 12, December 2003. http://www.firstmonday.dk/issues/issue8_12/ghosh/

57 marsupport@msdirectservices.com, email correspondence, May 20, 2004. When asked, "Does a MAR designation preclude using non Microsoft software/offering other products to those otherwise eligible for computers under MAR?", a representative replied, "All donated PCs must be installed with 98 or 2000, have a COA and be reported correctly". But the software limitation may only extend to the operating system. A request for clarification, a subsequent email stated, "The software loaded as agreed with the new recipient may include non MS software". (16 June 2004).

that no Linux operating systems may be offered to clients eligible for discounted Windows licenses.

Third, the programme only covers the operating system software. Microsoft Office and all other proprietary software from Microsoft are not available at similar discounts. However, MAR centres are permitted to install non-Microsoft applications on top of the Windows operating system.

A set of answers to frequently asked questions is available here:

http://www.microsoft.com/emea/refurbishers/en/frequentlyAskedQuestions.mspx

The complete text of the Microsoft Authorised Refurbishment Programme agreement can be obtained here:

http://download.microsoft.com/download/d/3/d/d3db3118-dc6d-4a08-967e-485f08a57ae5/microsoftEMEAMARLicenseAgreement2004.doc

7.7 Free/open source software

Not all software is distributed in the way as proprietary software such as Microsoft Windows. In contrast to the way Microsoft charges users for the right to use its programmes, some software is made available to users free of license fees. Free and Open source software is software that is made available with the source code open for anyone to look at. When programmers can read, modify, and redistribute the source code for a piece of software, the software evolves as people add to it, improve it, adapt it, and fix bugs. The creator of an open source software application holds the copyright for the work, but distributes the software under a license that grants a number of substantial rights to the user. These go beyond the usual rights of a user, seemingly inverting the traditional use of copyright, which has led to the term "copyleft". As such, they grant the user the right to use the software freely; freely access the source code; modify the software at will; and to distribute either the original or modified software without restrictions.

7.8 Product testing

Once a centre has determined the exact composition of its products, it should build a few samples and test the hardware and software. This will help to verify that the functionality and responsiveness of the software are consistent with expectations. Ideally. the centre should also find a testbed in which the envisioned audience can try out the product.

Tip: Testing the product

The centre can explore two methods to test its products. If the facilities exist, the centre should set up its own computer lab and open it to for public use. Technicians should scrutinise the stability of the product, audit reported failures. They should observe users interacting with the computers and interview them about the features they liked and disliked about the product. Alternatively, centres can find five or six potential clients with whom staff at the centre have an existing relationship, and provide the hardware and software at reduced prices in exchange for detailed feedback. After a given period of time -- a few months may be necessary in order to collect data about as many quirks of a given software and hardware combination as possible -- the centre should collate users' feedback and incorporate it into revisions of its product design.

Summary

- ➔ Usability is a consideration central to the design of products. It is important for a centre to produce platforms that its users -- especially novices -- can learn to use quickly and well.
- ➔ Since responsiveness is key to a user-oriented product specification, computers should be fitted with more RAM and higher processor speeds as long as the costs of these extra features keep prices affordable. Since product design must also be matched to the computer's intended use, the products must provide the applications that its users want and need.
- ➔ Standalone computers are suitable for home or office use, where a limited number of people use the computer. These machines should be outfitted with productivity applications, an Internet browser and an email client. Centres may also add other software such as an accounting package, graphics tool or database.
- ➔ Computer labs can be installed with machines that run independently of each other or be equipped with a server and several diskless clients. In each case, the computers' operating system must feature true multi-user functionality in order to protect data and streamline the task of administration.
- ➔ To promote sustainable use of the computers and take measures to ensure their longevity, computer refurbishment centres can include more than hardware and software in their product offerings. While a consideration of the operating system and applications is key to the product, just as important are issues of security and data protection. These safeguards lay the groundwork for a recipient's sustainable use of the PC equipment.

8 Inventory

Maintaining a record of all the equipment that passes through the workshop is an essential activity for a computer refurbishment centre. It serves many purposes. An inventory allows managers to keep an eye on stock levels, track installations, analyse failure rates and measure the productivity of the operation. A good inventory also makes it easier to report workshop activities and production volumes to outside interests such as investors or donor partners.

If structured in the right way, maintained diligently by employees and used correctly by managers, the inventory management system should enable a person to trace the whereabouts of a single piece of equipment from the moment it enters the workshop until it goes out to a client. It should also be able to track a piece of equipment as it returns to the workshop at the end of its life and is decommissioned for recycling. As well, an inventory management system should enable the purchasing manager at a centre to be able to know how much equipment remains in stock, and how much will be needed at a given point in the future.

As a general rule, computer refurbishment centres active in Africa manage their inventories poorly. A major problem is a lack of collective responsibility among staff for the importance of accuracy in record keeping and a collective recognition of the importance of integrating the system into the workshop environment. Choosing a method that suits the centre's needs and ensuring its collective use is essential to successful implementations of inventory management systems.

8.1 What is an inventory management system?

In its most basic form, an inventory management system simply tracks the exact location of equipment as it progresses through the different stages of refurbishment within in the workshop. Although it is not essential that inventory management systems be computerised, there are clear advantages in doing so. What is most important is that the inventory tracking system is designed to integrate into the production system that makes it easy for technicians and managers to use it.

The monitoring goals of a computer refurbishment centre -- what it wants to be able to record and analyse -- determine what kind of inventory system should be implemented. At minimum, an inventory system should be able to show inputs (which equipment has been received) and outputs (which equipment has been delivered to clients or decommissioned and recycled). But the system should also assist managers and staff in organising their work routines. An inventory management system should give employees a chance to track their assignments and gain a sense of their priorities. Without an inventory management system, it is impossible to tell what equipment is going where, what work has been completed, what work remains, and what, if anything, has gone missing in the sometimes chaotic atmosphere of a workshop filled with computers that all look alike.

The system should also be an integral tool in equipment failure analysis. By keeping a record of dates when equipment arrives and is refurbished, installed or returned to the centre, and also by logging who worked on what, where things went, and when they entered and left the workshop, a searchable inventory management system should be able to confirm a manager's suspicion that a batch of harddrives obtained from one supplier is substandard, or help to show the need for more training of employees at a certain stage of the production process. The management system keeps an eye on things that even the most vigilant staff and management team cannot.

8.2 Tracking numbers

Fundamental to inventory management is basic record keeping about the location of equipment. The best way to track equipment is by issuing a tracking number. A tracking number is a unique identifier assigned to one machine for the length of its life within the centre. It is assigned when it arrives, and is used not only while the computer is being tested, but also while the computer is on a client's premises.

Since the computer is the core unit that a centre deals with, only computers themselves require a tracking number. For the purposes of inventory, components within a computer, or attached to a computer as an external device, are always associated with a particular computer chassis. Thus, they should be tracked only in relation to the computer in which they are installed.

The serial number assigned by the computer's manufacturer can be used as a tracking number, but sometimes it is overly complex. Also, the format of serial number tends to vary -- some include numbers only, some letters and numbers, some are as few as five or as many as a dozen characters. This impedes tracking and also makes it difficult to know if the tracking number has the correct form, let alone the right content. Serial numbers must nevertheless be recorded. They should be transcribed once, only to provide a way to reconcile a serial number with a tracking number. Thereafter, the tracking number should be the computer refurbishment centre's main method of recording an item's movements.

A good tracking number is simple, and at the very least a little informative -- just knowing the number should tell a staff member something about the product. Managers should consider using a tracking number that contains the month the product arrived in the centre as part of its format, such as 2004-12-xxxx, where x is a series of numbers that varies.

Depending on the particular workflow and inventory design at a centre, it may still be a good idea to assign informative part numbers to harddrives and monitors as well. These numbers should have a different form from that of the computer tracking number, so that it is possible to identify the product type just by knowing its product number. Consider HD-xxxx for harddrives, and M-xxxx for monitors, where xxxx is a series of numbers that increases in increments, e.g., HD-0001, HD-0002, etc.

8.3 Inventory management options

The most elementary form of an inventory system is a paper trail -- a set of invoices and documents that show what went where at what times. Invoices from suppliers can show the receipt of incoming used equipment; invoices given to clients can record quantities of equipment shipped from the centre. Inside the workshop, a product sheet (sometimes called a route sheet), marked with a tracking number, will track what equipment is at what stage of the refurbishment or assembly process.

Product sheet tracking

A product sheet is a simple form that accompanies stock while it is in the workshop. When a computer comes into the workshop, an employee should immediately record the serial numbers of the processor, the unit itself, the harddrive, the RAM, and the monitor on the product sheet, and then assign the computer a tracking number. As each unit goes through testing, employees should make note of the specifications of each component -- the speed of the processor, the size and speed of the RAM, the size of the harddrive and the size of the monitor. Before the unit is shipped out, an employee should take a final record of what pieces are going to whom. (See the diagrams entitled Workflow in the Workshop processes section for a depiction of how inventory integrates with the production process.)

In short, a product sheet tracks:

(1)A unit, identified by its tracking number.

(2)A unit's status – untested, tested, configured, deployed.

(3)A part – a CPU, a stick of RAM, a monitor, a keyboard.

(4)A part's specifications – speed, capacity, brand, etc.

(5)A unit's location – in storage, in the testing area, in the configuration area, or assigned to a customer. (These are listed in Workflow diagrams as "storage", "unit", "configuration" and "deployed".)

(6)A part's location – in storage, or installed in a unit.

(7)Who is working on it – which team it has been assigned to.

(8)Who will receive it / who has received it – the client, address, the date of shipment.

A sample product tracking sheet appears in Annex K.

The process of testing and refurbishment sometimes requires technicians to change parts inside the computer. The product sheet accommodates these changes to the computer through the provision of extra fields for replacement or added parts on the product sheet. These extra fields allow for the components inside a unit to be replaced without creating the need for a new sheet, allowing the original product tracking number to be preserved. This permits a centre to track the entire history of the machine -- from intake through to production, showing if components had to be repaired, and what replacements were made along the way. If a component fails its diagnostic test, technicians can record the failure by crossing out the corresponding field, noting the decommission and adding information for the replacement part. A sheet similar to the product sheet should be made for harddrives and for monitors. (Fields to record internal component specifications can be omitted).

In addition to recording a unit's specifications and content, the product sheet can also be used to record the unit's progress through the refurbishment process. When computers first enter the workshop, they are dispatched to the testing area. After testing, the computers enter a queue to be fitted with a separately tested harddrive and installed with an operating system and applications. Then the unit is configured for a specific client. The inventory should record each unit's progress through these stages by tracking locations. A section of the sheet dedicated to tracking location should have appropriately named fields, such as "testing", "storage", "configuration" and, once the unit has been given to a client, "deployed". Client details and shipping dates are also recorded on the sheet.

The locations recorded for harddrives and monitors should be slightly different. Instead of "configuration" (which denotes the area of the workshop where computers pass through the installation and configuration phase of the refurbishment process), harddrives and monitor sheets should contain a location such as "unit" in which technicians can record the tracking number of the computer into which the harddrive is installed or with which the monitor was paired. The harddrive sheets or monitor sheet can then be either filed away after recording or attached to the CPU's product sheet.

Stock sheets

A set of daily inventory activity sheets should be kept wherever the inventory is stored. There should be one sheet for each component type. Whenever a component leaves the storage area, its serial number and specifications should be recorded, as well as the tracking number of the machine the component is being installed in. This provides a tracking method for keeping abreast of what is moving into the workshop. An inventory activity sheet, for example, could be dedicated to tracking RAM, and contain fields for recording the date, the serial number of the stick of RAM, who signed it out, and what computer the stick was destined for.

Another set of activity sheets should be kept wherever materials are sorted for recycling. There should likewise be one sheet for each component type. Whenever a component is being decommissioned, its serial number and specifications should be recorded, as well as the tracking number of the machine the component has been extracted from. This provides a tracking method for keeping abreast of what is leaving of the workshop.

These sheets should be reconciled regularly with product sheets. They should also be used to track part failures. If the workshop and equipment are working well, the rate of demand for new parts should be relatively stable. If there is a spike in demand for RAM, or a need for a lot of harddrives, that is a sign that something is either wrong in the production process or that a batch of inventory was substandard.

Incorporating spreadsheets

So far inventory management methods have been explained for scenarios which make use of paper-based tracking only. But maintaining inventories on paper can give rise to several problems. Paper can be easily misfiled or lost. Large volumes of inventory sheets are also exceedingly difficult to search. Keeping data in a set of spreadsheets can help to reduce these two problems. The method can improve searchability by reconciling large numbers of individual pieces of paper into one large file. If a spreadsheet is used in conjunction with a good data backup system, it can cut down on the risk of data loss

Based on these benefits a few refurbishment centres merge their paper-based systems with a set of spreadsheets in an effort to manage their inventories more closely. Staff have designed spreadsheets whose structure mirrors the structure of the product sheet such that a cell in the table corresponds to a field on the tracking sheet. Once data has been captured on the product sheets, the details are inserted into the appropriate spreadsheet.

A sample appears below. (N.B. The spreadsheet will be much wider than the width of a single page, and so the example just contains the first set of fields.)

Sample Inventory Spreadsheet

Tracking Number	Intake Date	Serial Number	Make	Model	CPU Speed	CPU Class
2004-0001	2004/01/31	44XDE0032	IBM	300GL	800	PIII
2004-0002	2004/02/28	790-49-FHGKS	IBM	300PL	500	PIII
2004-0003	2004/02/29	549-DGHE-22	DELL	OPTIPLEX	500	PIII
2004-0004	2004/03/31	4928-498-JJ-00	HP	OMNI	300	PII

Shortcomings of spreadsheet- and paper-based inventories

Spreadsheet-based inventories have their own drawbacks. Even though they are a better alternative to paper, spreadsheets are hard to search in different ways. For instance, while it is easy to look up what should be inside a given computer by finding the row of information tied to one tracking number, it is very hard to organise the data another way and show all the pieces of RAM that were replaced in, say, a seven day period. This reduces a centre's ability to trace error rates.

Staff attitudes and habits can also lead to problems with inventories kept on paper and in spreadsheets. Technicians rushing to begin their work may often transpose numbers or letters, riddling an inventory with errors. Handwriting can be hard to read, and what may have been an eight on paper becomes a "B" in the inventory; equally often misread are a zero and the letter "o". Eventually these problems and errors accumulate, limiting the utility of the inventory.

Staff interests can complicate the matter further. Generally speaking, those who are interested in computer hardware do not tend to show much interest in the kind of vigilance required to maintain an inventory, so specialist inventory trackers and administrative staff

will be needed, especially as production escalates beyond one manager's control. It may be a good idea to separate responsibility for inventory and technical diagnostic work anyway, since those who are entrusted with both inventory access and the right to declare parts fit or unfit may be in a conflict of interest. Some people may be tempted to decommission working parts and use them for their own ends.

Finally, because spreadsheet-based inventories require so much keyboard activity and attention to detail, it may require considerable work to train staff, especially if their computer literacy is low.

Nevertheless, spreadsheet and paper-based inventories can be started cheaply, with software many people are already familiar with. Managers may find it very quick to adopt a paper- and spreadsheet-based inventory as a refurbishment centre is establishing itself. It is not a long-term solution, but it is a cheaper one to begin with.

Database-driven solutions

Another option for inventory tracking is a customised database. Just as with a spreadsheet, the database should contain all the fields present on the product sheet. Much like a spreadsheet, a database is just a set of tables and fields. But databases are organised in such a way that the data can be formalised, reducing data entry error and ensuring uniformity. Databases can also create and maintain unique tracking numbers automatically. Data can also be arranged in predefined ways so it is possible to search and sort in much more complex layers than spreadsheets allow. This makes auditing the inventory much easier.

A database-driven inventory system usually consists of two layers: a database engine (sometimes called a backend) which stores data, and an interface (or front-end) which allows a user to access, edit and input data as well as retrieve reports. It is common these days to for front-ends to work within a web browser, because it means that many people can connect to the same database at once without having to install any additional software. Common backends include MySQL and PostGreSQL. A tool called PhpMyAdmin (http://www.phpmyadmin.net) is among the most common front-ends. Other database applications include Microsoft's Access (bundled with its Office suite of applications) and FileMaker Pro (http://www.filemaker.com). Many other database and front-end combinations have already been created, and a good proportion of these are free/open source tools.[58] One product applicable for use in a refurbishment centre is Web-Erp, a database and front-end which combine inventory tracking with parts ordering and client records management. It is an example of a data tracking system commonly referred to as an enterprise resource planning (ERP) application.

Shortcomings of database-driven inventory tools

If a centre can source or develop the expertise database administration requires, the investment can produce sizable returns in efficiency and transparency. But a move to any kind of database-driven inventory system would require the skills of someone familiar with MySQL or other databases to install the application, help transfer any existing data onto the new system, and ensure things are running as they should be. It will also be necessary for this person to be on hand for technical support. Database management requires intensive and ongoing attention; the skills required are expensive and in short supply.

Nevertheless, setting up the system might be the kind of discrete and defined project a local university computer science student could tackle over the course of a longer holiday, as long as she or he were well managed and as long as a suitably interested and motivated staff member were trained over the course of the project. The contract should be long enough to allow the student to perform the installation, train a counterpart in administration and see the project through its infancy. Training by job shadowing is no

58 See the subsection "free/open source software" in the section entitled "Product profiles" for more detail.

guaranteed solution, however, since its success depends not merely on the presence of technical skills in the trainer, but on the trainer's communication skills as well.

Bar coding applications

Another option centres can use to track equipment is a system that incorporates a bar coding system to generate tracking numbers and product identifiers automatically. This helps to automate the tracking process. A bar coding system requires both hardware and special software. At minimum, a centre will need to purchase a bar code reader, which attaches to the computer, a bar code printer, to produce labels for inventory, labels for the printer, and software that handles both the reading and production of labels. The basic concepts are still the same -- products are uniquely identified when they come into the centre, and from then on, all their movements are tracked. But because the computer handles the assignment, reading and recording of tracking and serial numbers, there is less room for error.

These systems can be built to process orders as they move from inventory to the point where they are sold to a customer. Items are tracked by their movements within the production chain and checked in and out of stations within that chain -- products are checked out of storage, checked into testing, or checked out to a client. Stock can be tracked when it comes into storage and also when the equipment is being configured and tested. Stock orders can also be prepared against an invoice that tracks all the hardware. Each of these actions means the invoice is already prepared once the equipment is ready to be shipped to a client. Some inventory management systems include Pastel (http://www.pastel.co.za), Odyssey (http://www.comtrex.com/) and the small business package Mind Your Own Business (http://www.myob.com/).

8.4 Planning for inventory management

The introduction of any inventory management system requires careful planning in order to maximise the likelihood that it will be used effectively. At the outset, managers should not only use a product to become familiar with the way the application itself works, they should also consider the impact the inventory management system will have on staff, maintenance and training needs. Key considerations include:

Who would be able to install it?
Who would maintain it? Does a staff member have the skills already?
Would computers have to be added at certain places in the workshop?
What training would have to be provided to staff to learn a new system?
Would it require stocktaking? (Is this desirable? Is this planned anyway?)
Would it require large amounts of data entry to begin with? Can staff be involved in the data entry?

As a centre grows its existing inventory solution may not suit its higher output or need for greater detail. The following additional considerations, taken in concert with the concerns listed above, may help managers map the migration from the existing platform to the new system.

How long would the migration to the new inventory system take?
Who would oversee the change?
Why is this change desirable?
Would existing data be able to be moved into the new system, or would it have to be retired?
What changes in processes would the software bring about? Are these desirable?

8.5 The management aspect

A common error at refurbishment centres is managerial tolerance of inadequate inventory mechanisms. Several still rely on spreadsheets and paper forms for tracking even though the stock-keeping method is inappropriate for the volume of equipment involved. One centre uses a spreadsheet so complicated only the director and the technical manager use it -- and its intricacy forces the technical manager to work with it during the first part of his work day, when, he says his "concentration is still sharp". Another centre relies on a web-based tracking system to synchronise its inventory with suppliers in Europe but its technicians cannot use it in the afternoon when international bandwidth is saturated. These experiences permit the wide application of one basic guideline: inventory managers should implement change before problems become chronic. It is wiser to implement a formalised inventory system while volumes appear manageable than it is to wait until stock has gone missing to decide to change systems.

A major cause of the legacy of poor inventory systems appears to be a lack of the technical and managerial skill required to oversee and integrate database tracking mechanisms into existing workshop practices. An inventory is too often seen by technicians as an accountant's problem instead of a tool that can help streamline workshop activities. In return, inventory managers complain that technicians are too unreliable to be trusted with maintaining stock sheets and hesitate to ask technicians to be too closely involved.

Solutions to these problems are not readily available, but a computer refurbishment centre on the cusp of establishing its operations should pay close attention to the way workshop and inventory design might be able to allow technicians, administrators and purchasing managers take group ownership of the process by seeing the value it presents them in their respective roles. Technicians can use an inventory to track their assignments and keep abreast of each other's progress in the various stages of refurbishment. Administrators can exert control over lost and misplaced stock. And purchasing managers can use inventory systems to time arrivals of new orders. While investment in a formalised inventory system may seem unnecessary as a workshop is becoming established, the cost of time and resources at the outset are likely to offset the costs of inefficiencies in the near future.

By contrast, sometimes an effective solution requires dedication rather than money. Computer Education Trust in Swaziland, a distributor of refurbished computers to the kingdom's public schools, chose another tactic to make its spreadsheet inventory work effectively. The executive director and two technical managers pored over spreadsheets on a weekly basis to attempt to derive failure rates, track stock and account for its hardware movement. The meeting was a fixture in the organisation's calendar.[59] The process increased the technical team's sense of involvement in the auditing process and helped to maintain the attention to detail so crucial for inventory management.

A number of disparate factors -- volume, staff size, workshop layout, as well as literacy and enthusiasm levels -- will together determine the appropriateness of a given centre's inventory system. At root, however, the system will rely on managerial and staff support to become an effective planning, auditing and tracking tool.

Summary

➔ An inventory should be able to track volumes of equipment over long periods of time and several locations. By integrating inventory with workflow, it is possible to keep an eye on how many computers are available for installation, and to match future demand with current supply. But most of all, inventory management is a mechanism designed to keep control over a process that comprises many different elements and locations.

59 Terence Sibiya, founding Executive Director, Computer Education Trust. Phone interview, February 2004.

- ➔ The different features of various inventory solutions will suit computer refurbishmentcentres at different stages in their development. The early appeal of a spreadsheet's ease of use may fade as volumes in the workshop increase. Likewise, an evaluation or audit may force a centre to be able to produce and track its stock in greater detail, necessitating the migration to a database system.
- ➔ Centres should invest time and effort into finding an inventory that suits their workshop conditions, workflow, and local practicalities.

9 Staffing

Building a motivated, skilled and task-oriented staff is fundamental to a computer refurbishment centre's success. One of the barriers to establishing centres in Africa is the shortage of a skills base upon which ICT ventures can be built. Rather than sourcing the technical skills to support a production and service environment, a computer refurbishment centre can develop its own ICT skills base through a training program. Production workshops and technical support programmes can run successfully with volunteers, where keen workers exchange their labour for the acquisition of skills. This arrangement, however, requires a special work environment to make sure that both trainees and the centre enjoy benefits from it.

At the same time, even though many skills can be developed through peer-to-peer and on-the-job training, the centre faces direct pressures -- particularly in the early stages of its development -- that demand the skills of experienced technicians and management. A centre's own needs dictate that certain skills should be sourced from qualified individuals from the outset. A third dynamic affecting a centre's human resource issues is the fluctuation in the staff it requires as the operation changes. During initial phases of the centre's founding, greater responsibility lies with fewer people. The need for volumes of technically skilled staff is not as high as the requirement of a unified and balanced management team.

9.1 Management and steering committees

When it comes to founding new operations, computer refurbishment centres can take some cues from best practice in other technology and connectivity projects. The *Telecentre Cookbook*, a guide written to shepherd founders through the process of establishing a community telephone and computer access centre, advises creating two bodies. It recommends stakeholders form a steering committee to be responsible for guiding the process of setting up a telecentre, who in turn nominate a management committee to oversee daily operations. The two committees in concert begin the process of founding the centre and bringing it into operation.

According to the *Telecentre Cookbook*, these bodies should include members from the community and local business representatives, as well as qualified professionals from different industries. It recommends the committee find a lawyer to advise on the legal procedures involved in establishing an organisation. It also suggests working with an accountant to understand tax implications and liabilities. The accountant may also be able to offer advice about how to set up accounts with a view to minimising both banking charges on international transactions and the centre's financial exposure to currency fluctuations. A computer refurbishment centre servicing schools may wish to include members from the ministry of education, faculty from teachers' colleges, and representatives from local and regional school governing bodies. The committee may also be well-served by the presence of industry members relevant to ICT provision: representatives from telecommunications companies, the state electricity supplier, as well as delegates from the local ICT sector, including systems administrators or ICT directors from local colleges or universities. Centres should try to include the expertise and access to information enjoyed by these representatives can help to give direction to operations at the outset as well as at critical junctures in the future.

A full description of the responsibilities and composition of these governing bodies is in the *Telecentre Cookbook*. It is highly recommended reading.

> Telecentre Cookbook,
> http://unesdoc.unesco.org/images/0012/001230/123004e.pdf

A guide to maximising the effective contribution of the board membership to an organisation is available at:

> Dynamic Boards (requires free registration), http://www.mckinsey.com/practices/nonprofit/ourknowledge/complisting/pdf/Dynamic_boards.pdf

9.2 Key roles

Key roles in the organisation are those that must always be filled. At the outset, the size of the staff will dictate that each member of the founding management committee assumes multiple roles. As the centre begins to grow, it will be necessary to add staff to ensure the continuous and smooth operation of the centre. Most of the changes to the management structure of the organisation will involve handing over some of the responsibilities of the director and core technical team to senior staff.

Executive director

The executive director is responsible for the overall management and running of the centre. She or he will be fundamental to the initial establishment of the centre, and will spearhead the initiatives to bring the centre into operation, including assessing the feasibility of the business, developing the business plan, defining the market positioning of the centre, forging partnerships and determining sales goals. At the outset, the executive director will also assume responsibility for sales, business and supply management, marketing, and, if qualified, accounting (see the four subsequent job descriptions). As the centre grows, these responsibilities should be shifted away from the executive director, who should then serve an ongoing supervisory and strategic role within the organisation, involved in such tasks as measuring performance, planning expansion, and gauging new market opportunities. The executive director is the main point of contact for the steering committee.

Business and administrative staff

Business manager

The centre should employ a business manager for each of its client groups. As mentioned in several places in this document, a centre typically has two kinds of clients: a number of similar clients whose computers serve the needs of large groups, such as schools, and a number of clients whose needs call for a computer to be used by fewer people in an office or home environment. The business manager for each group is responsible for co-ordinating all aspects of service provision, including sales and installation planning; forwarding projections of supply needs and installation schedules to those responsible for managing supply and the workshop; and ensuring new and prospective clients are assigned to client support staff. Business managers report to the executive director. At the outset, a single business manager may be able to handle both sales channels, but centre managers should consider grooming an understudy from within the organisation to fill a second business manager post. This will allow the business management position to be divided as sales volumes -- and, as a consequence, demand on the manager -- grow. A customer support representative is a likely candidate for understudy.

Supply and inventory manager

The supply and inventory manager assumes responsibility for sourcing and purchasing equipment, managing relationships with suppliers, arranging for shipment, overseeing delivery and customs clearance, as well as the management and accuracy of the inventory once computers enter the production process and are installed on clients' premises. The supply and inventory manager works closely with the business and technical managers to forecast equipment needs. The supply manager reports to the executive director. The job

should initially fall to the executive director, but given the time-consuming element of the work, the relative ease with which the role can be learned, and the clarity of the priorities of the position -- securing high volumes of uniform equipment at prices the centre can afford -- the position should be among the first responsibilities passed on to another member of the organisation.

Marketing and public relations officer

A marketing and public relations specialist oversees and manages the public profile of the centre in the community, including developing donation campaigns, announcing new project initiatives and forging new initiatives or partnerships. As a consequence of the impact this position can have on the visibility and profile of the centre, it should be among the last roles to be devolved from the executive director's responsibilities. The marketing and public relations officer reports to the executive director.

Accountant

The accountant manages all financial aspects of the centre, including budgets, tax liabilities, payments, salaries and financial reporting in accordance with legal requirements. At the outset, responsibilities may be such that an accountant can be hired on a part-time basis. The accountant reports to the executive director.

Technical staff

Technical manager

The technical manager is responsible for managing technicians in the workshop, designing work processes and ensuring the centre produces high quality, reliable technology. The technical manager is also responsible for planning and overseeing helpdesk and technical support functions. Maintenance and configuration of office ICT equipment also fall to the workshop manager. Likewise, those with a strong background in networking should act as technical liaison with counterparts at a partner Internet service provider.

A manager responsible for the workshop and its staff should have technical skills, with expertise in hardware and networking, as well as the communications skills and, ideally, management experience, to share knowledge with newcomers and volunteers.

It is advisable that two technical managers work in concert. Pairing the responsibilities for the smooth operation of the workshop allows both appointees to share the workload of a demanding position. It also lets the centre hedge its risk against productivity loss in the event that one workshop manager finds work elsewhere. The two technical managers should take the role as lead developers of the software and hardware combinations that comprise the centre's products. Technical managers report to the executive director.

Workshop technicians

Technicians will carry out the basic tasks of computer refurbishment, including cleaning, diagnostics testing, assembly, software installation and configuration, as well as packing and installing computers. They report directly to the technical manager.

The number of technical staff a centre requires is highly variable. Some centres assemble fewer computers with more staff, who are charged with responsibilities beyond computer refurbishment. Others wring high productivity from a small group more strictly assigned to the jobs of testing and assembly. Still others include a large number of trainees, which decreases productivity but fosters capacity building. In most cases, the division of labour and the volume of production will determine staffing needs. The following table provides a baseline indication of technical staffing levels at existing operations:

Staff size and output		
Organisation	**Approximate productivity**	**Technical staff size**
SchoolNet Namibia	up to 50 labs per school term	12 – 16
NetDay South Africa	one 20-computer lab per month	6
FreeComGroup	200 computers per month	12 – 16

Customer Support Staff

Customer support staff handle the day-to-day service needs of clients once they have received their equipment. Customer support staff liaise with clients, conduct feedback interviews, answer questions and act as the first point of contact for recipients of hardware and service from the centre. Much of their time is spent on the phone and writing emails to exchange information with clients. While not all customer support staff require technical skills to execute their jobs, knowledge of computer issues will assist them in advising clients and helping to resolve a given client's problems. Technically skilled customer support specialists should be charged with responsibility for attending to calls to a technical support line or in person. Customer support staff report to the technical manager.

If a centre supports more clients than one individual can reasonably handle, a good way to ease a customer support agent's caseload is to allocate responsibilities by region. Under this arrangement, one customer support person, for instance, would be the representative for all clients in the north, another for the east, and so on. The creation of more customer support roles may necessitate the creation of a position for a person to manage or co-ordinate customer support specialists. This position should report to the technical manager.

While the centre is testing the stability and usefulness of its products, customer support will fall to the technical staff. Once production has begun on a larger scale, a dedicated customer support staff should be drawn from the ranks of technicians. Ideal candidates for these positions are those who have shown a flair for interacting with clients and an interest in communicating their needs to others at the centre. A good predictor of performance is a good memory for names, an ability to listen and establish rapport with people quickly, and a disposition attentive to protocols and courtesy.

9.3 Technical staff: skills development

Centres can build local capacity through the creation of a training programme in which participants acquire skills and work experience gained at the centre on a volunteer basis. But the development of a skills training programme requires careful planning to ensure a balance between the interests of trainees seeking experience and the interests of the computer refurbishment centre in maintaining high productivity and quality. In a commercial environment, a salary compensates an employee for their labour; in a skills-development environment, the labourer must be rewarded with skills. An emphasis on skills transfer calls for a different management outlook and approach to production.

Commitment to skills development

A centre committed to skills development will have to ensure that management and other staff are attuned to the importance of skills transfer -- realising, for instance, that some tasks will take longer if the workshop has a large proportion of novice trainees, or that trainees face a learning curve if new tasks are introduced into the workshop. Developing an ethos sensitive to the impact trainees have on productivity is fundamental. But the ways to develop that ethos are difficult to prescribe. So much depends on the character of key staff members.

Nevertheless, a centre can take three concrete steps in order to enhance the likelihood that

its production environment optimises the opportunities for skills transfer and maintains a high-quality output. A centre can:

- Design the work environment to enhance skills transfer by creating a workflow that increases interaction between employees and facilitates the exchange of knowledge through cooperation and demonstration;
- Ensure that the key tools for workplace participation -- documentation and tools to carry out the necessary work, as well as orientation and guidance -- are in the hands of trainees when they begin work; and
- Measure each trainee's performance to verify the acquisition of skills.

Designing the work environment to enhance skills transfer

Designing the work environment in a way that enhances trainees' opportunities for skills development requires three things. Three things the centre should focus on are:

- Removing barriers to participating in the centre's workforce;
- Defining a clear plan for progress that sets out a vision for trainees' progress in acquiring skills;and
- Staff pairing and task rotation to enhance mentoring and peer learning.

Removing barriers to participating in the centre's workforce

For a workshop to show it is open to the contribution of volunteer labour, it must open its doors. It may not be necessary to advertise that the centre is looking to engage volunteers, but it is essential that everyone who shows up at the centre to apply as a trainee receives a clear explanation of the application process, a copy of the application form, and instructions about the next step. Typically, a centre should collect basic personal data, record the education levels of its applicants, assess their interests in computers, gain a sense of their experience with them, and pose one or two open questions (such as "What interests you about computers?" "Why do you want to work for this organisation?") that let a manager gauge both the inventiveness of applicants' answers and get a sense of their literacy. The application should also ask where the applicants first heard of the centre so that managers can trace how people are learning about the centre as a skills training venue.

The application form should not burden the technical manager with administrative problems: it should be short (one page or less) and it should not require attachments of testimonials or school certificates. Unless there is a plan or specific need for keeping and organising this information, a staff member can make not of it on the application instead. Some centres also collect a passport photograph.

Of course, the centre may not be able to take everyone who comes, and may often not be accepting new recruits. A good way to ensure that new volunteers do get a chance to be taken on is to plan for several intakes a year: depending on the type of centre, its clients, and local considerations such as school terms, it might be possible to pledge that every 3 or 4 months a new set of volunteers will be introduced into the workshop.

For example, FreeComGroup, in Cape Town, accepts interns on a scheduled basis through the Information Systems, Electronics and Telecommunications Technologies Sector Education and Training Authority (ISETT-SETA), a South African government-sponsored training program, and thus can tell applicants that it accepts people only at a given time. On the other hand, a centre that serves mainly schools might propose that it take on new volunteers only at those times convenient to its rollout schedule, which is often based on the school calendar.

An open-door policy can also be a source of feedback about the centre's presence in the community. A steady flow of job seekers is a good barometer of the centre's profile in the public mind as a place to work and learn. If young people frequently come to the workshop as volunteers, perhaps word is out at a nearby training college. However, if one demographic group that the centre would like to attract is not approaching the centre for skills training, managers should consider targeting different places with a more directed campaign. Often a simple poster or announcement on a community notice board will suffice.

Tip: Publicising the volunteer programme

Low cost ways to increase a centre's profile include: putting a poster in a local union office, adult education or employment recruitment centre; leaving leaflets at drop-in centres; putting a few brochures in waiting rooms where people have time to leaf through a description of the centre's programme; or posting an announcement in the local market. Likewise the local radio station could be asked to announce that the centre is looking for volunteers, but the centre should only do so if it is prepared to accept what might be a large applicant pool.

Defining a clear plan for progress

Once people have come forward to join the skills development programme, volunteers need to receive assurance that they will benefit from the donation of their time and effort through learning. A skills development plan that itemises the centre's vision of trainees' progress shows a centre's commitment toward this goal. Often this vision can take the form of the definition of some simple objectives. The centre should add expectations of how long each skill or piece of knowledge will take to acquire. For instance, for those volunteers that come without any knowledge of information technology, example objectives might include the following:

Basic skill objective	**Timeline**
Ability to identify all the parts in a computer and their function	2 weeks
Ability to use a checklist to identify visible, user-level errors in application and operating system function.	2-3 weeks
Ability to operate the inventory database	2-3 weeks
Ability to assemble a computer from components	2-4 weeks
Ability to test components and diagnose parts failure	4-6 weeks
Ability to browse and navigate through a file system with a basic understanding of its contents	4 weeks
Ability to install an operating system according to specifications	4 weeks
Ability to diagnose problems in software installation	6-8 weeks

These estimates are intended only as rough guidelines. A method for predicting the time it will take to acquire skills is impeded by the fact that some skills are additive -- consider, for example, how helpdesk work requires both client service skills and technical knowledge -- and some skills are developed independently of others -- for instance, typing and RAM testing. The speed of skills transfer also depends in an important way on the density of skills in a workplace: if only one person knows what to do, it will take much longer for

everyone else to learn the skill. But if eight or ten people all have comparable skills, and people learn from their peers, the speed at which that knowledge can be transferred through supportive collaboration is much greater.

These issues make attaching a timeline to the acquisition of advanced skills even more difficult. However, suggested advanced skills technicians should be encouraged to learn include:

Advanced skill objective
Ability to assist clients with basic, documented technical problems over the phone and in person
Ability to source, download, configure and install software or drivers
Ability to browse support sites to answer technical questions
Ability to access manual pages and technical literature and understand their content
Ability to develop improvements to workshop assets such as documentation and processes
Ability to develop improvements to workshop products

Independent of the difficulty of drafting a precise plan for progress, the communication of objectives to the volunteer helps to formalise the centre's obligation towards skills development. Some centres may choose to make this plan more concrete by drafting volunteer contracts. These documents may include the job description of members of the technical staff, as well as a definition of minimum time commitments (per week or month) expected of the volunteer.

Staff pairing and task rotation

The most efficient method to transfer skills is to break tasks into jobs done by groups rather than by individuals and to pair novice technicians with more experienced ones. It should be made clear that the expert is as much responsible for the teaching as the novice is for learning. Workers may be split into groups of four; the ideal balance is to have two more experienced people with two less experienced ones.

One group can be placed at each major station in the refurbishment workshop, exposing technicians to each different task. Trainees can be introduced to the different tasks incrementally, so that their exposure to new tasks increases as their skills grow. To enhance a centre's capacity for accommodating training groups, workshop processes can be split into parallel production lines in order to house multiple, independently productive stations for testing, assembly and all the other steps involved in refurbishment.

The following is a breakdown of workplace tasks, organised according to the skills required to carry out the job. This breakdown dispenses with displaying the refurbishment process in sequence (as outlined in detail in Part II of this document) in favour of depicting the kind of progress volunteers can make through the workshop ranks in order to learn and acquire specific skills. The list begins with the task that requires the lowest-level of skill required. This is where trainees might start their work at the centre. It ends with the highest level of skill. It shows how trainees might progress to roles of increasing responsibility.

- Quality assurance testing – Quality control is a good place for trainees to begin their roles in the workshop, because the job of verifying functionality is an opportunity for them to become familiar with the centre's products. A senior technician should be

responsible for final assessment, but inexperienced workers can be shown how to test for basic functionality and verify the operation of peripherals and applications.

- Intake and disassembly – Initial disassembly is a good place for technicians to start learning about hardware. Participation in the initial processing of computers also exposes trainees to the operation of the inventory system so crucial to a centre's efficient function. They should learn how to use it early in their time at the centre.
- Assembly – The task of assembling machines is a good opportunity for trainees to learn proper hardware handling and installation procedures.
- Cleaning and dust extraction. Except for the fact that use of the dust extraction machine can expose trainees to the importance of safety equipment such as eye- and ear-protection, cleaning presents limited opportunity for skills acquisition. Cleaning is a dreary, time-consuming but necessary job, and all volunteers should be rotated into the task on a regular basis. Generally no one should be exempt from cleaning since assigning the task to new volunteers will only stigmatise the role, and let more experienced technicians think the job is not expected of them.
- Testing – The job of testing components gives rise to the opportunity to operate the more technically intensive diagnostics programs and the chance to learn the basic diagnostic reasoning behind identifying failures. Given the financial impact a poorly followed decision-making process at the diagnostics stage can have, a more senior technician should be assigned to verifying apparent part failures and approving the decommissioning of parts.
- Monitor testing – Monitor diagnostics requires a special eye, since it is the most qualitative of the testing processes. It takes time to develop expertise in seeing which monitors are of a standard fit for another user. Many technicians can be assigned to the task on a rotating basis, but ideally the final word on monitor quality (especially for marginal or borderline cases) should fall to the same person for up to months at a time in order to maintain a standard of quality.
- Final configuration – Configuring specific network settings and finalising the product's functionality requires a technician familiar with the operating systems included in the centre's products. It is a good place to introduce technicians to basic networking concepts and configuration tools.
- Software installation and burn-in testing – A team of more experienced technicians should operate the imaging server and be responsible for preparing golden clients with the help of the technical managers. Burn-in testing, which uses the same workshop infrastructure as the imaging server, can be operated by less-experienced technicians under the guidance of the more senior operators.

To co-ordinate the kind of work rotation outlined above, the centre's technical managers (as noted above, it is recommended to employ two technical managers who work in concert) should be designated as leaders on the workshop floor. The managers are responsible for seeing that each of the technicians receives mentoring throughout their skills development period and they are the ones who share their more advanced skills with technicians. They are also responsible for changing and disseminating documentation. Their jobs routines should also include a considerable amount of unstructured time so that they can respond to technicians' requests as they arise. Since there will frequently be situations where technicians will encounter unfamiliar problems and not know how to proceed, it will fall to the technical manager to see that anomalies are quickly addressed, that queries are answered and that, to the best of the technical managers' ability, each obstacle that stands in the way of a workshop team is removed quickly.

Tools for workplace participation

In addition to timing and organising work in such a way as to maximise the chance of skills transfer, the centre has an obligation to ensure that the trainees have the documentation and tools to carry out their work.

Orientation and training documentation

A major problem for newcomers at any organisation is ignorance about staff responsibilities and hierarchies. The centre should prepare guidelines or a briefing pack that explains who volunteers will be working with and basic job descriptions of key staff members. One centre mandates that participating in a full workshop tour at the time of application is a prerequisite for becoming a volunteer. By understanding all the parts of a workshop, a technician will begin to get a good idea of where she or he might fit in.

However, more than orientation is required. An environment where people are picking up skills on the job requires procedures to be documented: that way, if volunteers can read, they can get involved. Expectations, procedures, instructions and how-to briefings should be written down, and given to volunteers when they start. Documentation should be sensitive to differing literacy levels and visual impairments.

Good documentation ensures that the knowledge possessed by a few is accessible in principle to all other staff. By itself it is insufficient for most learning, but the presence of documentation lays the groundwork for skills acquisition. It also helps to ensure that the centre maintain high quality in its production even though the workforce it uses may be relatively inexperienced. For more detail on procedures documentation, see the section entitled "Business drivers" and refer to Part II of this guide.

Toolkits

A toolkit is the set of screwdrivers, floppy disks, crimpers and other gear that technicians require to work with computer hardware and software. Each volunteer needs tools to do his or her job, but toolkits can be expensive, and can easily go missing. There are a number of solutions to this problem. One solution is for the workshop to own several sets of tools, and for the technicians to sign a toolkit out on a daily basis. At the end of the day, the workshop volunteers must return all the tools to the workshop manager to be signed back into the storeroom.

Another solution is to give each volunteer a set of tools when he or she starts at the centre, as well as a small loan to pay for them, with the understanding that if the volunteer still works for the centre after a given period -- six months, for example -- that the loan is forgiven. This arrangement can help to entrench the volunteer's sense of the centre's commitment to their placement in the skills training programme.

Suggested contents of a toolkit for servicing computer hardware are listed here:

> Belkin: Standard Computer Toolkit,
> http://catalog.belkin.com/IWCatProductPage.process?Merchant_Id=1&Section_Id=&pcount=&Product_Id=21748
>
> Mike's Hardware: PC Troubleshooting Toolkit,
> http://www.mikeshardware.com/howtos/pctoolkit/
>
> Tech Republic: Create Your Own Toolkit,
> http://www.faculty.uaf.edu/ffsdc/syllabus/c211links/tshoot2/three/

Skills monitoring and certification

Since volunteer staff exchange their labour for the opportunity to acquire skills, a centre has the obligation to measure the rate of its trainees' skills acquisition. Two main methods

for evaluating technicians' skills and progress are through internal review and through testing.

Review

Technical managers should be sufficiently involved in the day-to-day operation of the centre that they gain a sense of individuals' progress, and can influence trainees' job assignments to address shortcomings in their performance. For instance, if successive errors seem to suggest that a trainee is having problems learning how to configure and test network devices, he or she should be given more time at the appropriate work area to improve that skill. An experienced group partner should also be encouraged to spend more time with her or his colleague demonstrating and re-demonstrating the proper procedure. If errors are found to be more widespread in the workplace, the technical manager should consider revising the relevant documentation to clarify the steps involved.

In addition to this informal review and performance monitoring, technicians should also be evaluated on a weekly or monthly basis to gauge individual progress against the estimated timelines outlined in the skills development plan.

Testing skills

Testing is a good method of measuring skills acquisition. Unfortunately, it often intimidates people, but much of the anxiety around examinations can be alleviated through the testing environment. If people are encouraged to think of tests as a way to understand how they have progressed and where improvement is needed, it is easier to remove the intimidation and stigma around testing.

But large, comprehensive tests are not a good idea, because success or failure becomes too important, and the larger goal of the test -- to disclose strengths and weaknesses in understanding, and to make sure that workshop experience translates into comprehension -- becomes overshadowed. So a workshop full of volunteers will be better served by a series of short (perhaps five to ten minutes in length), relatively informal, relatively frequent tests, both written and practical. These might be given once every few weeks, if a large group is all developing at the same pace, or on the basis of demand if many volunteers are at different skill levels.

Since testing is for the purpose of evaluating skills rather than classifying people, all tests must include a review afterward, to ensure that the volunteer sees the benefits of the process. For instance, if a volunteer shows that she or he has a poor understanding of one kind of process, the tester should assist the volunteer to become more involved in that aspect of refurbishment.

Tip: Testing

Managers should be sure to have a large pool of questions for the test. This prevents people from memorising and regurgitating answers. There are a number of online test generators and pre-written ICT tests available online. Internet searches can produce sample questions that should be adapted to situations more likely to resemble the workplace scenarios your volunteers will recognise. ICT training centres may also be able to share copies of outdated, practice, or sample tests that allow a trainer to formulate a sense of testing formats. Good practical tests include configuring dial-up access, assembling a computer and subjecting it to burn-in testing, cutting network cabling and configuring an email client.

Certification

No matter how much effort a centre expends emphasising the value of testing as a way to measure skills development, if the purpose of testing appears unrelated to their career development, trainees may also begin to question the value of the exercise. Centres should explore the feasibility of structuring the training toward the attainment of an accreditation recognised and valued by the local ICT industry. A recognised qualification will enhance the volunteer's prospects for employment after they leave the centre. Managers may also reward trainees with bursaries to subsidise the costs of study and examination, and grant study leave and organise a trainee's workload to give relevant practice. Possible certification options include the A+ and N+ certificates as well as the Red Hat Certified Engineer qualification.

CompTIA Certification,
http://www.comptia.org/certification/default.aspx

CompTIA A+,
http://www.comptia.org/certification/a/default.asp

CompTIA Network +,
http://www.comptia.org/certification/network/default.aspx

Red Hat Certified Engineer,
http://www.redhat.com/training/rhce/courses/

Complementary skills development: typing

Typing is not a technical skill, but it is essential for anyone who works with computers. Since the keyboard is among the primary interfaces for using computers the skill, speed and confidence with which people can type determine to a large extent the success people have with computers. The workshop should do as much as it can to encourage the technicians to improve their typing skills.

One solution involves outfitting one or two computers in the workshop with typing tutors and encouraging technicians to use them on a daily basis for short periods of time. Two common choices of typing tutors are:

Mavis Beacon, (Windows)
http://www.mavisbeacon.com

TuxType, (Linux and Windows)
http://tuxtype.sourceforge.net

9.4 Motivating staff through production targets

An important aspect of the production environment concerns the centre's relationship with the staff as a whole. The team must be motivated, rewarded and measured much in the same way that individuals are. A good way to motivate the staff as a whole is through the definition of production targets. These should be expressed in concrete figures.

Example targets include:

- A precise number of computers to be refurbished in a given month or quarter;
- A target for increasing the number of products that pass final quality assessment checks on the first time through the process;
- A target for reducing the number of part or product failures reported in the first month after installation.

These precise numbers give the whole workshop a concrete barometer against which to measure its collective performance. These targets should not simply be imposed from management. It is important to quantify and justify to staff why these goals are realistic and achievable in order to assure the mutual investment of staff toward the goal. One easy way of making targets realistic and allowing the involvement of the workshop team is by keeping and posting records of production levels for the last week, the last month, and the last few months. This lets all technicians take part in understanding the variations in productivity.

Summary

➔ A computer refurbishment centre has complex staffing needs. At the outset, it requires the experience and involvement of a few committed organisers that articulate the vision and direction of the centre. In the early stages, it requires the concentrated effort of a small team of technical and nontechnical staff to pilot the centre through the complicated set-up phase. And to flourish in the long term, it requires the efforts of a dynamic team of skilled technicians.

➔ The need for skilled labour creates an opportunity to develop the skills of a workforce in-house. By initiating a volunteer program under which enthusiastic trainees exchange their labour for skills, the centre can meet its labour force needs and nurture the interests of members of the communities in which it operates.

➔ This arrangement demands a workshop take several steps to ensure that both volunteers and the staff see benefits. It requires the removal of barriers to volunteer eligibility, the provision of structured work plans as well as the necessary tools, documentation and work structure that foster skills transfer. This should be combined with a way to monitor the progress of both volunteers' skills acquisition and the production outputs of the workshop.

➔ A rotating, team-oriented approach is one method of organising work activities to maximise the opportunities for skill sharing. While testing programmes can enable a centre to monitor the pace of skills acquisition, orienting a centre's training programme toward the attainment of a recognised qualification can improve trainees' employment prospects in the ICT job market at large.

10 Increasing impact and ensuring sustainability

Refurbishment centres, particularly those that have positioned themselves as service providers to large-scale initiatives such as national school ICT provision programmes, must develop a process to gauge the readiness of applicants to receive computers and to assess the needs of its client base. Not only is the practice core to a service-oriented business, the development of an assessment tool is a potential source of added value to a centre's clients and to its contractors.

Research into shortcomings of past ICT provision and service programmes in Africa has shown two common implementation failures. First, computers are frequently installed in sites whose lack of infrastructure such as power and security mean they are poorly prepared to receive ICT.[60] Second, providers and recipients too often focus on connectivity and technology as ends rather than as the means by which users can accomplish other goals.[61] These failures are expensive. Providing computers and the support infrastructure necessary to maintain them is a costly venture, and each time a computer is placed in an environment ill-equipped to use it, the value of the investment is diminished.

Inadequate organisational preparedness is almost as detrimental to the value of ICT investment as inadequate infrastructure. John Dada, director of Fantsuam Foundation, a low-cost computer supplier in Nigeria, expressed the problem this way:

> After satisfying our client's desire to join the status of "computer owners" how do we get them to make the purchase worth its cost? How do the [small and medium-sized enterprises] SMEs integrate the technology into their businesses? How do the civil society organisations, the faith-based clients, do the same, and individuals do the same?[62]

This concern highlights a problem common to environments where enthusiasm for ICT exceeds users' skills base. Clients know enough about computers to want to own one -- even if it involves serious financial hardship -- but they lack the skills to derive maximum value from the computers as productivity tools. Conscientious providers have a responsibility to assist users to realise the full potential of the ICT they receive. Toward this end, a centre should develop means of defining the physical requirements to be eligible for ICT provision, a process for determining the readiness of applicants to receive ICT and tools for fostering the organisational planning that underwrites effective integration of ICT into projects and programmes.

These services also have a secondary function. If a centre has a high profile within the community in which it operates, the centre will be the target of more requests than it can fulfill. The centre can also use these tools to manage demands on the centre by ranking the priority of applicants according to their preparedness to receive and use ICT in a widely applied and transparent manner.

10.1 Priority ranking

When servicing large numbers of similar clients, a centre must take steps to ensure individual applicants have prepared their facilities to receive computers. Inadequate readiness assessments can lead to high failure rates. A review of the Telkom SuperCentres project and the Thintana I-Learn project, two programmes that have outfitted schools with computers in South Africa, showed that 82 of 205 schools received computers despite their

60 Ian Braid and Geoffrey Daniells. "Project Refcomp: Project Overview." Unpublished, shared via email.
61 Mike Trucano and Robert Hawkins. "Getting a School On-line in a Developing Country: Common Mistakes, Technology Options and Costs". *TechKnowLogia.* (January - March 2002):54-58. http://www.unescobkk.org/education/ict/resources/technologies/techknowlogia_checklist.pdf
62 John Dada, Fanstuam Foundation. Email interview, February 2004.

lack of basic preparedness. Almost ten per cent of schools that received computers had no electricity. The latest audit of the programmes showed that a third of all modems and more than one quarter of all computers had ceased to function. The report also measured a high correlation between disuse and theft: four of the ten reports of stolen computers took place at schools without electrical power.[63]

Assuring that recipients meet a basic standard of structural preparedness is essential. The Western Cape Schools Network, which provides computers to schools in this South African province, also mandates that schools install counter-like computer desks (900mm high, 750 mm deep) around the perimeter of the room at their own cost, and that schools insure the computers against theft. Until these structural needs have been met, schools cannot receive computers. Computers for Schools Kenya (CFSK) and SchoolNet Namibia each mandate that applicants meet certain physical requirements in order to be eligible to receive computers.

SchoolNet Namibia has mandated that schools must:

- Dedicate a room to house the computers;
- Ensure that it is fitted with burglar bars and other necessary security;
- Install a telephone line to be used only for Internet access;
- Upgrade the quality and quantity of electrical supply so that a circuit can support five to ten computers and monitors running simultaneously.

Ranking criteria

One formalised approach for priority assessment uses a priority calculator to aggregate a set of criteria and produce a score used to rank applicants. This example, taken from SchoolNet Namibia's school ranking mechanism, shows how physical and institutional criteria can be combined to determine the priority of individual applicants from a pool of more than 1,700 potential clients.

Since many schools are able to meet SchoolNet Namibia's physical infrastructure criteria, the organisation has derived a formula for managing the volume of demand it faces from eligible applicants. It determines the priority of schools based on its mandate to ensure that disadvantaged schools have access to its services. To aid in its decision-making, schools are ranked on a point system based on a number of criteria.[64]

Criterion	Point Value
Senior secondary school (11-12)	70
Junior secondary school (8-10)	65
Combined school (mainly secondary)	60
Combined school (mainly primary)	55
Senior primary school (5-7)	50
Junior primary school (1-4)	45
Cluster centre status[65]	100

63 Braid and Daniells, unpublished.
64 Peter Ballantyne. "Evaluation of Swedish support to SchoolNet Namibia." (2004):17. http://www.sida.se/content/1/c6/02/ 42/81/SIDA3557en_SchoolNetNamibia_web.pdf
65 A cluster school has been earmarked by the Namibian Ministry of Education as a place whose facilities are to be shared with nearby schools.

Criterion	Point Value
Hostel at school	60
Per learner	1
Per teacher	2
Ratio learner : teacher > 40:1	15
Ratio learner : teacher range 30:1 to 40:1	10
Ratio learner : teacher < 30:1	5
No telecommunication	15
No electricity	15
Remoteness > 30 km from town	20
Remoteness > 20 km from town	10
Remoteness > 10 km from town	5

Schools with neither telephone access nor electricity may be eligible to receive solar powered computer labs and wireless Internet connectivity, depending on their location. Currently, wireless Internet access is available in two regions of the country only -- in the capital and in the densely populated rural north. A school is eligible for solar power only if the extension of the national power grid will not reach the school within two years.

Observers have pointed out that the priority list may give too much focus to disadvantaged schools, whose generally higher student-teacher ratios may mean that teachers are already too overworked to accommodate new technologies into their work. Since less disadvantaged schools may be in a position to make better and perhaps more immediate use of the technology, it has been suggested that SchoolNet may wish to recalibrate its point assignments.[66]

Independent of specific criteria, the institution of a priority ranking mechanism serves two important purposes. Not only does it assist decision making within the organisation, its use also insures the centre from charges of bias or favouritism in its decisions. The priority tool and structural readiness requirements add an important measure of transparency to the process. Since computers are so highly sought-after, the use of a standard tool to rank requests allows the centre to communicate its methods clearly to every applicant and justify its determinations of fitness with reference to its ranking system.

10.2 Additional considerations for schools

Physical infrastructure criteria are only preliminary indicators of readiness and eligibility. Refurbishment centres should aspire that their ICT provision programmes produce more concrete benefits for the recipients. In schools, this particular benefit might be to integrate ICT within the existing curriculum, to foster and promote the use of the Internet as a supplement for poorly resourced libraries, to increase communications skills or to produce locally relevant content.

The achievement of these ends rests on much more than the stability of the electricity supply and appropriate security measures. The successful integration of ICT into schools and educational environments depends on many things, including the involvement and commitment of teachers and principals, the presence of educational content relevant to the

66 Ballantyne, "Evaluation", 17.

curriculum and on the assignment and development of projects that encourage directed use of ICT.

A full discussion of the issue is beyond the scope of this document, but three brief examples can illustrate fledgling developments to improve the ways and means with which ICT are adopted at schools.

- Principal involvement - Principals are often a school's gatekeepers. But they frequently lack information and training to make well-informed policy decisions. Consequently, they may, for example, protect the computers with undue vigilance, and limit students' access to them. Computers for Schools Kenya involves school principals and even members of the Board of Governors in pre-service training, educating them not only in basic computer use and maintenance, but also in a program to sensitise administrators to issues of access, use and security. These inclusive training tactics respect principals' roles as gatekeepers but provide them with the information to make better access policies.
- Educational content - Some teachers are keen to use computers as a learning tool, but many have difficulty developing or finding suitable material. SchoolNet Namibia therefore developed its product to include LearnThings (http://www.learn.co.uk), a web-based interactive curriculum and review program. It is based on the General Certificate Of Secondary Education (GCSE) secondary school curriculum, the educational model upon which Namibian secondary schools' International GCSE course work is based. Students can access the content from the school laboratory's server.
- Directed use - Students are keen to use the Internet, but they often need encouragement and direction to use it for educational purposes. Research projects focusing on specific topics can help to ensure that Internet access produces educational outcomes. Namibian school website-creation projects in the past few years have focused on locally relevant issues such as domestic violence, HIV/AIDS and indigenous culture.

10.3 Additional considerations for businesses and organisations

Service-oriented computer refurbishment centres also have an obligation to develop similar readiness assessments for clients other than schools. Since this group has greater overall diversity, the likelihood of developing an effective yet standard ranking and readiness tool is lower. Instead, a refurbishment centre should attempt to inform applicants about their products and provide consultation about the ways organisations and enterprises can use these products to address specific administrative needs and communication goals.

Organisations need to integrate the use of technology with existing and planned programme goals in order for computers to enhance their work. Experience has shown that community service organisations tend to underplan and overpay for their technology assets.[67] As the observation from Nigerian computer provider Fantsuam Foundation notes, organisations also tend to focus on computer ownership as an end in itself; only afterward do organisations search for ways to justify the expenditure. Centres oriented toward conscientious service delivery should offer consultation to organisations to help them decide if computers are appropriate for the organisation.

The consultation will primarily involve activities to assess the ways in which the use of computers can be linked to ongoing activities. In most cases, organisations consider computers only as devices that help to streamline internal processes, but consultants can also help organisations think about the ways that computers can be used to share information with other organisations and increase its communications reach.[68] In most

67 Natasha Primo, Director, WomensNet. Interview, May 2004. Rudi von Staaden, eRiding Manager, Ungana-Afrika. Interview, May 2004.
68 Natasha Primo, Director, WomensNet. Interview, May 2004.

cases, an organisation's vision and mission statements, as well as its three-year plan will provide the founding material upon which a technology plan can be developed.

Familiarisation

Many organisations will also need to understand how refurbished computers differ from new ones, and will want to gain a sense of older computers' benefits, appropriateness and risks. To meet this marketing requirement, centres may wish to run workshops tailored to particular audiences, such as SMEs and NGOs. These information sessions can also be used as a sales tool. Prospective clients can be invited to attend a short information session on technology planning techniques and the potential affordability of refurbished computers in organisations with smaller cash flows. The workshop facilitator can use the opportunity to position the centre as the source of consultation and affordable products, and highlight the availability of services from the centre that can help shepherd clients through the technology planning, acquisition and integration processes.

Tip: Technology planning workshop tools

Materials in the Multimedia Training Kit (MMTK) specifically address the issues relevant to the use of refurbished computers in organisations and offices. It also includes some documents about technology planning. Workshop facilitators can use the lesson plans and worksheets provided by the MMTK to structure the information session. The MMTK is available at:

http://www.itrainonline.org/itrainonline/mmtk/index.shtml

Budgeting and forecasting costs

Planning and controlling ongoing costs is also a major issue for organisations and small enterprises.

According to Richard Heeks and Richard Duncombe, authors of *Information, Technology and Small Enterprise, A Handbook for Enterprise Support Agencies in Developing Countries*,

> Enterprises tend to be fairly good at recognising the immediate, overt costs of ownership:
> - Hardware: the computer and peripherals (e.g. printer, modem, UPS).
> - Software: the operating system and application programs (where not pirated).
>
> However, they are not so good at recognising the other components that make up the total cost of ownership (TCO). TCO estimates suggest that other costs may make up as much as 60-70% of total costs. These ongoing and/or hidden costs can include:
> - Operational costs: printer ink/toner, paper, disks, electricity, insurance.
> - Internet access charges: local call charges plus those charged by the Internet service provider; there may be extra costs for email and for Web page hosting.
> - Upgrade costs: new hardware and software necessary to keep up with trends.
> - Training costs: for attending formal courses or for self-training.
> - Entrepreneur/staff time costs: expended on planning the introduction of ICT, on installation, on climbing the learning curve, on dealing with viruses or hackers, on playing games or searching non-work-related

Web sites, etc.

These issues are addressed directly by a forthcoming CATIA report on the total cost of ownership of refurbished and new computers. It will include a cost of ownership calculator and provide the relevant background to allow organisations and businesses to determine if a new or used computer best suits their needs.

Total cost of ownership is just one aspect of introducing ICT into organisations and small businesses. Planning for sustainable ICT integration is an intensive process that requires not just technical knowledge but financial acumen and organisational awareness as well. A number of guides and worksheets have already been developed with these priorities in mind. Centres should make these, as well as the consultative assistance necessary to using them effectively, available to prospective clients.

Valuable examples of technology planning documents include:

Information and Communication Technology: A Handbook for Entrepreneurs in Developing Countries, by Richard Duncombe and Richard Heeks, http://idpm.man.ac.uk/rsc/is/ictsme/entrephbk/index.shtml

Information, Technology and Small Enterprise: A Handbook for Enterprise Support Agencies in Developing Countries, by Richard Heeks and Richard Duncombe, http://idpm.man.ac.uk/rsc/is/ictsme/esaghbk/index.shtml

Digital dividend or digital divide? Guidelines for Development Practitioners, by Melody Kemp, Stuart Mathison, Jane Prasetyo, The Foundation for Development Cooperation, http://www.fdc.org.au/files/guidelines.pdf

Information Management Planning Guide: A practical process to plan strategically for the use of information and technology within a mission-driven organisation, from the Minnesota Department of Children, Families and Learning, http://www.roma1.org/documents/MN/MNimtp.html

TechSoup Information Technology Planning Worksheets, http://www.techsoup.org/howto/worksheets.cfm

A good discussion of issues relevant to ICT development in general is:

"Ownership and Partnership – Keys to Sustaining ICT-enabled Development Activities", by Peter Ballantyne. *IICD Research Brief*, December 2003, http://www.iicd.org/base/page?lng=1&nav=30&sub=340&code=&template=publication

Summary

- ➔ Computer refurbishment centres have a responsibility to raise awareness about ICT integration issues and to promote ways that computer ownership can bring concrete benefits to organisations and businesses that use ICT effectively. As a consequence, the centre should strive to be regarded not merely as a supplier of computers, but as a place that can help people determine their needs and shape the context within which computers can become effective, productive tools.
- ➔ Readiness and planning tools also help centres remain productive. Since demand for computers can frequently outstrip available supply, a centre providing services to large numbers of clients will inevitably receive more requests for computers than it can meet. As a consequence, it must develop a method of assessing the eligibility of applicants and of ranking the priority of eligible clients. The development of standard ranking tools helps to drive decision-making; if the tool is transparently applied, the method can also defuse criticisms of bias and favouritism in a centre's decisions.

- ➔ Given its role in the community as a trainer of staff and its profile as a dispenser of valuable and often-coveted equipment, a centre's choice to advise its clients as well as provide them with computers will likely bring longer-term benefits to the centre and to its relationship to the community in which it operates.
- ➔ Computer refurbishment centre managers wary of the cost implications of administering a readiness and needs assessment programme may have recourse to follow an emerging trend in the ICT sector in some developed countries and subcontract specialty needs and readiness assessments to a third party. Centres may also be able to levy a service fee for these consulting services, or embed a charge into a service contract.

11 Technical support

The provision of technical support is a major function of any computer refurbishment centre. It is essential to minimising downtime and maximising the availability of the client's computer. It is also a key factor in helping clients transform their inhibitions about new technology into positive attitudes about computers. A responsive and effective technical support system is difficult to design and achieve. A centre must define four essential components of its technical support program:

(1) It must decide upon its service mechanism -- for example, if it will give technical support over the phone or in person.

(2) It must also define which kinds of problems it should train its technicians and clients to solve using each mechanism, and which problems mandate that equipment be replaced rather than restored.

(3) It must also develop a process of escalation, by which unsolved problems receive greater attention by more people until the solution is found.

(4) Finally, it must attach timeframes to each service in order to allow a centre to make and keep commitments to its clients.

11.1 Problem solving strategies

The act of solving technical problems, whether conducted on the phone, via email or in person, involves isolating possible reasons for the reported failure and successively eliminating them. This process can be effectively represented in flow-chart diagrams, which are a very helpful reference for technical support staff.

An example of step-by-step problem solving

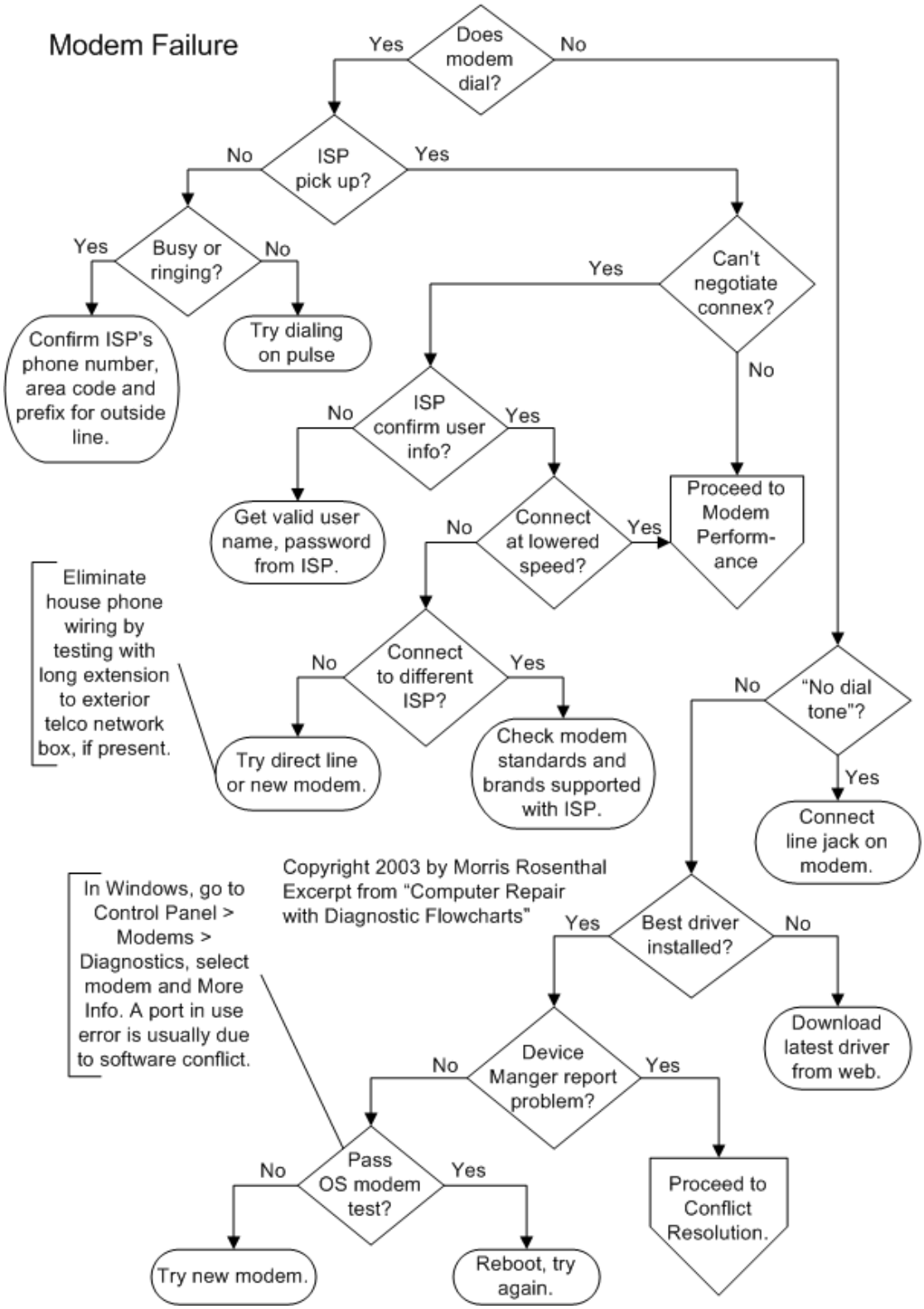


Image from http://www.fonerbooks.com/modem.htm. Used with permission.

A number of valuable diagnostic flowcharts are available at the site promoting Morris Rosenthal's book:

> "Computer Repair with Diagnostic Flowcharts" is available at:
> http://www.fonerbooks.com/pcrepair.htm

Customised adaptations of these flowcharts should be prepared for all technicians to use as reference tools. The preparation of diagnostic flowcharts is a good advanced exercise for those learning effective troubleshooting techniques; forcing technicians to break down computer actions into component processes reinforces the importance of the process of confirmation and elimination.

The demand for technical help has produced many websites dedicated to the issue. Good technical resources are available at:

> Tech Support Alert's Best Tech Support Sites on the Web,
> http://www.techsupportalert.com/
>
> Frequently Asked Questions : IS Computer Consulting, Oregon State University,
> http://tss.oregonstate.edu/consulting/faq/?page=home&type=normal
>
> Annoyances.org – Resources for Windows Users,
> http://www.annoyances.org

11.2 Service strategies

A computer refurbishment centre should give technical support both over the phone and in person. Clients should be encouraged to bring faulty equipment to the centre in order to have it repaired. For clients a long distance from the centre, however, phone support is likely to be a much more feasible option for timely service delivery. A telephone-based helpdesk should be the central point of contact for clients reporting problems, and the initial source of assistance. If first-line telephone support fails to solve a client's problem, a centre must arrange for the equipment to be replaced or for an on-site technical support visit to address the problem.

Remote assistance via the helpdesk

The helpdesk's existence, operating hours and phone number should be well advertised to clients. The use of toll-free numbers removes the economic disincentive to call for technical support; if possible, the line should be free to call from both fixed lines and mobile phones. If no such toll-free arrangement is possible, the centre should adopt a policy that users can call the centre, give their number, and be called back immediately. Since the loss of connectivity -– either through poor phone lines or modem failure -- is likely to be a common problem, helpdesk staff should not count on a client's access to email or instant messaging to give and receive help, a practice that is gaining popularity in the developed world.

Phone-based technical support should focus on recording all clients' error reports and attempt to diagnose the cause of the malfunction. But clients should be told to expect that helpdesk attendants can actually solve only a few common and predefined problems. The importance of limiting clients' expectations of the breadth of service available over the phone stems from the fact that communication, not technical trouble, is the biggest difficulty of phone-based problem solving. The lack of a common vocabulary for describing what appears on a screen impedes people's ability to interpret instructions and descriptions. And though users have coined metaphors to describe computer states ("hanging", "freezing", "crashing"), these terms mask technical problems that less experienced users -- especially those on slower computers -- may diagnose prematurely

and inaccurately. Finally, even if the solution is known, describing the steps involved and finding out if those steps have been executed or completed as expected is often difficult.

Two basic solutions that take into consideration the constraints on communicating technical information over the phone can improve the effectiveness of phone-based technical service. First, the diagnostic workflow approach should be translated into non-technical language. Helpdesk attendants should be trained to eliminate technical vocabulary and jargon from their speech as much as possible. This method reduces some of the confusion in communication. But this solution still leaves considerable room for problems describing what appears on a screen. A more effective solution calls for users and helpdesk attendants to follow instructions jointly. Using a fax to send detailed instructions or a booklet prepared in advance, helpdesk attendants can walk users through the diagnosis and solution of a number of defined problems. Ample use of screenshots and other graphics reduces communication problems. Documentation allows the completion of certain steps to be confirmed more easily -- instead of the question "What does the screen look like now?", technicians have recourse to the query "Does your screen look like the picture on page three?".

Examples of defined problems a helpdesk and clients should be trained to solve remotely, aided with reference to common documentation include:

- Verifying basic hardware function – checking power, device and network cabling;
- Modem and Internet access troubleshooting – checking cabling, modem response, line operation, dialing, authentication and hang-up;
- Isolating and solving booting problems on thin clients to boot media or cabling.

System replacement

Given the difficulty of solving a wide range of problems over the phone, a helpdesk should be used to record and diagnose problems that are then solved using a different service mechanism.

One mechanism available to a centre is system replacement. Since on-site service can be expensive to give to clients located a long distance from the centre, it may prove more cost effective to replace a client's faulty unit than to send a technician to the client's premises to fix the problem.

Delivery services such as couriers or informally arranged transportation can be used to supply a client with replacement parts. If, for example, a user calls with a problem about a monitor, helpdesk attendants can rule out basic power, resolution and cabling problems with the cooperation of a user over the phone. Then, rather than fixing more complicated problems remotely, technicians should arrange to send a replacement monitor to the user, who, in turn, returns the problematic monitor to the centre. Under controlled workshop conditions, the item's malfunction can be diagnosed. Then it can receive necessary repairs and be prepared for another user or, if the problem warrants, it can be decommissioned altogether.

If smaller, internal parts such as a network card or harddrive fail on a computer, an entire unit, rather than the part itself, should be sent to the client unless the technical capacity exists to replace the fault. In most cases, the need to replace whole units will be driven by the difficulty of achieving an accurate diagnosis of particular errors. In cases where whole computers are exchanged, diagnostics testing within the workshop should isolate the fault and return the remainder of working equipment into working inventory. If any data is recoverable, it should be copied from the harddrive and returned to the client. In other cases, the drive itself might be able to be returned to the client.

Computers For Schools Kenya builds a similar capacity for replacing faulty hardware into its provision of products. In every standard computer lab, a school receives one full working

computer, monitor and peripherals as backup. Problems must be reported within 24 hours, but the teachers are authorised to replace computers as they see fit. The malfunctioning unit must be returned to the centre promptly.

On-site assistance

It is impossible to eliminate completely the need for on-site service, even using telephone services to record problem reports and using delivery services to replace faulty equipment. However, given the expenses and logistical difficulties of planning site visits over a large geographical area, a centre should seek to reduce its on-site service burden as much as possible. The establishment of satellite offices and remote support partners located in different regions can reduce the costs of meeting on-site support.

> **Example**
> SchoolNet Namibia opened a joint office with a computer services business in the densely populated north of the country; technical staff there service the support needs of clients within the region. SchoolNet and its partner share costs on facilities. SchoolNet uses couriers to satisfy its satellite offices' supply needs. Costs are reconciled on a monthly basis. Before the foundation of the satellite offices, technicians would travel the 800km from SchoolNet's headquarters in the capital to service clients. Only when large numbers of support visits were necessary could the trip be financially justified. Prolonged absences of technicians whose presence is needed in the workshop compounded the disincentive for frequent service trips. As a result, several schools with resolvable problems had to wait long periods for service.

The presence of a satellite office can increase response time, but the reduction in travel requirements is not the only factor that contributes to the improvement in service provision. If technicians in the workshop are expected to be responsible both for production and service, there exists a tension between the responsibility to service existing clients and the incentive to continue to expand a client base. Clearly splitting the two responsibilities creates a clear mandate that some technicians should concentrate on service alone.

As much effort as possible should be expended to allow the technicians at satellite centres to focus on the core task of technical support provision. Administrative responsibilities should be handled centrally as much as possible. If volumes of replacement and service records remain small (and, if the office has an appropriately defined regional responsibility, such office overheads should remain small), one or two technicians should be able to handle their job assignments and record-keeping without requiring access to an inventory system of the scale required at the main office's refurbishment centre. However, given the importance of auditing and tracking products as they are provided to clients, repaired or decommissioned, the satellite offices will need some form of inventory trail. Depending on local electricity conditions, a rudimentary spreadsheet-based inventory system, the contents of which can be emailed to the centre and imported into the main office's inventory records, may provide an effective solution.

A satellite office will typically require a store of replacement equipment whose size should be determined by the logistics and costs of shipping equipment between the operations' headquarters and the office. The longer shipment takes, and the faster the supply is being depleted, the larger the stock kept at the satellite office should be.

A satellite office will also require the security and facilities sufficient to house the equipment with a minimal amount of exposure to dust, heat and risk of theft. It will also need some form of communication with the main office and communicating with clients. But it should not take incoming calls from customers. The task of recording incoming error reports should still fall to the main office, in order to support ongoing auditing and problem tracking. Technicians at the satellite centre should receive their work orders from the central helpdesk, on either a daily or weekly basis, depending on local conditions, workload and transportation.

11.3 Staffing needs

Phone-based and on-site service require considerable staff resources, particularly as the centre's client base grows. Some staff must be allocated solely to the task of technical support.

> **Example**
> The experience of Computer Education Trust (CET) in Swaziland gives a telling example. Despite a mandate to service every school in the nation, CET has only three technicians on its staff. Together they are responsible not only for preparing computers for use in schools[69], but also for installation and on-site service. The founding director, who has since departed the organisation, thought the job demanded ten staff, but since the onus on training fell to him alone, he lacked the time to train more technicians. The result was overwork, and long lag times between service visits.[70] As an evaluator concluded in 2002, "[t]he team has one vehicle, but with 40 schools and 600 installed computers, their resources are very stretched. There is now not enough time to carry out preventative maintenance visits. The lack of maintenance resource is a potential crisis area for CET".[71] In the two years since, the number of technicians has not increased, although the Ministry of Education now helps CET deliver computers to schools. Still, despite the lack of additional staff, the programme continued to expand. Three technical staff are now supporting 1,700 computers at 85 sites and the director reports staff size as its largest impediment to improving post-installation service.[72]

While the major underlying problem at CET is overall staff shortage, one option open to managers in this situation is to dedicate a smaller proportion of the workforce to production and installation and a much larger proportion to full-time service provision. This slows down the growth rate of not just output but technical support liabilities as well. An approach that dedicates more resources to addressing clients' support issues might be a better way to ensure that the computers remain operational and useful to the client.

Calculating staffing levels

Centre managers can make use of existing online tools to predict the kinds of staffing levels required for any technical support team. Ideal staffing levels are a function of the amount of time needed to solve a problem, and the number of hours available for technical support provision. The formula can be applied after an initial data collection period.

Technical Support Staffing Equation[73]	
Variable	**Description**
Incidents	Number of incidents for a specific period of time
Average time	Time spent to resolve a single incident (usually expressed in hours)
Utilization rate	Percentage of time actually spent resolving incidents

69 CET receives refurbished computers from Computer Aid International, but the computers require basic maintenance and software installation before being deployed at schools.
70 Terence Sibiya, founding Executive Director, Computer Education Trust. Phone interview, February 2004.
71 Tina James. "Chapter 3: Findings and Recommendations." *An Evaluation of the Computer Education Trust (CET) In Swaziland*, (2002):15. Retrieved from Imfundo Digital Brain. http://imfundo.digitalbrain.com/imfundo/web/plan/cet/?verb=view
72 Sibongile Kunene, Director, Computer Education Trust. Email interview. March 2004.
73 Robert Francis Group. "What's happening, Helpdesk?" *Analyst Corner*, *CIO,* December 7, 1999. http://www2.cio.com/analyst/report285.html

Technical Support Staffing Equation	
Available time	The number of staff working hours
SVT	Percentage of time accounting for sickness, vacation, training, etc.
Formula	

$$\text{Number of Staff Members} = \frac{\text{Incidents} * \text{Average Time}}{(\text{Available Time} * \text{Utilization Rate} * (1-\text{SVT}\%))}$$

Another useful resource is:
Helpdesk Frequently Asked Questions – Staffing Requirements Calculator,
http://www.coastaltech.com/hd-staff.htm

11.4 Pro-active support

Pre-emptive support and maintenance can reduce the number of problems that require urgent attention. Pre-emptive support strategies fall into three main categories: training, scheduled calls, and activity logging.

Training

Training in basic diagnostic routines is the most powerful mechanism through which a computer refurbishment centre can reduce its support burden. Recipients should be trained to recognise and solve cabling problems related to network and electrical faults and to use diagnostic documentation to solve modem and other Internet connectivity problems. Users should also be encouraged and trained to use existing help documentation both on the computer itself and on the Internet. Since an effective confidence builder for novice computer users is solving a problem on one's own, centres and their training partners should expend considerable effort to develop the resourcefulness and self-reliance of its user base. Toward this end, training sessions should also include practical troubleshooting exercises and sample scenarios as an element of course work.

Scheduled calls

Offering customers scheduled courtesy calls helps to build a good relationship once they have received equipment. Support staff should try to call clients on a weekly basis in the first two months of their receipt of computer equipment, and bi-weekly or monthly thereafter. Not only does this reinforce a customer relationship, it may also pre-empt the emergence of serious problems -- for example, if incorrect and potentially damaging use of the computers is detected early, as might be the case if a computer is shut down improperly on a repeated basis. Scheduled visits, if affordable and practical, can serve similar purposes and further enhance a centre's relationships with its clients. Good post-installation support can also be considered as a marketing tool: customers may spread word of attentive and courteous service and attract more business to the centre.

Activity logging

Another form of pre-emptive technical support involves measuring clients' ongoing use of ICT. Centres can use the data kept in Internet connection logs, which record the time a client connects to the Internet and signs off again, as a prompt for providing technical support. A client's computer can be configured to email these logs to the centre on a regular basis, and design a system to calculate the frequency by which users access the internet. Changes in the frequency can be used, for example, to measure the impact of a recent training session on a client's use of ICT or to highlight the need for financial or other kind of support to promote greater use of the Internet. Sudden stops in Internet access can prompt a technical support call or visit.

Internet service providers (ISPs) also log the times that its clients access the Internet. Centres may be able to forge a special relationship with an ISP that grants the centre access to the ISP's logs about the frequency of Internet use among customers of the centre. In the majority of cases, however, such collaboration will be difficult to arrange because of the kinds of data involved.

No matter how it is collected, this data must be used only with clients' permission. Crucial to the agreement between the centre and its client (and the ISP, if applicable) is securing the user's informed consent about monitoring details. Users must be briefed about the kind of information being shared and must also be given an option to refuse monitoring on their computers and to cancel the activity at any time, without penalty. The centre must also guarantee that the information will be used only by the centre for the purposes clients agree to. As well, the centre must promise not to sell or divulge information for commercial purposes. Sample privacy policies available on the Internet should be able to provide a starting point for the centre's own user agreement and for the methods it can use to inform its users before they grant or withhold consent. For more on this issue see the section entitled "Business Drivers".

11.5 Service standards, timelines and escalation

Essential to technical support is a set of guarantees about service standards. Good customer service requires clarity about timeliness and responsibility. In the absence of clear guarantees, technical support can be plagued by poor communications and different expectations. Typical lapses include: problems are reported to the centre but they go unresolved for days; clients do not know who is working on their problem and do not know who to contact for an update; the technical support team may promise to solve the problem during an on-site visit, but the client receives no guarantee when that will happen.

To avoid these pitfalls, a centre should strive to develop standards of both timeliness and escalation to ensure that problems are recorded, addressed and solved within a defined period, and, if they are not solved, that a more senior member of the organisation is notified and held accountable for addressing the problem. The size of the staff, a centre's area of responsibility and the capacity of the client to participate in finding a solution are each factors in a centre's calculation of appropriate timeframes for promising a solution. In many cases a commitment to a truthful, but lengthy timeframe is more important to a customer relationship than a broken promise of a quick resolution. A target to aim for is to resolve problems over the phone within perhaps three or five calls on successive days; once five days have elapsed, a replacement should be shipped. If, after replacement, the problem persists, an on-site visit should follow as soon as time permits.

Such a timeline can only be effective if there is a system of escalation in place to monitor the time elapsed between the report of the problem and provision of a solution. Helpdesk management software often features a system by which a more senior staff member is notified if a problem has not been resolved within a given time period. For example, if a helpdesk attendant has failed to solve a problem within three days, the helpdesk manager can automatically receive an email that explains that a solution to a given problem has not yet been registered as solved. If another two days pass, the technical manager can be similarly notified. Staff of successive seniority can automatically be brought into the loop if a particular problem is ignored.

More detail about these kinds of management ideas are available online. Good helpdesk management resources are available at:

> Help Desk FAQ - The Basics,
> http://www.ksasystems.com/prolink/mirror/basics.shtml
>
> Help Desk FAQ – Other Resources,
> http://www.ksasystems.com/prolink/mirror/other-resources.shtml

11.6 Technical support management software

A supply and support centre should use helpdesk management software to assist staff in keeping track of calls and recording solutions if the load on the helpdesk is sufficiently large to warrant the expense and administrative time to support the application. While a spreadsheet can be used to log problems and record calls, a formal helpdesk application brings distinct benefits. The application should also allow managers to calculate the average time required to solve problems, as well as add some facility for categorising problems according to their type. It should also be able to prompt technicians about outstanding, unsolved problems by recording the time elapsed since a call was first recorded. It should also enable escalation -- the automatic notification of more senior staff of unsolved problems -- after a specified interval. As with the inventory system, it is advantageous if the software can be accessed with a web browser, allowing simultaneous use by multiple staff. The human resource needs of a web-based, database-driven support tracking tool are similar to those required for implementing and maintaining an inventory database. See the section entitled "Inventory" for more detail.

Many software options are available online, often for free. Request Tracker is one free/open open source application that meets these needs. It allows users to track reported problems, assign the responsibility for recording a solution to identified helpdesk users and supports escalation. It also contains a facility for keeping track of documentation about solutions to commonly encountered problems.

> Request Tracker documentation and source code are available from Best Practical:
> http://www.bestpractical.com/rt/
>
> Raspberry, a South African company, provides customised service and support for Request Tracker. Information is available from its website:
> http://www.raspberry.co.za/raspberry/Products/rt

Oregon State University's helpdesk software is another option. It provides similar call tracking, solution management and escalation facilities. It is available from the project's home page:

> OSU Open Source Lab - Home,
> http://osuosl.org/projects/helpdesk/

Summary

- ➔ To realise the benefits of ICT, good technical support is key. The presence of technical support engenders trust between a centre and prospective customers who may worry that their own inexperience should discourage them from purchasing a computer and coming to rely upon it.
- ➔ Given the potentially high frequency of problems the combination of new users, older hardware and a harsh environment may produce, the technical support arm of a centre's customer relations service must receive considerable attention.
- ➔ A centre should implement both remote and on-site support systems, carried out with specifically tasked staff and supported by management software. Support systems should be established with a view to training and preparing clients to support themselves as much as possible.
- ➔ Proactive customer support measures such as scheduled service calls and activity monitoring can help bolster a relationship with a client and improve both support levels and quality. Of all measures to improve customer service, the definition, communication and adherence to standards of response and resolution time is paramount.

12 Facilities and infrastructure

A computer refurbishment centre has certain core infrastructure needs. It requires stable electricity, access to the Internet and sufficient storage space to house a relatively large supply of hardware. It also needs to be accessible to those whom it employs. With these criteria in mind, a few existing computer refurbishment centres have chosen to house their operations within high-profile community access centres. Although these locations are ideal, sometimes the facilities require upgrading or modification in order to enhance their suitability for working with computers and computer equipment.

12.1 Size considerations

Essential facilities in a centre include secure storage, a well-ventilated workspace and an office area for administration. The precise dimensions of each part of the facility can vary, but the envisioned volume of production, as well as projections about storage required for incoming supply and outgoing products will mainly determine a centre's need for space. African refurbishment centres, because most of their equipment is sourced offshore, likely require storage equivalent to the volume of at least one shipping container, independent of production scale.

Example: Matomo Technologies
Matomo Technologies, an assembler of new computers under contract to Hewlett-Packard, for example, has designed its production line so that about 20 employees can carry out the final assembly of computers. Four production lines fit inside a space no larger than 150 square meters. But its warehouse, which stores both incoming parts and computers destined for stores, dwarfs the centre, with multiple rows of shelving providing thousands of square meters of storage space.

Example: Computers For Schools Columbia
Computers For Schools Columbia, a national programme modeled on the Computers For Schools Canada programme, uses a distributed regional approach in its refurbishment programme in order to meet its supply and storage needs. As its website notes, "each centre…[has the] capacity to receive and to refurbish the computers donated in its city and the bordering regions. The capacity of each centre has been calculated considering the concentration of computers in the city and the projections of the volume of donations at local level."[74]

12.2 Electricity

A stable electrical supply is essential for the operation of a refurbishment centre. Without a reliable source of power, centres cannot run the software and equipment necessary to support a production environment that requires inventory tracking, testing stations and other infrastructure in order to function. Centres may have to install brownout rectifiers (devices that correct fluctuating or voltage on a circuit) to stabilise voltage fluctuations on circuits or, in severe cases, install its own generator.

Example: Fantsuam Foundation
Nigeria's Fantsuam Foundation, in the town of Kafancha, near Bayanloco, set up its operations in the same building as a well-known telecentre. Its existing popularity within the community gave the computer centre an instant profile to the public; its location in the community also ensured its presence became known to those whom the centre hoped to recruit as volunteer technicians. But the site was not perfect. A major problem in Kafancha is the electricity supply, where power failures of two and three hours are, in the words of one employee, essentially routine. As a workaround,

74 Computadores Para Educar, "Reacondicionamiento."

the Foundation installed a 100kvA diesel generator and runs it during morning and evening classes held at the centre. Since it is too expensive to run all day, the centre turns off the generator between two in the afternoon and the time that classes resume at six in the evening.

12.3 Telephony and Internet connectivity

Telephony and Internet connectivity infrastructure are likewise crucial. So many activities fundamental to a computer refurbishment centre hinge on the availability of Internet access that the speed afforded by traditional dial-up connectivity will be insufficient for an active workshop. Instead, a centre should install some form of high-speed dedicated Internet link (such as ADSL, wireless, satellite or a leased line). But there are significant price differences between different forms of always-on connections and prices also vary widely across the continent.[75] Since Internet connectivity will be among a refurbishment centre's highest ongoing costs, managers should give careful consideration to the benefits a broadband connection can bring, and select an option that offers acceptable quantities of bandwidth as affordably as possible.

Example: SchoolNet Namibia
SchoolNet Namibia faced a major problem with telecommunications when it moved into a new location in its second year of full-scale operation. There were no telephone lines at all. Telecom Namibia, the national telecommunications provider, had pledged to install lines before the move, but the work had yet to be started. SchoolNet elected to hire a work crew to lay an underground telephone cable and then petitioned Telecom to enable the phone service. Telephony was a key concern for SchoolNet since the organisation leases a dedicated line to connect to the Internet and hosts a toll-free number that allows its clients to contact the centre free of charge from a land line.

12.4 Paying for and equipping the centre

Leasing or renting facilities and paying for their modification and upkeep can prove to be an expensive proposition. For a lot of centres it might prove effective to bolster or forge anew its relationship with government ministries and other well-resourced organisations to see if these entities can assist either with finding facilities, donating equipment, giving furniture or supporting the costs of modifying existing premises. Since it can require considerable capital to lease a building, centre managers should seek to negotiate free rental courtesy of a gift in kind from the building owner. The opening of an office creates a centre's largest opportunity to receive material rather than monetary donations. Many companies have spare office furniture; some may even have office supplies and stationery to spare. Centres should attempt to source such equipment as cheaply as possible.

Examples
Computers for Schools Columbia, for example, leveraged its relationships to find and furnish appropriate space. Each of its five centres was established with the help of the local Chamber of Commerce, which in many cases also paid for interior modifications to the buildings. A partner company such as the local utility company or telecommunications provider agreed to cover the cost of the lease or rental of the site. In a similar vein, Computers for Schools Kenya houses its operation inside a prominent boy's school in Nairobi. The executive director persuaded the principal to donate workspace in exchange for free maintenance for the school's computer laboratory.

75 Indications of the price fluctuations across Africa are available at http://www.afrlct.org. See in particular "Internet prices in Africa. A comparative study." http://www.afrlct.org/images/Internet_prices_in_Africa.pdf

12.5 ICT equipment

A well-planned office network can improve office communication and efficiency at the same time as it distributes all-important Internet access among its staff and volunteers. The number of staff and volunteers, the size of the workshop space and the volume of production will all help to determine the number of computers that will be needed in the office, as well as their placement.

Helpdesk attendants, for example, will require computers to log incoming calls. The supply manager and executive director will likewise require their own computers to communicate with equipment brokers, partners and others. Computers are also needed to track inventory. Generally, a computer should be placed at every inventory choke point -- for instance, wherever inventory moves in and out of storage, and if possible, wherever stock changes location or status, such as moving out of testing and into configuration, or wherever computers pass the burn-in test and move to the final configuration stage. The presence of a networked computer, able to access and change information about the movement of inventory, will help to maintain the integrity and accuracy of the records.

Two or three computers should be available within the workshop for researching and troubleshooting. Technicians need access to the Internet to solve problems, download drivers and to read documentation. Staff should also be encouraged to use email to communicate with colleagues and clients, as well as invited to use other applications as a way to promote basic ICT literacy and productivity.

In addition, installing an extra two or three network points in the workshop can make configuration and software updates more efficient. Some hardware-identification utilities, for example, work only if the computer being probed is present on the network. Network access is also useful for testing configurations during quality assurance testing. A computer should also be dedicated for use as a fileserver, with the aim of building a local driver library that reduces the reliance on the Internet.

12.6 Location considerations

The location of the centre is another important concern. Since its equipment is valuable, the location likely requires good security infrastructure. SchoolNet Namibia and the Fantsuam Foundation each employ round-the-clock security guards to reduce the centre's risk of losing equipment to theft. And since the centre will be receiving often large shipments of computer equipment, the site must be accessible to large trucks making deliveries. If a place is far away from residential areas, the cost of transportation might discourage poorer people from coming to the centre. If a place is perceived to be unsafe for certain groups of people, locating premises there will make it more difficult for those groups to visit and work at the centre.

Summary

- ➔ Computer refurbishment centres require three main features in their facilities: size sufficient to store equipment, carry out refurbishment and conduct business; stable electricity to support the infrastructure of the operation; and a form of Internet connectivity to enable communication with suppliers and provide a method for sourcing software.
- ➔ At the same time, facilities can be costly to modify, expensive to furnish and difficult to find. A centre should turn as much as possible to its partners and other possible donors in order to find premises and equipment as cheaply as possible.
- ➔ While the features of a given facility are important considerations, it is also important to find a location for the centre that gives access to staff and the general public.

13 Partnerships

A computer refurbishment centre comprises just one element in the web of services, support, training and strategy required to increase ICT distribution and uptake in Africa. Even at a local level, the entire scope of the task of ICT integration is beyond the scope of one organisation. It is therefore important that supply centres forge partnerships to spread the considerable onus of ensuring sustainable ICT growth across several industry, community service and government sectors.

13.1 Recipients

Throughout this document, the words "recipient" and "client" have been used to denote those individuals or groups whose technology needs the refurbishment centre services. The words were chosen for their clarity. In one important respect, however, the words "client" and "recipient" -- and "beneficiary" even less so -- fail to capture that those serviced by the centre are important partners in marketing, feedback, service improvement, programme development and revision initiatives at the centre.

A centre should strive to include its partners in planning and review strategies, and use them -- especially in the early stages of product development -- as sources of expertise about the reliability, appropriateness and usability of a centre's products. Recipient partners can bring other benefits as well: they can spread word of the refurbishment centre, providing free advertising; offer their experience to a neighbour or allied organisation, reducing the service burden on a refurbishment centre. They can even partner together with other recipients to form their own independent service, maintenance and support networks. Without fostering such partnerships, each of these responsibilities would fall to the centre alone.

Likewise, feedback programmes about service quality with a view to service improvement are essential to initiate, but generating buy-in from local partners on the activity can be difficult unless they too see benefit to the program and bear an allegiance to the success of the centre's initiatives. Sometimes a good relationship suffices; in other cases, feedback programs can be supported through incentive programs such as mentions of partners in newsletters, public acknowledgments, printed thanks and photographs, and even gifts such as printer cartridges or paper, diskettes, USB memory sticks and other rewards.

Developing a sense of ICT ownership is another goal of service delivery. The centre should strive to ensure that, as much as possible, recipients come to view computers they have acquired through the centre's services as their own property. Generally it seems that a sense of ownership is developed in proportion to the difficulty with which barriers to access and acquisition are overcome: people own what they fight for much more than what they are given. For refurbishment centres, this means that managers should design service programs not to eliminate all barriers to access, but to replace truly unconquerable impediments with still-onerous but more realistically removable ones. In many cases this calls for the lowering of financial barriers -- ensuring equitable and affordable pricing instead -- and leaving the temporal or moderate logistical barriers for clients to solve. Examples include asking the client to undertake the site preparation necessary for installing computers: welding burglar bars in place, upgrading electricity circuits or installing a telephone line. Centres may also mandate, for instance, that training and consultation precedes receipt of ICT equipment, or that recipients participate in arranging for the transport of computers.

The partnership system at Computers For Schools Kenya (CFSK) serves as a good example. While schools do not have to bear the entire cost of computers, they must pay both a US$26 one-time administrative fee for each computer they receive and an annual US$38 overall maintenance fee thereafter. And since schools often have their own buses,

teachers and principals are required to arrange the transport of computers from CFSK's Nairobi headquarters to the schools themselves. They are also trained to set up the labs on their own.[76] SchoolNet Namibia likewise expects schools to assume some of the logistical burden of computer provision. Schools are required to feed and house technicians and trainers when they come to work at the school, and to pay at least the installation fees for telephone lines. Even though the organisation provides a warranty with its computers, schools are encouraged to take equipment they suspect is damaged to SchoolNet itself and to pay couriers' fees for the delivery of replacement equipment,

> The essay, "Ownership and Partnership – Keys to Sustaining ICT-enabled Development Activities", by Peter Ballantyne, provides a good background on partnership development issues. It is available at: http://www.iicd.org/base/page?lng=1&nav=30&sub=340&code=&template=publication

13.2 Telecommunications provider

A major component of the ongoing costs involved in ICT ownership are the charges levied for Internet access. If a connection is established over a phone line, users in many countries must not only pay a subscription fee to the ISP, but also pay for the cost of the telephone call. Initiatives underway in several countries in Africa, including Egypt, Senegal, South Africa and Namibia, focus on the determination of a discount on charges for calls made to an ISP, often called an e-rate.[77] Some initiatives also include discounted telephone installation charges, as well as reduced rates for ISP subscription services.

In Senegal, for instance, Sonatel, the national telecommunications company, and the Ministry of Education reached an agreement to reduce the cost of Internet access for learning institutions. Sonatel installs telephone lines intended for Internet access for free. In turn, the government mandates that the monthly line charge remain at a fixed level for a guaranteed period, and that the cost of calls to the ISP be discounted by 75%. Schools with ISDN lines receive a 50% waiver on installation costs and 75% discount on usage fees. Leased lines are offered at 50% discounts.[78]

In Namibia, SchoolNet Namibia and Telecom Namibia have launched the Xnet Development Alliance Trust in an effort to fix the costs of Internet access.[79] Under the terms of the agreement, schools and educational institutions can access the Internet for a fixed rate of US$45 a month, independent of usage volumes. Schools must pay to install a line dedicated to Internet access. Calls to numbers other than the ISP are blocked. Schools that access the Internet via a regional wireless network pay the same fees as schools that use telephone lines. The ability to fix costs at a set rate enables schools to budget, raise funds and plan for Internet access.

13.3 Training partner

An alliance with a training partner, or the development of an in-house training service, is essential to the success of any technology provision campaign. Many end-users will want

76 Musili, Interview. Also from: SchoolNet Africa. "CFSK Case Study." *SchoolNet Africa: Course for Technical Service Centre Managers.* http://www.schoolnetafrica.net/fileadmin/1MillionPCsTraining/Resources/Module%202/Computers%20for%20Schools%20Kenya.doc

77 "E-rate is at its simplest a nationally agreed discounted rate for Internet access for schools: often this rate is enshrined in the relevant telecoms legislation at a national level and therefore the responsibility of the regulator." Balancing Act. "E-RATE FOR AFRICAN SCHOOLS &SHY; HOW WOULD IT WORK AND WHO PAYS?" http://www.balancingact-africa.com/news/back/balancing-act_159.html

78 SchoolNet Africa. "Affordable Bandwidth For African Schools." http://www.schoolnetafrica.net/fileadmin/resources/Affordable%20Bandwidth%20for%20African%20Schools.pdf, p.21.

79 SchoolNet Namibia. "Xnet Development Alliance Trust launched." http://www.schoolnet.na/news/stories/xnetlaunch.html

assistance to learn how to use applications to prepare documents and read email. Effective Internet searching techniques are a vital teaching requirement. Much training software and many curricula have already been developed for basic ICT skills training. One recently published review of 15 training products is:

> Review of Basic ICT Skills and Training Software For Educators in Africa, http://imfundo.digitalbrain.com/imfundo/web/papers/ictreview/?verb=view

In addition, training providers should supplement formal training programmes with specific tasks relevant to the computer refurbishment centre's operations. If, for example, the refurbishment centre mandates that end-users install their computers and network devices themselves, the trainer and centre management should develop materials to support the expectation. If clients are expected to be able to fix certain kinds of problems, such as troubleshooting Internet access, with assistance over the telephone, trainers should teach and test students so that they can meet those expectations.

Training agencies and the refurbishment centre should devote considerable work to the identification and definition of the key learning outcomes course work is expected to produce. Poorly communicated expectations can strain the partnership and frustrate end-users.

13.4 Government

Governments are sources of valuable information. They can particularly help with planning long-term provision programmes. Access to the plans for the expansion of the nation's electricity or telecommunications grid, for instance, can enable a refurbishment centre to time its expansion into regions or markets to coincide with the presence of complementary infrastructure.

The ministry of education can be another key partner. Staff at Computers For Schools Kenya, for example, spent close to a year redesigning and updating the secondary school computer science curriculum before a single computer had been deployed to schools.[80] The Kenyan Ministry of Education's acceptance of the revision paved the way for a large-scale school installation program. Similar curriculum review initiatives are under way in Namibia, where work to localise existing online curricular content has begun at the National Institute for Educational Development.

13.5 Tertiary institutions

Tertiary educational institutions can also become valuable partners. Not only can engineering and computer science faculties provide a significant labour and recruitment pool, the participation of faculty and information technology directors at universities, which are often the most advanced publicly owned data centres in a country, can give refurbishment centre management access to otherwise costly consultation. A close affiliation with teachers' colleges can also increase ICT training capacity. Mandating that teachers acquire ICT skills prior to accreditation both encourages skills acquisition and raises the likelihood that ICT trainers, if sourced and trained in concert with a teacher accreditation programme, will have the pedagogical abilities to transfer skills.

13.6 Materials recycling

Suppliers of used computer equipment will frequently encounter parts that have reached the ends of their lives and needs to be decommissioned. Due to the presence of lead, mercury, cadmium and other hazardous elements in electronics parts, computers must be

80 Musili, Interview.

disposed of in a manner sensitive to the effects these metals can have on the environment. Some centres active in Africa subcontract the responsibility of environmentally sensitive disposal to operators that specialise in reclaiming precious metals such as gold from printed circuit boards, harvesting scrap metal from cases and other parts and ensuring that hazardous waste is diverted from landfill. Computers For Schools Kenya (CFSK), for instance, exports its end-of-life equipment to a recycler in Asia with whom one of CFSK's suppliers, Digital Links, has a standing contract. Other suppliers use Desco, (http://www.desco.co.za), a recycler based in Johannesburg, South Africa. A complete discussion of the issues pertinent to the decommissioning of computer waste, including considerations for contracting a disposal partner, is available in Annex M.

13.7 SchoolNet Africa's "One million computers for African schools" initiative

On 1 August 2003, SchoolNet Africa sent out a call for partners in its bid to procure and distribute one million computers to African schools. Plans include lobbying corporations to receive end-of-lease computers, supporting the establishment and development of low-cost computer refurbishment centres, and lobbying governments to reduce or eliminate import tariffs on computers destined for educational institutions. Centres may be able to participate in this continent-wide initiative. Complete details are available at:

> One million computers for African Schools: A Call For Partners,
> http://www.schoolnetafrica.net/fileadmin/resources/Call_for_Partners.pdf

Summary

- ➔ Since hardware and technical support comprise only a small part of the broad-based initiatives required to ensure sustainable ICT expansion in Africa, partnerships are key to a centre's success.
- ➔ Foremost among these partnerships is the one the centre develops with its clients, who can give valuable feedback to the centre about its products and services. Several other partnerships are likewise key to success.
- ➔ Given the priority of controlling ongoing costs, refurbishment centres should seek to partner with local telecommunications providers with the purpose of driving down connectivity costs to affordable levels.
- ➔ Given the importance of end-user skill development, a partnership with a training agency can help to satisfy the needs of a centre's user base, including both basic instruction to learn applications and interfaces, as well as specialised training to solve technical problems common to the products the centre distributes.
- ➔ Given the position of government as a source of valuable information, participation with government agencies is vital if long-term programmes are to be planned effectively.
- ➔ Given the responsibility of a centre to dispose of end-of-life equipment responsibly, a partnership with a reputable recycler is also necessary.
- ➔ Finally, given the involvement of SchoolNet Africa in computer supply and service issues in concert with its One Million Computers For Africa initiative, managers should endeavour to familiarise themselves with this programme.

14 Centre development chart: key concepts and priorities

The preceding pages have documented each of the key concepts and priorities involved in establishing and managing a computer refurbishment centre. The following tables provide a summary of each of the key issues. They are intended to assist readers envision a roadmap of the processes involved in setting-up a centre and managing it through to productivity.

The chart breaks the process of establishing a centre into three phases:

1. *Feasibility* focuses on determining the viability of the enterprise by looking at import restrictions, gauging the availability of stock and assessing the levels of market demand and interest. It is also designed to verify the presence of partners willing to forge the partnerships crucial to the success of an ICT enterprise.

2. *Product, process and support strategy development*, dedicates attention to determining the centre's products and developing the support infrastructure. It lists the prerequisites of product development -- design, stability testing, feedback, piloting -- before the workshop goes into production.

3. *Production Phase* gives attention to the changes necessary as a computer refurbishment centre begins to distribute its product, solicit and support new clients. It also covers how the centre's management team must start to shift responsibilities to a greater number of staff. As the overall management burden increases, the centre must also time its supply to meet production demand, and begin to funnel greater organisational attention toward technical support.

Each phase consists of a number of core activities pertinent to a particular stage of business development. Each activity consists of a number of steps. Each activity within a phase is assigned a duration. This is an estimate of the total amount of time it will require to execute the steps involved in each activity. Each activity in a phase can be executed concurrently. To assist readers digest the key concepts involved with the execution of each step, the rightmost column of the table lists the area in the report where content is most pertinent to the activity listed.

Establishing a computer refurbishment centre: Key concepts and priorities

Phase	Phase leader	Relevant section of the report
Business Area	Duration	
Activities		
Phase I: Feasibility	**Led by: Executive director; steering and management committees**	
Import and registration	90 days	
Find fellow importers to understand their experiences and hear their advice		Shipping & customs: Assessing local conditions
Find out about rules and regulations		Shipping & customs: Customs clearance. Also see "Tariff information for African countries" in Annex B.
Liaise with Trade ministry; inquire re: discount/ preferred service		Shipping & customs: Assessing local conditions.
Anticipate costs – shipping, tariff, VAT, delays, license application		Shipping & customs: Shipping costs - Use the online freight calculators listed. See also "Keys to reducing shipping costs" in the same section, also Annex B.
Register as importer if necessary -		Shipping & Customs
Sales	90 days	
Host workshop to assess interest of potential clients		Business drivers: Volume of demand; Increasing impact and ensuring sustainability: Familiarisation.
Liaise with govt to assess interest in school/telecentre initiatives.		Business drivers: Market positioning
Conduct market research to assess price points		Business drivers: Demand drivers
Begin to develop product specifications and features based on local demand and cost projections		Product profiles: Hardware acquisition costs; Business drivers: Demand drivers. Also see the total cost of provision document included in Annex J.
Supply line	30 days	
Investigate prices and sources, market dynamics		Supply Management: Prices
Sign up to mailing lists, announcements		Supply Management: Tip
Browse web for suppliers, compare price, availability		Supply Management: What to buy. Also see the list of sources in Annex A.
Establish contact with brokers		Supply Management: Tip
Assess feasibility of local parts supply		Supply Management: Local Donations
Find broker for network and peripherals - UPS, Modem, cabling, switch		Supply management: Peripheral Equipment
Begin cost projections for international supply; begin forging supplier relationships.		Supply management; Shipping and customs; Business drivers; also see the cost of provision document in Annex J.
Partnerships	ongoing	
Investigate possibility of ISP partner- discuss terms of service, e-rate,		Partnerships: Telecommunications provider
Find disposal/recycling partner		Partnerships: Recycling. Also see Annex M
Find training partner		Partnerships: Training partner.
Establish partnership base		Partnerships
Key Considerations for advance:		
If customers exist		
If partnerships in place - e-rate, e-readiness criteria, ICT alliance		
If import is feasible		
If supply line able to be established		
Go To Phase II		

Phase II: Product, Process and Support Strategy Development	**Led by: Technical manager(s)**	
Develop hardware/OS/Application combination	30-120 days	
Determine product specifications based on cost projections and local demand.		Supply Management: Prices; Business drivers: Demand drivers; Product profiles.
Source a test supply: based on affordable supply forecasts, source equipment (small volume = ~1 pallet) representative of envisioned product		Supply Management: What to buy.
Develop OS/Application/Hardware trial version		Product profiles
Test product and processes	90+ days	
Refurbish some items from test pallet. Test software on a sample from pallet. Subject trial version to typical burn-in, longevity, stress testing		Part II:Technical procedures; Quality assurance: Burn-in testing
Assess performance and functionality. Build golden client from one member of sample.		Quality assurance; Assembly, software installation and burn-in testing: Simultaneous software installation. See also Annex L
Refurbish remaining hardware; install software. Perform quality assurance testing.		Part II: Technical procedures
Install products in a test environment. Find clients with whom centre has good relationship and who are close-by, patient, communicative, to serve as test bed; feedback learning into product profile. Potential clients: those affiliated with board/steering committee.		Product profiles: Testing
If facilities permit, establish own lab and encourage drop-in use. Log performance and maintenance issues closely. Document solutions		Product profiles: Testing
Refine build based on testing results.		Product profiles
Refining processes	60 days	
Based on lessons learned from product development, build and refine testing, specification, installation procedures in conjunction with ICT manager.		Technical processes
Develop workshop procedures manual; staff-wide review		Technical processes; Business drivers; Staffing: Orientation and documentation.
Publish procedures manual; implement review process		Business drivers, Staffing
Service strategy	90+ days	
Define readiness criteria in concert with service contractor (government, corporate social responsibility initiative, donor), if market position demands.		Increasing impact and ensuring sustainability: Priority ranking
Improve workshop/seminar on ICT and refurbishment issues; begin hosting introductory workshops.		Increasing impact and ensuring sustainability: Familiarisation
Customer support strategy	90+ days	
Use testbed clients to refine procedures for giving technical support.		Technical support: Proactive support
Use testbed clients to define training needs to offset support reliance		Technical support: Training

Phase II (contd): Product, Process and Support Strategy Development	**Led by: Technical manager(s)**	
Locate Site:	60+ days	
	Investigate sites with appropriate size; ensure sufficient storage, security	Facilities and infrastructure: Size considerations
	Seek among partners for low-cost facilities available as in-kind donations	Facilities and infrastructure: paying for and equipping the centre
	Establish availability of telecommunications	Facilities and infrastructure: Telephony and Internet connectivity
	Stabilise or supplement electricity as needed	Facilities and infrastructure: Electricity
	Seek donations for furniture, modifications	Facilities and infrastructure: Paying for and equipping the centre
	ICT for workshop - install server, inventory and helpdesk management systems, desktop computers.	Facilities and infrastructure: ICT in the workshop
Core Staff Expansion	30 days	
	Expand technical staff beyond core development team by bringing on trainees.	Staffing: Technical staff
	Train technical staff in production and support	Staffing: Technical staff
	Refine documentation based on training experiences	Staffing: Performance measurement
Key Considerations for advance:		
If product is stable If reliable, ongoing supply exists If staff prepared If support plan is in place If site secured		
Go To Phase III		

Phase III: Production Phase	**Led by: Executive director; management committee**	
Customer Relations	ongoing	
	Business manager begins information workshops	Increasing impact and ensuring sustainability: Familiarisation
	Training partner starts training courses for clients	Partnerships: Training Partner
Staff Adjustments	ongoing	
	To enable director to continue focus on partnerships, business and partner development, build management layer into staff.	Staffing: Executive director
	Hire/promote purchasing/inventory manager to handle supply	Staffing: Key roles
	Hire/promote internal business managers for each product/customer line	Staffing: Key roles
	Hire/promote public relations officer	Staffing: Key roles
	Regionalise support model - dedicate customer relations for regions to specific people; e.g. NorthEast State Manager	Staffing: Key roles
	Deputise regional support coordinators – clarify roles of technicians responsible for support	Technical support: Staffing size
	Increase number of volunteer/trainee staff on production line	Staffing: Technical staff size
	Shift experienced technicians to quality assurance & support provision	Staffing: Key roles
Supply	ongoing	
	Stabilise inventory size by improving coordination of shipments/installation	Supply management
	Begin to solicit interests in commercial partnerships/long term supply contracts	Supply management
	Identify production/supply bottlenecks, pace production accordingly	Supply management
Support Capacity	ongoing	
	Increase support capacity through establishment of satellite offices to handle local technical support issues	Technical Support

PART II. TECHNICAL PROCEDURES FOR COMPUTER REFURBISHMENT

Efficient computer refurbishment centres require formalised internal technical procedures to produce high-quality products consistently. Part II of this guide focuses on the technical detail required for proper execution of the core tasks of refurbishment, collectively called "workshop processes". Supplying a refurbished computer to a client involves five basic steps: cleaning; testing each part for faults; assembling a computer from parts and installing software on it; quality assurance testing; and packing and shipment. Together these processes will restore a computer to a working state, fit for its next owner.

A depiction of the order in which technicians carry out workshop processes is given in the workflow diagrams entitled "Intake and disassembly", "Component testing", "Harddrive testing", "Monitor testing", "Assembly, configuration and burn-in testing". They demonstrate how equipment passes through each stage, as well as help to show the integration of inventory with workshop processes. The diagrams also depict the process of evaluation that goes into deciding which equipment should be kept for re-use, which pieces should be kept aside for replacement stock, and which should be recycled.

This part of the guide is targeted to technical managers who will oversee workshop staff and be responsible for the centre's production. It is aimed at readers with moderate ICT literacy. It assumes readers are familiar with computer hardware, software, basic installation and networking concepts, and are comfortable searching, browsing and downloading from the Internet.

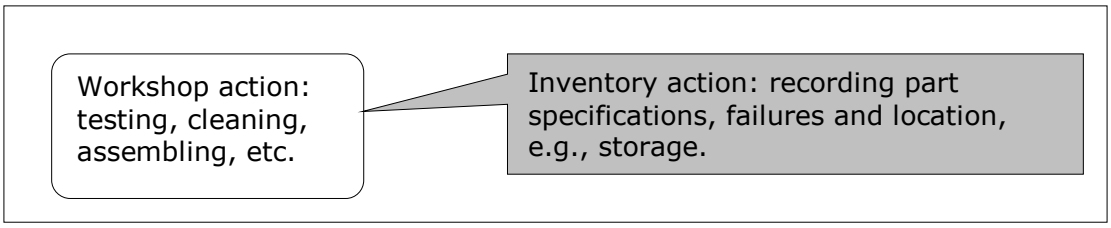
Each step involved in the refurbishment process is detailed:

- *Cleaning.* Before the computers move into the workshop, the cases should be removed for cleaning. Using a vacuum, compressed air or high intensity blower, dust and debris should be extracted from the interior of the computer case. Cases should be cleaned with a light detergent and stripped of any badges, decals or other material that the manufacturer or former owners applied. See the section entitled "Cleaning" for more detail.
- *Testing.* Software is used to identify faults in components. All equipment should be tested before it is used in production in order to eliminate the cost of warehousing material that has no value, and to reduce the rate of replacement for equipment that fails after it has been given to a user.
- *Assembly, software installation and configuration.* Tested equipment is assembled according to a set of specifications defined in the product profile. Technicians should follow a standard procedure for assembling the computers. Once the computers have been assembled, an operating system and applications are installed on the harddrive. Then drivers and any hardware are installed or added to the configuration. Finally, networking is configured and applications are installed. In an environment where large volumes of computers are loaded with software, centres can use a method that installs software on large numbers of computers simultaneously in order to save time and effort. Each of these steps is outlined in the "Assembly, software installation and configuration" section, which describes the steps in more detail and gives instructions and links to sample documentation and reference material.
- *Quality assurance testing.* The hardware configuration is tested using a program called a burn-in test, which stresses the hardware. A technician then verifies that the product complies with quality standards against a checklist. See the section entitled "Quality assurance testing" for more detail.

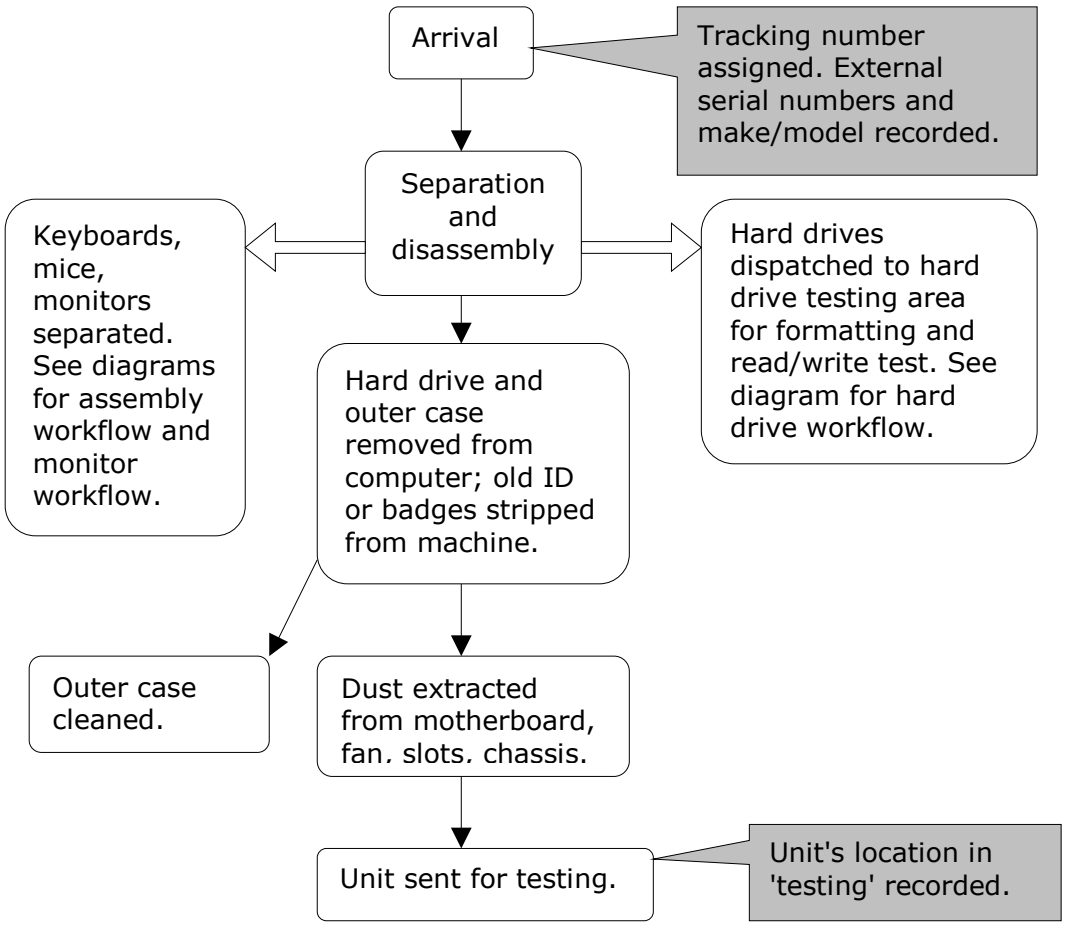
- *Packing, shipment and installation.* The tested computers are packed together with other necessary equipment and installed in the new location. See the section entitled "Rollout and installation" for more detail.

The following workflow diagrams set out workshop actions and corresponding inventory actions:

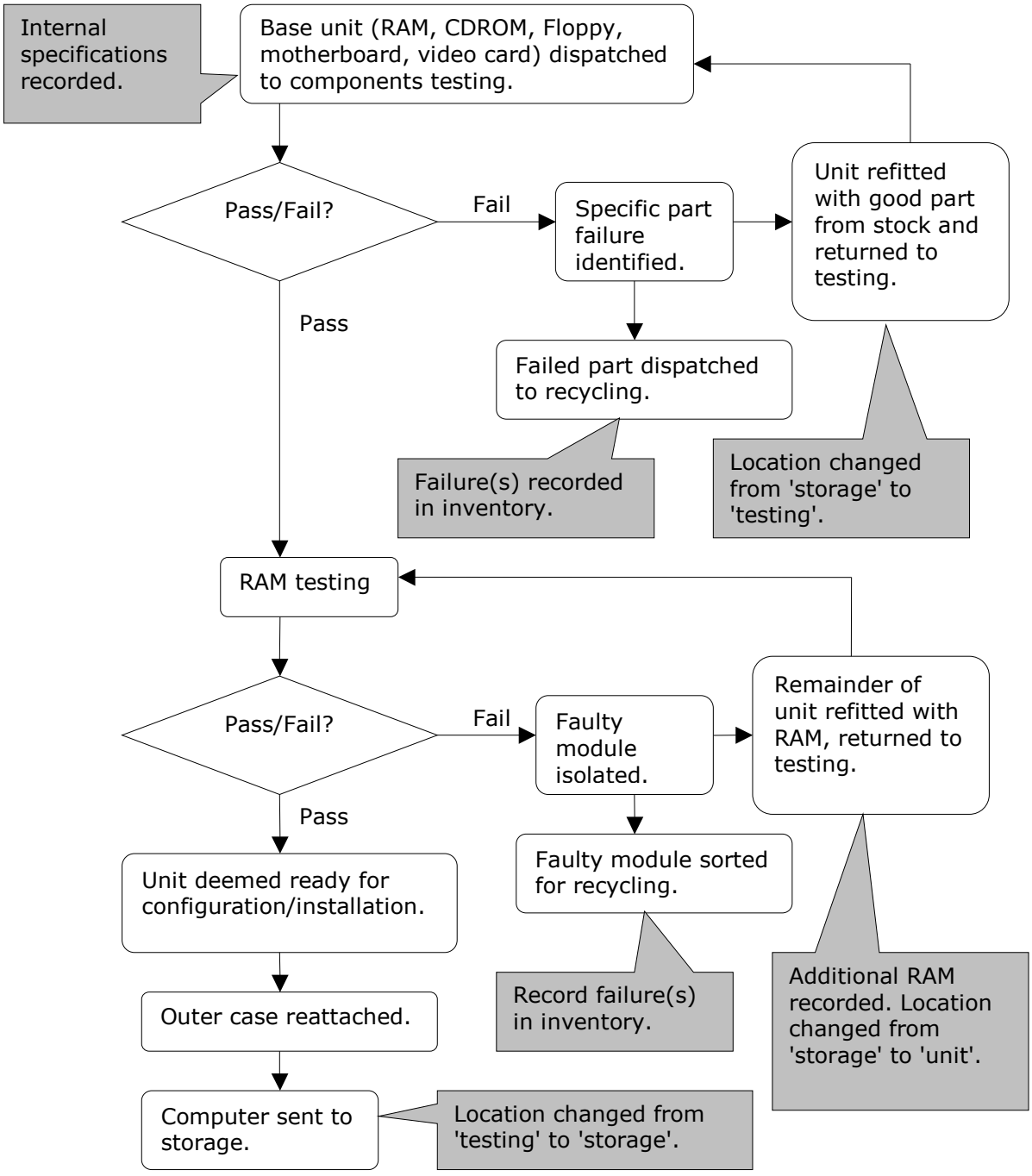
Legend to diagrams



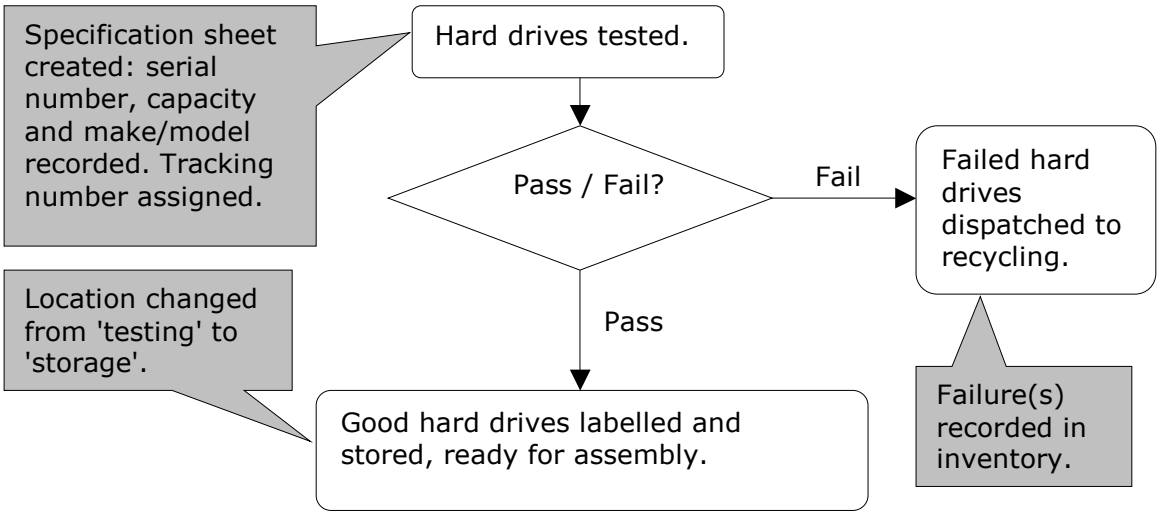
Workflow diagram: Intake and disassembly



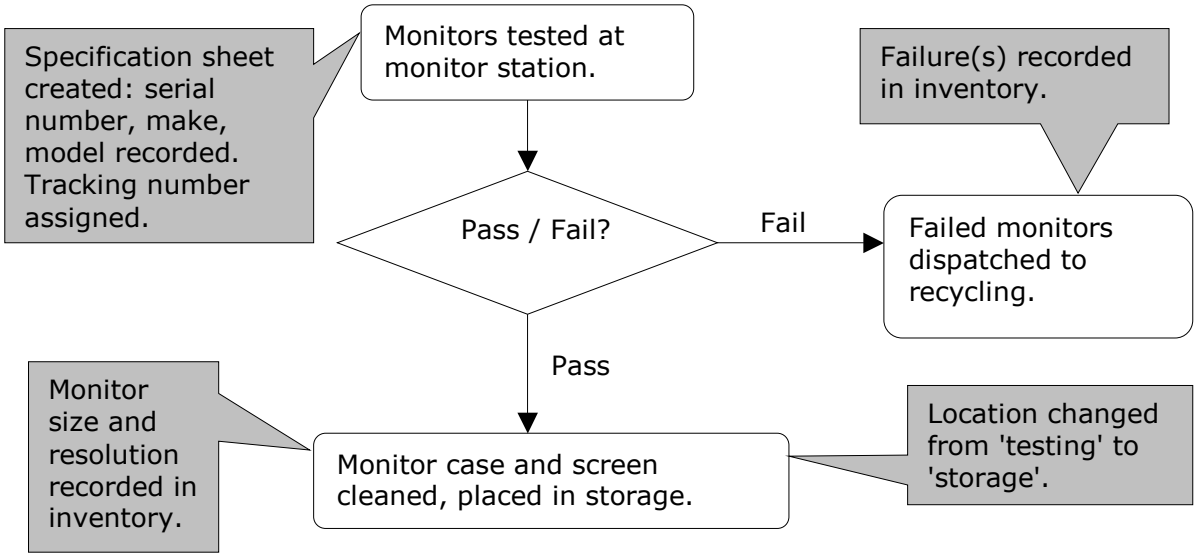
Workflow diagram: Component testing



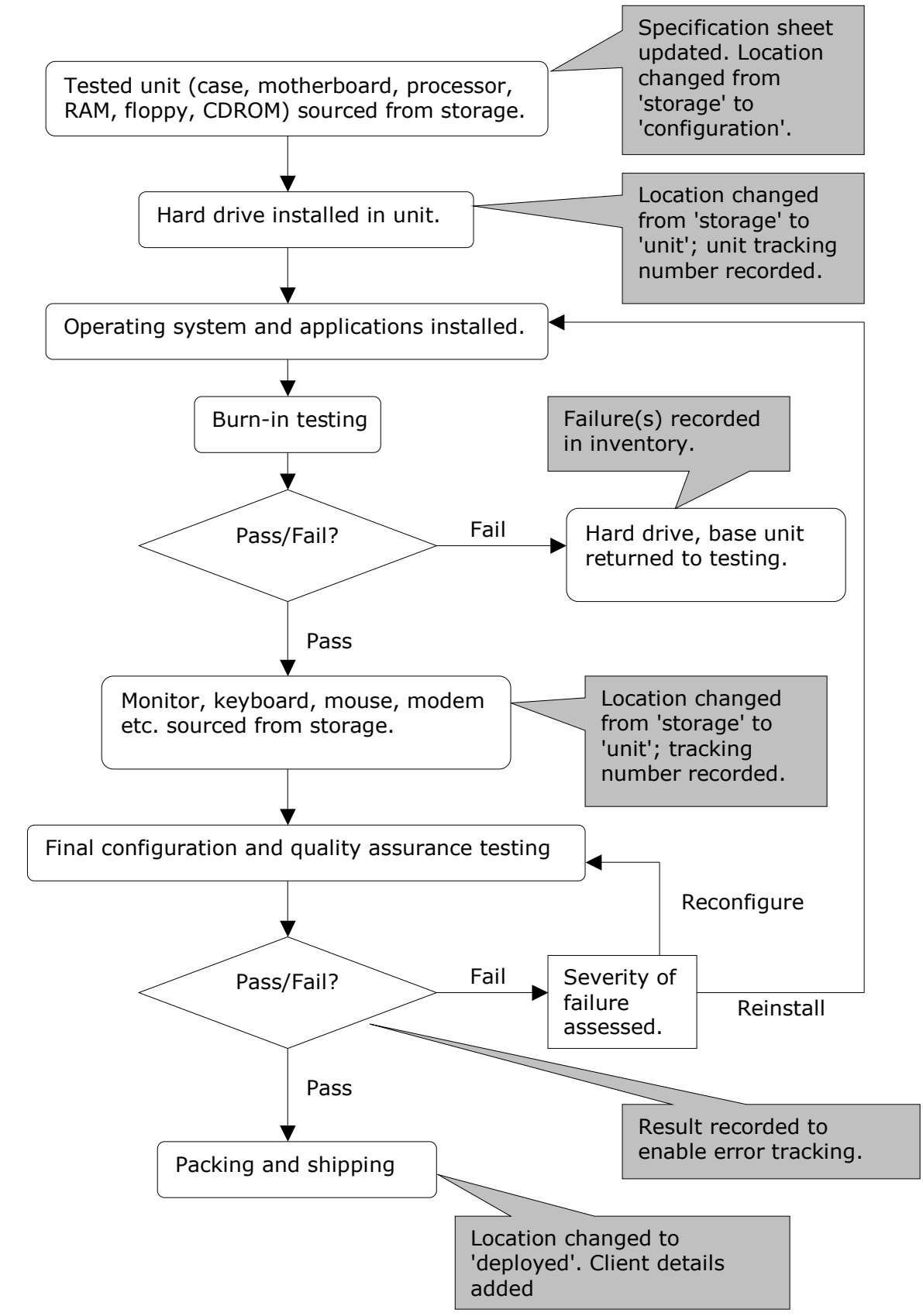
Workflow diagram: Harddrive testing



Workflow diagram: Monitor testing



Workflow diagram: Assembly, burn-in and configuration



15 Cleaning

Dust and other debris accumulates on computers and inside their cases during standard operation, and especially while they are in storage or transit. Dust can harm computer parts in several ways. Some kinds of dust can conduct electricity; other particles in dust have magnetic properties. When these particles settle on circuit boards and into the slots on motherboards, they can cause short circuits and destroy data. As a consequence, thorough cleaning must precede diagnostic testing. Passing compressed air over each internal surface inside a computer is the best method for clearing it of harmful dust. This section describes effective methods for extracting dust from equipment.

15.1 Dust extraction

Releasing compressed air over the slots, pins, corners and circuit boards inside a computer case drives fine particles out of the areas where the dust can damage the operation of a computer. Technicians have recourse to three methods for extracting dust: they can use cans of compressed air, handheld blowers, or a dedicated dust extraction machine.

Aerosol cans of compressed air obtained computer shops can be used to clean surfaces. Canisters tend to have small volumes of air and limited usage times. An electrically powered handheld blower also delivers the necessary compression to blow dust out of slots and away from circuits. But since handheld blowers and canisters are likely only to dislodge most of the dust into the immediate area, they should not be used in the same room as the workshop.

The best method is to construct a dust extraction machine. It has three main parts. An AC-powered compressor delivers high-pressure air through a triggered, fine-tipped nozzle. A rotatable tray accommodates the computer to be cleaned, and gives the technicians access to every surface. A wall-mounted extractor fan extracts the dislodged dust. Flexible tubing connects the fan to the work area, which is housed under a partially enclosed metallic hood. The presence of an extractor fan and hooding prevents dislodged dust from settling in the surrounding area. A purpose-built dust extraction machine at FreeComGroup in South Africa is pictured below.

Tip: Building the dust extraction device

Since panel beaters and other spray painters commonly need air compressors, hoses and the high-pressure nozzle used to release the air in bursts, hardware supply stores and auto shops might be a good source for such equipment.

15.2 Cleaning the cases

The cases on computers should also be cleaned. A mild cleaning agent is good for removing dust and dirt; a compound such as rubbing alcohol is effective for removing layers of glue and other stickers attached to the computer by previous owners. Monitors should be wiped with a soft cloth. Technicians should avoid using any abrasive agents on the screens.

Exterior view: Dust Extraction Machine

The dust extraction machine at FreeComGroup, Cape Town, South Africa.

Interior view: Dust Extraction Machine

A technician uses the rotatable tray to clean a case before inserting a motherboard.

16 Testing

Testing hardware is a major part of any operation that refurbishes used computers. Workshop testing should focus on four things: the integrity of the memory, the function of the motherboard and other devices, the quality of the harddrive and the quality of the monitors. The purpose of testing is to determine which equipment is still usable, and which cannot be passed on to other users.

Testing should be stringent, and err on the side of caution. It is much cheaper for a centre to choose not to install a part than it is to insert a faulty component in a machine that will require service, maintenance or replacement within a short period of time. The costs of service, let alone transportation and a client's downtime are much higher than the cost of a single part.

Testing is most effective when a specific software test is conducted on a computer's individual components. A wide range of suitable diagnostic software is available from both the commercial market and the free/open source software community with different functionality and price levels. Given that testing is a core function of any refurbishment centre, it is a worthwhile investment to choose a good, reliable product that will help to streamline and standardise the process of testing.

A refurbishment centre also needs a utility to deal with hard-drives and the data that comes on donated machines. The problem is two-fold: not only does the centre need to make sure the drive works, corporations and private donors often need assurances that the data on their harddrives will be destroyed such that no one would have access to private or confidential information that was once stored on a disk. A single utility that reads, writes and destroys data can help a centre converge its requirements with a donor or supplier's expectations.

16.1 Diagnostic software options

Software selection criteria

A testing utility should assist a refurbishment centre with decision-making: does the testing software give a clear verdict on what is wrong? Does it tell the user if the parts work or not? The most useful kind of pronouncement a testing or diagnostic utility should give is error reporting detailed enough for the workshop to determine a computer's PASS or FAIL rating. If the software does not give a pass or fail rating, or does not report errors so that a technician can pass or fail a part based on the number or type of errors encountered, then it is not software appropriate to a workshop.

AmiDiag

The industry standard diagnostic product is American Megatrends' AmiDiag Suite. It costs US$259, but comes with special kinds of hardware that allow all parts to be tested. AmiDiag provides exhaustive functionality; it is also user-friendly and well documented. For these reasons, AmiDiag may well be a worthwhile investment.

> Details are available from the American Megatrends website:
> http://www.amidiag.com/products/

TuffTest and PC Check

Many other low-cost testing utilities provide similar diagnostic functions as AmiDiag. Two popular ones are TuffTest and Eurosoft's PC Check. These products, which are a tenth of the price of AmiDiag, may be a good option for smaller volume refurbishment centres, and may be a low cost option for new centres. They are available at:

TuffTest,
http://www.tufftest.com/index.htm; US$29.95

PC Check,
http://www.eurosoft-uk.com/

MemTest86

One very capable memory testing tool is called MemTest86. It is widely used, well supported and easy to use. Since it is issued under the Gnu General Public License Bootable versions are available; they can be created on both DOS and Linux platforms.[81] Documentation is bundled with the software download. MemTest86 is free, robust, well supported and decisive. It is a reliable choice for RAM testing.

Memtest can be downloaded for free from the project website:
http://www.memtest86.com/

Tip: Purchasing online

AmiDiag, TuffTest and other software products can be purchased online, but not all African countries are eligible to use credit cards over the Internet. To get around this problem, it might be possible to ask a supplier -- one with whom a centre has a good relationship -- to buy the product on the centre's behalf and include it in a shipment of computers. The software could be paid for at the same time as the invoice for computers and other equipment is settled.

16.2 Harddrive testing

A utility to destroy data on used harddrives is an essential tool in a refurbishment centre. Not only will the utility help to diagnose the fitness of the drive, its use will also allow a centre to comply with legal requirements necessary to respect privacy and intellectual property.

Background: legal standards for data destruction

In 1998, the UK Government mandated that companies which collect or store personal or confidential data are legally responsible for ensuring that all traces of such data are destroyed when a computer is decommissioned or resold. Fines amount to GBP£5,000. This means that any harddrive that once contained correspondence, tax information, personnel records, or virtually any other kind of document must be not just thoroughly erased, but overwritten multiple times so that the data formerly stored on the disk is irretrievable. Similar legislation has been passed in the EU, the United States and in other countries.

The consequence for refurbishment centres is that merely erasing or formatting a previously used harddrive is insufficient to meet compliance standards because some data recovery tools can restore data that has been erased by a user. Today's security advisors demand not just deletion, but a kind of data destruction in which the substance that once held the data be overwritten multiple times. Overwriting with different patterns three or four times makes sure that almost every last trace of old data is unrecoverable. The use of

81 General Public License. The GPL is a license for distribution of free software that permits copying, modification and redistribution. It was created by the Free Software Foundation for its projects such as GNU, and has been applied to Linux as well. See also the Free Software Foundation's "GNU General Public License." http://www.gnu.org/copyleft/gpl.html

a robust data destruction method is also key to ensuring suppliers that former users' data will be destroyed in compliance with their expectations and with the law. Such a guarantee can be key to successfully soliciting computer supplies directly from countries where data privacy legislation is in place.

Data destruction utilities

The problem of data destruction is so common that there are many suitable utilities for performing a conscientious data destruction routine on harddrives. One appropriate utility is called Active@ KillDisk. Another method combines a Linux bootdisk called Tom's RootBoot in conjunction with a conventional Linux utility called badblocks. The advantage of using badblocks with Tom's RootBoot is that it allows several disks to be blanked at once. Since a single test can take an hour or more, parallel operations can save a lot of time.

A free version of Activate@Killdisk is available at:
http://www.killdisk.com/downloadfree.htm.

Tom's RootBoot is available for free download from:
http://www.toms.net/rb/

Harddrive diagnostic testing

The badblocks utility tests a drive for the presence of malfunctioning blocks -- the smallest units on a drive -- by writing data to each block and seeing if that new data can be read. At the end of a test, the utility reports how many bad blocks it found on the drive. When used as a diagnostic utility, the badblocks function should be run several times. At the end of multiple test sequences, those drives that show the presence of no more bad blocks can be retained and prepared for another user. Those drives with bad blocks remaining should be dispatched for recycling. This standard has its origins in a self-repairing feature of harddrives. Modern hard disks have extra sectors of free blocks; when an error is found, the harddrive dynamically remaps bad blocks to the spare blocks with no user or software intervention. If errors persist after multiple sequences of tests, it is a sign that the drive's spares have all been filled and that there are still more problematic areas. In this case, the harddrive has many more bad sectors than are visible. It should be disposed of.

Example: FreeGeek

FreeGeek, a refurbishment centre on the west coast of the United States, recommends running four passes of the badblocks test. Those drives on which the test finds no more bad blocks after four passes are used. Its procedure is documented at:

http://www.freegeek.org/howto/testing/harddrive/oldharddrive.html

Testing drives' internal parts

Harddrives may also require diagnostic testing to verify the fitness of the internal parts. In these cases, the best resources come from the harddrive companies themselves. Most harddrive manufacturers issue their own free diagnostic tools for use testing their own products. It is a good idea to create a library of manufacturer's tools to test harddrive performance. Links to tools created by the most common manufacturers are available from the site:

Motherboard.cz,
http://www.motherboard.cz/diagtest/

16.3 Monitor testing utilities

Monitors need to be tested for quality and clarity. The task is more qualitative than quantitative. Tests display a series of patterns on a screen that allow a technician to judge certain properties of the screen. Common problems on old monitors include poor focus, a persistent flicker, a hum, or a distorted screen. Monitor tests typically try to induce those effects to show which monitors may have faults. Ultimately, monitor testing is more about judging certain qualities rather than measuring performance against an objective standard. Since the job of assessing the quality of pictures can be rather subjective, it is best to assign the task of monitor testing to one person for long periods of time. Because the procedure is also partly comparative, monitors need to be attached to a standard input so that performance can be assessed relative to other displays. A good free monitor testing utility is available from E-leader. It is available at:

Monitor Test,
http://www.monitortest.net

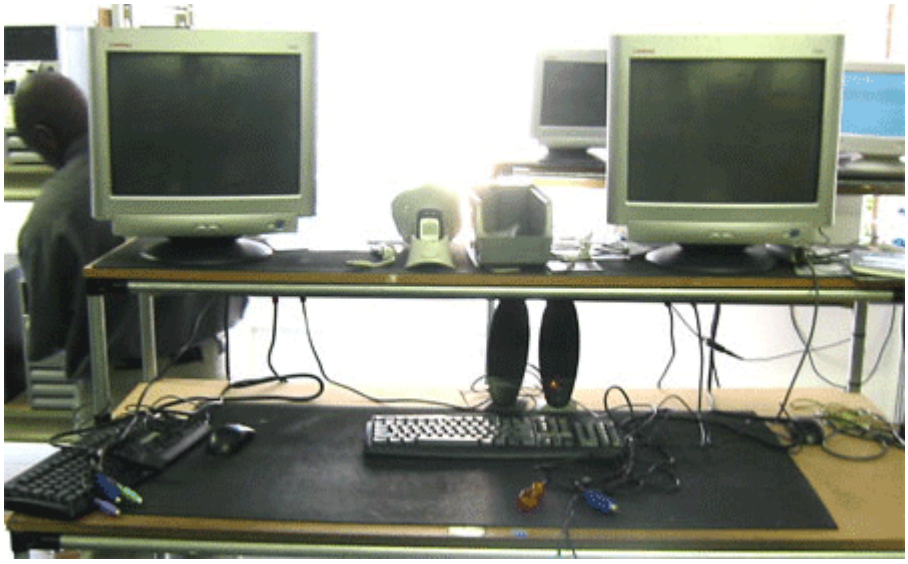
16.4 Preparing the workshop

Central to the idea of testing is the importance of controlling the number of variables in the testing environment. This means standardising both how something is tested -- by using the same software testing programs and in what computer it is tested -- by using the same equipment to test the same pieces. This means that a specific, dedicated testing area, equipped with purpose-built systems, should be created:

- A RAM testing area should provide space where a number of computers without peripherals can be put on a bench, plugged into monitors and keyboards that are known to work, and be left unattended for the duration of the test. It is best to test RAM in the machine it first arrived with because not all motherboards are compatible with all speeds and types of RAM.[82]
- A hard-drive testing machine should have all the parts of a computer and all peripherals, but no dedicated harddrive. All parts -- including the IDE cable (a standard interface used to connect drives to a computer system) -- should have been tested beforehand. By using all available IDE connectors, up to four drives can be tested at once. Since the tests take several hours, at times it may be necessary to build more harddrive testing stations if shipments are particularly large.
- A components testing area should be built to allow multiple machines to be easily swapped in and out from a table fitted with a set of peripherals. The picture below, taken from an assembly centre in Johannesburg, shows two full sets of peripherals set up around a work area. The open table gives two technicians easy access to the insides of the machines; putting the monitors on a shelf above increases the work area. The standard set of peripherals allows technicians to isolate and attribute any errors they find to the machines themselves, because the peripherals are known to function. The black matting on the desk surface is what is known as an anti-static mat. It reduces the chance of an electrostatic discharge, which can harm computer parts. Technicians also stand on similar mats and wear an ankle strap. It provides an electric ground that further reduces the chance of a damaging discharge.

82 For more on this issue see Crucial.com and use its interactive RAM diagnostic tool at http://www.crucial.com.

A workbench with peripherals



A workbench at Matomo Technology's assembly centre in Johannesburg, South Africa. The black desk covering is an anti-static mat.

- A monitor testing area should be built to test several monitors at once. In addition to a dedicated testing computer to run the testing software, the monitor testing area requires the following additional hardware:

  Fusebox: Monitors carry a lot of voltage, and if they are faulty, they can cause a short circuit. It is best to protect the rest of the work area from the monitor testing area by placing the test area is on its own fused circuit.

  Shelving: Monitors need to be tested over a long period of time, so it is best to create a system where many can be tested in parallel. The workshop should be outfitted with a set of shelves that house a minimum of eight monitors, with plenty of space on both sides of the shelves to make it easy to move bulky monitors in and out.

  Video splitter: A video splitter is a small device that shares the video signal from one PC to several monitors at once. Typical splitters have two, four or eight output connectors; linking two eight-way splitters allows a technician to use one computer to test 15 monitors at once. Splitters cost about US$100 online. The model below features nine ports. One port receives a feed from the central computer. Its signal is then replicated through the remaining eight output ports.

A VGA splitter

16.5 Documenting testing procedures

Since the effectiveness of testing depends heavily on standardisation, it is essential that all staff test products according to the same procedures. A clearly documented process is essential to ensuring that all technicians follow the same protocol when deciding which parts are fit for installation in a computer bound for another customer, and which parts are best decommissioned. Exemplary testing documentation is available from the aforementioned FreeGeek, a US-based refurbisher. The quality of its documentation -- clearly structured and written, uniform in tone and voice -- is testament to the high priority the project has been given within the centre's core management team.[83] The project is partially complete. Documents are publicly accessible via the FreeGeek website.

FreeGeek Testing How-to,
http://www.freegeek.org/howto/testing/

FreeGeek Memory Testing How-to,
http://www.freegeek.org/howto/memory/index.html (uses MemTest86)

FreeGeek Monitor Testing How-to,
http://www.freegeek.org/howto/testing/monitor/index.html (uses AmiDiag utility)

FreeGeek Harddrive Testing How-To,
http://www.freegeek.org/howto/testing/harddrive/oldharddrive.html

Summary

- ➔ Testing is the first stage in refurbishing a computer. Its purpose is to remove faulty parts and computers from the production stream by administering a standardised set of tests before dispatching the computer to a client.
- ➔ It is useful to conduct diagnostics testing on purpose-built machines in order to isolate failures to certain parts. Likewise, harddrives should be formatted in parallel on one machine, given the length of time the process requires. Monitors should be tested in batches to allow a dedicated assessor compare display qualities.
- ➔ Testing is a centre's best mechanism for defraying the costs of hardware-related failure and service. By instituting rigorous measures at the outset, a refurbishment centre should be able to reduce the load on its technical service personnel and avoid the high costs of on-site visits, the shipment of replacements and the cost -- in both time and goodwill -- to a client.

83 Ron Braithwaite, Collaborative Technologies Co-ordinator, FreeGeek. Email interview, March 2004.

17 Assembly, software installation and configuration

Once components have been exhaustively tested and shown to work, technicians can begin the process of reassembling computers and preparing them for their next owners. This process involves several steps. First, the hardware must be reassembled to a specification in accordance with the centre's product profile. Next, harddrives must then be loaded with operating system software. Once the operating system has been loaded, it may be necessary to install applications called device drivers in order that particular devices can work in concert with the operating system. Once drivers have been loaded, the computer can be configured to operate on a network. Finally, applications such as word processors and email clients can be installed. Since the process of installing operating systems, drivers and applications on large numbers of computers is time consuming, centres have recourse to the use of software called an imaging or multicasting application to install each different kind of software in parallel.

17.1 PC assembly

The main tasks involved in the assembly of a computer are the fastening of the motherboard to the case, the connection of drives, the insertion of network and video cards, the installation of memory modules and the connection of the power supply. Four clearly written and well-illustrated guides are:

PC Hardware Repair and installation guide,
http://www.wiu.edu/users/mscmr1/index.htm

Building Your Own PC, Part 2: Assembly Step by Step,
http://www6.tomshardware.com/howto/20020918/

PC Tech Guide,
http://www.pctechguide.com

Assembly Guide – ESC Technologies,
http://www.whatisnew.com/guides/AssemblyGuide-FifthEdition.pdf

17.2 Operating system installation

An operating system is typically installed from a CDROM. Typically, all that is required is the insertion of the CDROM into a computer set to boot from the CDROM drive; the installation program will be loaded automatically. Guides are available below.

Windows 98 and 2000

How to do a clean installation of Windows 98,
http://www.pctechguide.com/tutorials/Win98Install1.htm

Windows 2000 Professional Install Guide,
http://www.blackviper.com/Articles/OS/Install2kPro/install2kpro1.htm

Linux distributions

Migrating From Windows To Linux, Part 2: Installation,
http://www6.tomshardware.com/howto/20040412/wintolinux-01.html

SuSE,
http://www.suse.de/en/private/products/suse_linux/pers/installation.html

Mandrake,
http://www.mandrakelinux.com/en/fdoc.php3

Debian,
http://www.debian.org/doc/user-manuals#install

RedHat,
https://www.redhat.com/docs/manuals/linux/

K12LTSP Installation Guide,
http://www.k12ltsp.org/install.html

Linux Terminal Server Project,
http://www.ltsp.org/documentation/index.php

17.3 Driver installation

Once a user has installed or reinstalled an operating system, it is often necessary to download additional drivers for the particular components inside a given computer. Drivers are small programs that work together with an operating system to make particular parts of a computer work. Technically, any piece of hardware that a Basic Input Output System (BIOS) cannot operate requires a driver. (A BIOS is the application that allows the computer's hardware and operating system to communicate.)

Many operating systems now detect a lot of common hardware, and the drivers for those devices are included in the installation media. But older operating systems such as Windows 98 do not recognise and support a similar breadth of hardware, particularly when the hardware is newer than the operating system. A basic rule is: the older the operating system and the less common the component, the greater the chance that the operating system will not recognise a given piece of hardware. Users will have to source and install the driver manually.

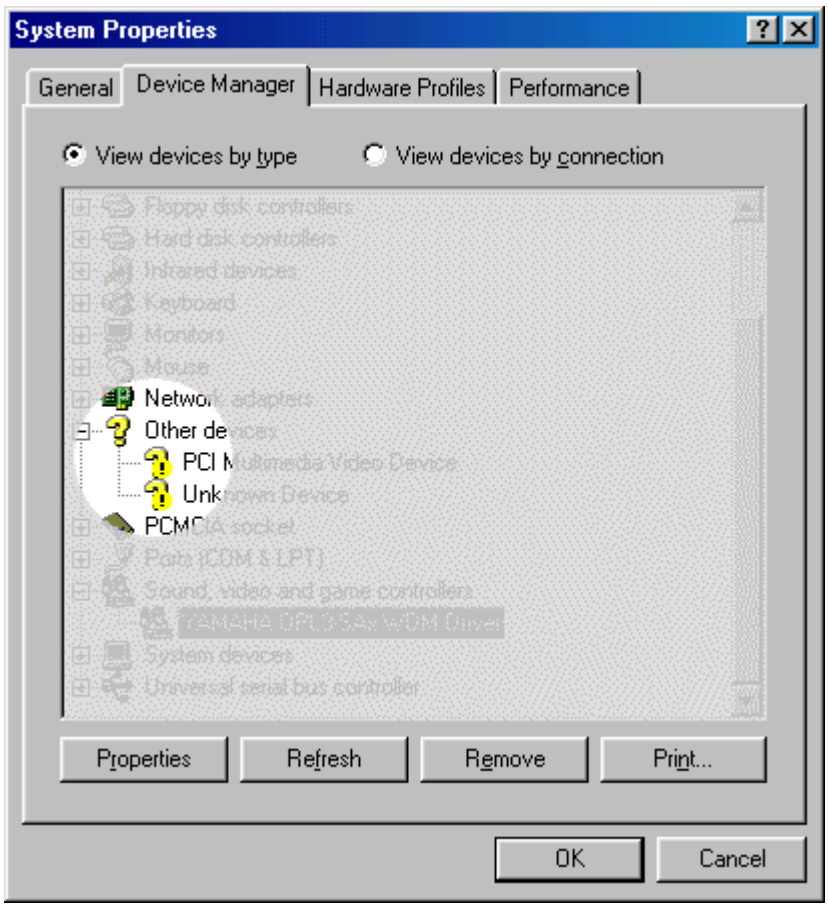
If the operating system does not recognise a device, the device driver has to be downloaded from the Internet or installed from a CDROM. When people buy a new computer, they often receive their drivers on a compact disk in the same package as their computers. But it is very rare that a supplier or reseller includes driver disks with a shipment of computers. Because it is hard to predict what hardware will be detected and what will not be, drivers should be installed only after technicians have installed an operating system and found the hardware not to be supported.

Many of the most common hardware drivers for Linux are included with the installation media. Other drivers (or modules, as they are often called) may have to be sourced from the manufacturer. Some hardware management utilities -- Mandrake's HardDrake and SuSE's YaST, for example -- may also streamline the process. The principles of driver installation remain the same as listed for Windows below.

How to tell if drivers need to be downloaded

After installing a Windows operating system, right click on "My Computer". Select properties. From the System Properties window, select Device Manager if Windows 98 or Hardware Profiles > Device Manager if Windows 2000.

The Windows 98 Device Manager



Undetected Devices will be listed differently from devices Windows recognises. They appear with yellow question marks.

Getting drivers: Tier-1 computers

Tier-1 manufacturers such as IBM, Dell, HP, its subsidiary Compaq, and a few others make it very easy to find and download drivers and install BIOS updates because each of their computers was made in accordance with a model number. By law, anything made with the same model number must have the same equipment inside. So if the model number is known, what is inside in known.

But the label on the computer is sometimes insufficient to figure out the model number. For instance, the IBM's PC 300GL is among the most common computers ever built -- but despite having a name that makes a computer sound and look like it is the same model as other computers which resemble it, not all computers that have 300GL stickers on the outside are the same on the inside. Technically, the 300GL is not a model designation at all. IBM calls its 300GL a computer family -- and there are more than 20 types within that family. Each type has multiple models.

So manufacturers' naming conventions can complicate the matter of sourcing drivers. But most support pages on manufacturers' sites begin with a tutorial or guideline for determining your model number. At the appropriate PC manufacturers' technical support website address (a list of manufacturers' support sites follows at the end of this subsection), submit the make and model number, and, in some cases, indicate the operating system to be installed to see a list of components that need drivers. If the

computer that requires drivers is the one being used to browse, sometimes a link at the manufacturer's website will identify the machine automatically.

Once the machine that needs to be updated has been correctly identified, the website will present a list of drivers and utilities to download. The list can be long, but read carefully -- many options will apply only to some versions of an operating system, or involve features that are not available or needed (such as backup or data transfer utilities). If there are multiple versions of the same driver or BIOS, choose the one released most recently. Then, download each driver. Some manufacturers allow a number of drivers to be packaged into a single download that can be unzipped once the file has been saved on the local computer.

Tip: Managing a driver library

Always save drivers for the same computer to the same folder. Name the folders after the computer model so that the updates will be easy to find in the future. If possible, copy the drivers to a driver library on the fileserver . This will save bandwidth if the drivers are needed again.

Getting drivers: when computers are not Tier-1

Computers made by manufacturers other than Tier-1 companies will be a bit more difficult to find drivers for. Generally speaking, the search for drivers for components inside these computers begins with motherboard. The motherboard must be identified in order to find out what components are installed and hence what drivers are needed. From there, it is possible to work out where the necessary drivers can be found.

Identifying the motherboard

When a computer boots, the first screen to appear often tells much of what is needed. Typically, a logo appears in the upper part of the screen, and a number is flashed in the lower part. This is the BIOS identification string.

What is a BIOS ID string?

> "The BIOS String ID number is assigned to every motherboard made. It is not always unique but there is usually some good info hidden in the string. The most useful is the portion which identifies the manufacturer of the motherboard."[84]

How to identify the motherboard

(1)Turn the system power off.

(2)Unplug the keyboard or hold down one of the keys on the keyboard.

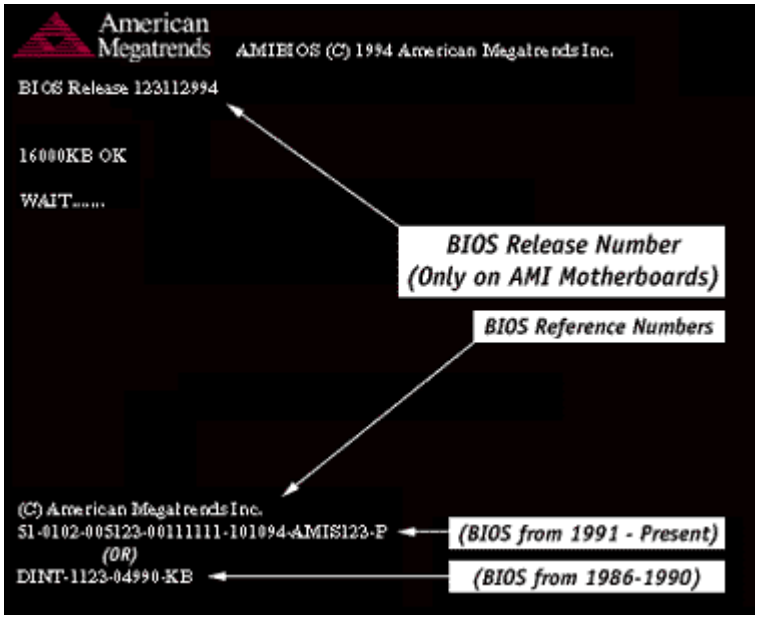
(3)Power-on the system (this should give a keyboard error).

(4)Notice the long string of numbers in the lower left hand corner of the screen.

(5)Read the BIOS identification string. It will look like one of these one of the pictures below.

84 Motherboards.org. "BIOS String ID", http://www.motherboards.org/articlesd/tech-planations/13_1.html

BIOS Identification Screen



Source: http://www.ami.com/support/bios.cfm

This screen identifies the manufacturer and a release number. Here is another screenshot from Award, another manufacturer.

Source: http://www.biosupgrade.co.uk/awardid.jpg

The BIOS ID string is clearly shown on the lower left. The manufacturer is on the upper left. From the BIOS ID string often a listing can be obtained of the kinds of on-board components (on-board components are part of the mainboard itself) that are installed along side the CPU, such as the video or VGA chipset, and any on-board sound adaptor.

Write down the ID string when it appears on the screen. Before any boot sequence starts, reboot and double-check the string that was written down.

Searching for drivers

If the manufacturer is known, start looking for drivers at its support site. (Online resources for common hardware manufacturers are listed at the end of this subsection). The BIOS ID string can also be typed into a search engine to check whether it returns any results. Try it as it is written on screen first, then gradually take out hyphens and break up the string into chunks if useful results are not obtained.

A good resource is the set of motherboards ID tools at motherboards.org, as well as the listing of manufacturers' sites at http://motherboards.org.cz.

Once the motherboard has been idenfitied -- its maker, type, and version -- the drivers for the on-board features should be able to tracked. Drivers can be downloaded from the motherboard or chipset sites in the same way that they are presented on PC manufacturers' sites: identify the model number; choose from a number of options; and download the drivers.

Once the right drivers have been identified, download each one. (Some manufacturers allow packaging of a number of drivers into a single download that can be unzipped once they have been saved on a local computer). Always save drivers for the same computer to the same folder. Name the folders after the computer model so that the updates will be easy to find in the future.

Installing Drivers

Most drivers for Windows come in a form that is executable. Installation typically just requires a double-click to launch the program. Expect to have to reboot.

Most drivers for Linux (or modules, as they are called), if they have been sourced from the manufacturer, are available in a prepackaged form (such as .deb and .rpm) that package management applications can take care of. Some rare and older versions of hardware modules may need to be compiled (built from source code) for the particular system. This can be difficult. Be sure to get as much documentation as possible before installing modules from source. Search user groups and mailing lists -- chances are someone else has encountered the same problem.

To look for rare drivers, start by searching with as many specific terms as possible. For a problem with an Nvidia graphics card on a SuSE 8.2 system, search "Nvidia SuSE 8.2 ". Technicians may also search the distribution's support site or mailing lists hosted by the distribution.

Drivers: online resources

Many drivers can be found online. The following resources for locating and downloading drivers are sorted according to manufacturer and component type.

Manufacturers

IBM Support and Downloads,
http://www-307.ibm.com/pc/support/site.wss/home.do

HP Support and Downloads
http://welcome.hp.com/country/us/en/support.html

HP and Compaq,
http://h10025.www1.hp.com/ewfrf/wc/siteHome?lc=en&cc=us&dlc=en

Dell Product Support,
http://support.euro.dell.com/za/en/filelib/index.asp

Sound and video cards

ESS,
http://www.esstech.com/techsupp/faq-identify.shtm

Ati,
http://www.ati.com/support/driver.html

CreativeLabs,
http://us.creative.com/support/identifyproduct/

Motherboards

American Megatrends,
http://www.megatrends.com/motherboards/

Via,
http://www.viaarena.com/?PageID=2

Sis,
http://www.sis.com/support/

MSI – Microstar,
http://www.msi.com.tw/program/support/driver/dvr/spt_dvr_list.php

Gigabyte,
http://www.gigabyte.com.tw/Tree/Tree_63.htm

ASUS,
http://www.asus.com.tw/support/support.aspx

General Linux-related information

http://www.linuxquestions.org
http://www.linuxnewbie.org
http://www.tuxfiles.org/
http://www.justlinux.com/

For basic and advanced questions, users can also search newsgroups related to GNU/Linux. (Search usenet groups with a web interface such as Google Groups or Gmane.)

comp.os.linux.answers	FAQs and How-To
comp.os.linux.hardware	Hardware-related discussions
comp.os.linux.setup	Setup and configuration of Linux systems
comp.os.linux.networking	Networking related topics
comp.os.linux.x	Using the X Window System
comp.os.linux.misc	Miscellaneous topics

BIOS updates

Another configuration task is updating the BIOS. Manufacturers frequently issue BIOS updates to improve the way the computers handle low-level operations. A BIOS update must be installed a little differently than a driver, but the concepts -- identifying the device first, then searching the web for the drivers, then downloading the software -- are the same.

An operating system will not state directly if the BIOS needs updating. The only way to be sure is to visit the motherboard or computer manufacturer's site to see if there is an update available. BIOS updates need to be installed from what is called a flash utility. It overwrites the memory where the BIOS is stored, a process known as "flashing". Sometimes the utility is bundled with the BIOS update, sometimes the utility and the update are two programs that must be copied to separate floppies. Often instructions are available from the same place as the download. Sometimes the updates will come with a file called README.TXT. Be sure to read it: it will explain the procedure.

A tutorial and guidance on BIOS flashing is available here:
http://www.pctechguide.com/tutorials/BIOS1.htm

A great resource on everything about BIOS is:
http://www.wimsbios.com/index.htm?/HTML1/faq.html

Another resource is:
http://www.computerhope.com/help/bios.htm

17.4 Configuring network settings

After the operating system and drivers have been installed, technicians must configure network settings to allow computers to communicate with one another on a local area network, access the Internet or to share drives and printers.

Windows 98 and 2000 networking

Example documentation for settings up and configuring networking is available from Microsoft as well as a host of independent sites.

Windows 98 Internet Connection Setup Page,
http://www.annoyances.org/exec/show/ics_98

Windows 98 Support Centre,
http://support.microsoft.com/default.aspx?scid=fh;EN-US;w98

Networking, Internet and Administration: Windows 2000,
http://www.annoyances.org/exec/show/category04

Windows 2000 Product Documentation,
http://www.microsoft.com/windows2000/techinfo/proddoc/default.asp

Linux networking

Network setup guides for most Linux distributions are included with installation documents and available from the distributions' website.

Network Administration Tools,
http://www.redhat.com/docs/manuals/linux/RHL-7.2-Manual/custom-guide/ch-network-config.html

17.5 Ethernet cabling

In addition to configuration, computers also require physical connections to other computers in order to communicate with them. Ethernet cabling is the name commonly given to the coaxial cable used to connect various devices including computers, hubs, switches and routers on the network. The most popular kind of cabling is known as Cat 5 or Cat 5e, which can be sourced from most hardware suppliers. Cable can be purchased in

pre-cut lengths or in bulk. Bulk cabling must be cut to an appropriate length and fitted with a cable connector known as a RJ-45. Good documentation about how to crimp an RJ-45 onto a length of Ethernet cable is available at the site listed below.

> How To Make A Cat5 Ethernet Cable,
> http://www.lanshack.com/make-cat5E.asp

17.6 Application installation

Applications are commonly installed either from CDROM or from files downloaded from the Internet. The procedure for installing applications is generally the same as the method for installing any other kind of software. Installation instructions are typically bundled with the software packaging or available from the application website.

17.7 Simultaneous software installation

The lengthy process of software installation can be bypassed and streamlined with a production method called multicasting, or imaging, which allows many computers to be installed with software simultaneously. This procedure involves setting up a single computer, sometimes called a golden client, and then copying the contents of that computer's harddrive onto many computers. It can reduce the amount of time it takes to install software on one computer from hours to minutes.

The process of imaging, or multicasting, takes advantage of the fact that every piece of information about how a computer is configured is stored just like any other piece of data: it is on the harddrive. By capturing the precise arrangement of data on one harddrive and printing it verbatim onto another harddrive, it is possible to replicate the precise configuration of one computer, and bypass the labour-intensive process of installing an operating system, drivers and applications on one computer at a time. It can reduce the installation time on each computer from hours to minutes, but because of the extra time involved in capturing and recording the image, this method begins to become time and cost-effective only in cases when any more than approximately ten computers need to be configured in the same way.

Multicasting can only be effective under stringent circumstances. Because the image contains not just an operating system, but drivers as well, imaging is only effective when the hardware on the golden client and the hardware on the computers that receive the golden client's disk image are identical. The target computers must have the same motherboard chipset, the same network and video cards, the same CDROM, and identical other componentry. Imaging software distributors say that it is possible to install the same image on slightly different harddrives, but it is not recommended, because the kinds of problems that it may produce may be harder to diagnose and take longer to fix than it would to conduct a single installation (The likelihood of encountering problems depends on the software used and the extent of the variance in hardware). It may also take some time for these problems to emerge.

Some imaging applications can distribute images over a network; others use a compact disk produced on a CD writer to copy the image. The application then copies the CD's contents onto a client's harddrive. Networked imaging applications require a little more infrastructure to set up, but since they allow eight or more clients to be imaged at once, it is more efficient and cost effective in the long run.

Multicasting requirements

Simultaneous installation of an operating system onto a number of similar computers needs four things:

- A number of computers equipped with identical hardware;

- A computer, sometimes called a golden client, from which to derive the image;
- An imaging application, which captures and installs the image from the golden client onto other computers;
- Either a network over which to deliver the images or a CD burner to create CDROM copies of the image.

Multicasting: step by step

Set up the golden client

To build a golden client, it is essential to pick one computer whose hardware is representative of the computers in stock. Conduct a survey of the hardware profiles by comparing system summaries as computers go through the testing process, and select a computer whose profile matches a large enough number of clients to warrant the effort of imaging. Sometimes a workshop may find it necessary to create three, five or even more golden clients, depending on the quantity and diversity of the stock.

Install an operating system and supporting software such as drivers, as necessary. Then submit the client to rigorous checking, taking care to verify that all the hardware is detected by the operating system and that all applications are installed and work. Follow the appearance and performance checklist in the section entitled "Quality assurance testing" as a guide. Take time and effort to ensure everything is correct -- any errors on the golden client will be passed on to each client that receives this image.

Capture an image from the golden client

All imaging software (three options are discussed at the end of this section) contains a function that allows an image to be captured. This process involves reading the complete contents of the harddrive and copying it to a file. This is can be a time-consuming process, but needs little operator attention.

Distribute the image

Once the image has been captured, the process of deploying that image to clients can begin. If the image is on a CD, it may be wise to copy that CD several times, and keep the original in a safe place. If the image has been uploaded from a golden client onto a server, each target client should be attached to the network. A floppy disk will be needed to boot each client and instruct it to search for the server from which the image is downloaded.

Test the image

Once the image has been loaded onto the target clients, they should be subjected to burn-in and quality assurance testing. For a full description of this procedure, see the section entitled "Quality assurance testing".

Multicasting network setup

Although imaging can be performed with CDROMs, network-based multicasting greatly improves efficiency. In order to minimise space, the network can be built into a set of shelves. Since it is an inefficient use of space to preserve room on these shelves to attach a monitor and keyboard to each computer being imaged, operators can use a piece of equipment called a KVM (keyboard, video, mouse) switch to eliminate the need for multiple sets of peripherals. A KVM switch employs a single set of peripherals to control a number of computers. Cables from the keyboard, monitor and mouse run into the KVM switch; another set of cables runs from each client into the back of the KVM switch. A set of buttons on the front of the switch allows a technician to toggle between one computer and another. The number of computers a KVM switch can handle should determine the number of computers being imaged at once. KVM switches are not compatible with all older equipment; typically only PS/2 and USB connectors are supported.

Image server specifications

An image server's specifications should be driven by a fit between the demands of the imaging software, performance, and cost. Disk space is certainly important, and given that the server may house a golden client specification that could require considerable effort to replace, it is a good idea to use new harddrives in the image server and to make backups of the images when they are captured. The server should also be dedicated to imaging only. No other critical data should be stored on it and it should not perform additional tasks.

Imaging software: possible products

g4U

One ghosting utility available under the Gnu Public License is g4u -- Ghost for Unix. It is a small command-line application that clients can run from a floppy drive and which uses a standard protocol to send its files to the server. Most Linux servers have the capability to operate as a g4u image server without modification. The program only has to run on the clients, and it can do so from a floppy disk. Any kind of operating system, including Windows, can be imaged under g4u.

> Documentation and the g4u program are downloadable from the project website:
> http://www.feyrer.de/g4u

SystemImager

A more extensive and versatile multicaster is a piece of software called SystemImager, which runs on a Linux server and multicasts images over a network. The application's documentation is extensive and clearly written. It includes sample configurations and step-by-step direction. It is free/open source software.

> SystemImager is downloadable from the project website:
> http://www.systemimager.org/download
>
> Documentation is available from the project page.
> http://www.systemimager.org/documentation/

Ghost

A standard commercial imaging product is Symantec's Ghost software. It comes in two versions: a home version, intended more for backup and rapid restoration, which uses a CD or networked drive to install an image, and an enterprise version, which handles multicasting over large numbers of computers designed to reside permanently on the same network. A home edition of the Ghost program should satisfy a centre's needs, since image deployment and capturing are all the refurbishment centre requires.

> Product profiles of Symantect Ghost are available online:
>
> Personal & Small Business,
> http://www.symantec.com/sabu/ghost/ghost_personal/
>
> Enterprise: Symantec Corporate Edition,
> http://nct.symantecstore.com/0060/620011_ghost.html
>
> Symantec offers animated tutorials to users of the home edition:
> http://www.symantec.com/techsupp/ghost/ghost_2003_info_tutorial.html

Notes about imaging Windows

If Windows software is being imaged, an extra step is required in order to ensure that the Windows software is legal. When a disk is imaged, the software contains the product registration key from the original image. To install Windows legally, each machine must have its own product key.

Later versions of Windows that were installed in a factory contain a Certificate Of Authority (COA) sticker permanently attached to a computer's case. This unique key is valid for the life of the hardware. The "regedit" Windows utility allows a Windows 98 product key to be updated in accordance with the COA. However, Windows 2000 and XP product keys cannot be changed after installation. Instead, the golden client from which the image is drawn needs to be installed with a program called SysPrep before the image is captured. Some proprietary ghosting programs will include a description of how to set up ghosting for Windows 2000 in such a way that license requirements can be satisfied. A full discussion of SysPrep starts with the documentation at the Microsoft SysPrep download site:

> Windows 2000 System Preparation Tool, Version 1.1,
> http://www.microsoft.com/windows2000/downloads/tools/sysprep/default.asp

The software is available through links on the page listed above. For more information about using Microsoft in refurbishment programmes, see the subsection Microsoft Authorised Refurbisher Scheme in the section entitled "Product profiles".

Imaging hardware

A final option for imaging dispenses with networks, servers and clients entirely. Instead of serving an image between computers, it is possible to buy a device that copies harddrives before they have been fitted to a computer. One product, called OmniClone5, can copy five disks from one "golden image" in about five minutes. The device is fitted with a six IDE connectors; a technician must only connect the drives to the connectors and press a button to start the imaging process. At about US$4,000, the option becomes cost effective only at very high volumes and only with highly standardised equipment. Smaller versions of the OmniClone, which clone two drives at once, are also available, but, at US$2,200, a centre still requires high production volumes to justify the cost.

> Read more about OmniClone at:
> http://www.logicube.com/products/hd_duplication/omniclone5u.asp

Summary

- ➔ The set of resources provided in this section cover each of the main steps involved in assembling a set of tested parts into a functional computer and installing it with software in accordance with the centre's product profiles. Technical managers can adapt these existing documents for use in a centre's own refurbishment workshop.
- ➔ If the centre's supply is sufficiently homogeneous, the workshop should employ an imaging application to reduce the time required to install software on large volumes of similar computers. Technicians can deploy images either over a network environment or by CDROM. Several different applications are available.

18 Quality assurance testing

Quality Assurance testing is an exhaustive set of tests designed to detect failures in its hardware or software installation after the computer has been assembled but before the equipment is delivered to the client. It is performed on new computers as well as refurbished ones. It is the final step before delivering the product to a client. Quality assurance testing comes in two phases: a burn-in or stress test, which is designed to put strain on the hardware components of a computer and ensure all the components work together, and a set of qualitative tests, in which an employee verifies that the computer's functionality lives up to the level of performance promised to the client.

18.1 Burn-in testing

Burn-in testing has its origins in a phenomenon discovered in the manufacturing process that showed that the majority of failures occur either right at the beginning of a product's life or close to its end; very few failures occur outside of those two periods. Since refurbishment often calls for new parts to be inserted in old machines, or for disparate parts to be merged to form one machine, refurbished computers must be tested rigourously for defects that emerge from these new combinations of parts.

It is much more cost effective to catch those early failures before a part leaves the workshop, since, once a product has been delivered to a client it costs money, time and, more importantly, goodwill, to replace a fault. A burn-in test is designed to catch some of those early failures and remove the faulty parts from the production stream. In this sense it supplements diagnostic functions carried out in components testing.

Typical burn-in tests will force the processor and RAM to conduct a number of looping calculations that force a lot of data to be written, manipulated and rewritten. In the process the components will be forced to run at or near their maximum capacity for a long period.

Since burn-in testing is such standard practice, a number of tests are available. Typical burn-in tests run from a floppy. If the computer runs for an hour under the harsh conditions of a burn-in test, it is likely the computer will be able to withstand the pressures of its working environment.

Some appropriate applications include:

- Lucifer - an open-source burn-in test that is free to download and use. It is available in both Linux and DOS versions from:

  Lucifer,
  http://petertodd.ca/lucifer.php

- HOTCPU - another kind of test freely available. Like Lucifer, it imposes a strain on the processor and RAM inside a computer. It runs on Windows. It can be downloaded from:

  HOTCPU,
  http://www.7byte.com/index.php?page=hotcpu

- AmiDiag - its diagnostics package features a standard burn-in test. It runs a set of tests for a defined period, then issues a "pass" or "fail" rating to each computer based on the number and type of errors. For more detail, see:

  AmiDiag,
  http://www.amidiag.com

Because burn-in testing takes place after installation of the operating system and applications, it can be run from the multicast/imaging area. (See Simultaneous Software Installations: Workshop Preparation for setup). If errors are encountered, the computer should be submitted once more to testing and diagnostics to see if the motherboard, RAM and CPU are in working order.

Once the computer has passed the burn in test, it should move to the next phase of Quality Assurance: the qualitative tests.

18.2 Optional burn-in testing: longevity and temperature testing

In addition to burn-in, some manufacturing processes recommend that a computer be tested to see if it can withstand stresses more typical of its operating environment. A longevity test will verify if a computer can run for long periods of time at a variety of temperatures. Some suggested longevity testing includes:

- Running a computer and monitor inside a hot, poorly ventilated or sun-soaked room for a number of hours;
- Running a computer and monitor overnight, exposing it to falling temperatures;
- Running a computer and monitor all day, shutting it down overnight, then turning it on in the morning, when its parts are coldest;
- Running a computer for two or three days continuously, turning it off until it cools, then restarting it.

Without resorting to expensive equipment or infrastructure such as temperature controls, electricity regulators and air flow and dust monitors, it is difficult to institute longevity testing that is rigorous and quantitative. Nevertheless, even the informal, variable testing against longevity and temperature conducted in the workshop will serve to build confidence in the robustness of the equipment.

18.3 Quality assurance: appearance and performance checklist

The performance checklist is the final stage of preparation before the computer leaves the workshop. The checklist is intended to verify that the computer is correctly configured and installed to work as promised. The procedure requires no special software, and is designed to ensure that programs open, that modems can connect to the Internet, and, if so designed, that applications such as email clients are configured to download and send mail from the right servers. A standard visual inspection should ensure that the product looks clean, that its buttons and lights work, and that all cables are in order. As with all other processes, the technician conducting the inspection should sign off on all the work. A sample Appearance and Performance checklist, developed at Cape Town based refurbisher FreeCom Group is available in Annex L.

18.4 Testing Guidelines

Functionality

The following questions outline the kind of basic functionality a centre should verify before products are handed over to clients. The list is not complete.

General function

Is the boot order set correctly?
Does the computer boot without error?
Does the admin/root account login work?
Is the admin/root password set to the standard?

Does the standard client/user login work?
Is it set to the default password?
Does the desktop have the right resolution?
Does the CD tray open?
Can it read a CD?
Does the floppy drive work?
Can it save a document to a floppy disk?
Does the modem dial on demand?
Does the UPS work?

Applications

Does the word processor open?
Can the document be opened? Saved?
Do other office applications open?
Does the web browser open?
Can website be browsed?
Is the DNS set correctly?
Does the email client open?
Are pop and smtp servers set?
Can email be sent/received?
Can attachments be sent/received?

Appearance

Does the computer look clean?
Does the monitor screen look clean?
Is the keyboard clean? Does it work?
Does the mouse work? Does it roll smoothly?
Do its buttons work?

Many other parameters should be tested depending on the type of installation. If the computers will be networked, technicians should test them in a networked environment. As much as it is possible, technicians should pre-cut and test the cables that will be used in the client's actual network. They should also test the hub or switch with those cables.

After testing, each item should be marked so that the items that were paired for testing can be paired again when they are installed. The purpose of testing is to establish that the computers are in a working state. Once that state has been established, technicians should take every effort to preserve that working state by marking the pairings that were proven to work.

Tip: Keeping track of equipment

Different colours of nail polish serve this purpose well. Before each network or computer is dismantled, technicians should discreetly mark each connector with one or more dots or stripes of nail polish to make it easy to reconstruct the tested state. If possible, use the polish to mark which parts go in which ports as well, so that if a novice had to reattach all the computers, he or she could do it by matching the markings on the computer and network cables with markings on the ports and connectors.

Summary

- ➔ Quality assurance testing is the final stage in the multi-step process of preparing a computer for a client. It should be given special attention, as it is the last opportunity in the production cycle to catch errors.
- ➔ Quality assurance involves two components: burn-in testing, which is designed to highlight flaws and incompatibilities in hardware; and qualitative assessment, which is designed to catch problems with the software, peripherals and networking components of a product.
- ➔ Quality assurance should be assigned to trustworthy technicians who appreciate importance of delivering computers to clients with a uniformity of look, feel, behaviour and stability. Technicians carrying out final tests should be encouraged to sign their names to QA checklists as a means of enforcing their accountability in the process.

19 Rollout and installation

Packing and shipping the computers demands preparation and care to ensure that every piece of equipment arrives at the client's premises in good condition. Once computers have passed the performance assessment test, the equipment should be packed for transportation to a client. Items should be packed carefully. The contents of each shipment should be verified against a packing list. If a refurbishment centre's service contract includes installation, technicians should prepare a toolkit to troubleshoot commonly encountered problems. Finally, recipients should confirm the arrival of computers via email or fax.

Packing list

Items should be packed against a packing list, to ensure that no part is forgotten. As well as list all the computer parts and relevant peripherals, the checklist should enumerate plugs, plug adaptors, extension cords, cabling, software restore disks, backup utilities, any glue needed to secure cables or plugs, and everything else destined for installation. The technician who packed the equipment should sign the packing list. Another person should verify the contents before the equipment is shipped.

Packing

Computers are surprisingly robust, but technicians should pack equipment with care. Monitors should be wrapped in bubble wrap and placed one to a box. A few computers, also covered in a layer or two of bubble wrap, can go into one box. Standardising the way things are packed helps to eliminate error. Technicians should try to sort all networking gear -- modem, hub, RJ-45 cable ends -- together for easy verification and likewise pack all power-related equipment -- extension cords, uninterruptible power supply units, for example -- in the same box. By packing like with like, it is easy to verify that the required number of keyboards, mice or plugs have been included with the shipment.

Toolkit

The centre should also prepare a toolkit for installers. Each should include a crimper for cutting Ethernet cable; Phillips and slot screwdrivers for modifying power plugs and refitting any hardware; a set of boot floppies or restore discs in case of error (these should be left at the site, in the hands of someone trained to use them); a backup modem; a few spare network cards (with installable drivers on floppies); and two Ethernet cables known to work. One cable should be crossover, which allows two computers to connect without need of a hub (how to cut a crossover cable is covered in the Lanshack tutorial cited in the the section entitled "Assembly, software installation and configuration"), in case the hub is suspected to be bad. Another straight cable should be able to rule out if a network problem on site is due to a configuration problem or attributable to a freshly (and incorrectly) cut Ethernet cable. This toolkit should also be used for on-site technical support after installation. The most common problems with troubleshooting new installations is the lack of Internet access: since technicians grow to be reliant on the workshop and on the Internet as a source of replacements, reference and utilities, they are ill-prepared in advance to deal with problems that arise where the supply has been cut off. A few basic, trusted tools -- most importantly, the extra cabling and the boot utilities -- go along way to reducing headaches during installation.

Optional on-site installation

If installation is part of the service contract, technicians will have to travel to the client's premises and install the computers and, if applicable, the network cabling. Once all the computers have been set up, technicians should conduct another performance assessment test in the presence of the person assuming responsibility for the laboratory. She or he should also sign the performance assessment test results (see the section entitled "Quality

assurance testing" for a set of questions appropriate for assessing a computer's performance). The installers should also post a contact number and email address for the centre, and explain the procedure for reporting a fault to the refurbishment centre.

Confirmation

The final step in installation is the confirmation. The person responsible for the computers in their new location should record all the computer tracking numbers, as well as the serial numbers of the rest of the equipment, and send a signed list back to the refurbishment centre. Alternatively, the centre can furnish its client with a list of the serial numbers and corresponding devices, which the recipient can use as a checklist. This safeguard provides a record to both the refurbishment centre and to the client that all material has been received.

The best option for confirmation is to prepare a word processor document template in advance, and store an empty registration form on the administrator's desktop. The person responsible should fill the form out in the presence of the technicians, and email it to the centre. (Some centres may wish to dedicate an email address to this purpose -- for example, confirm@thecentre.org). In addition to recording the delivery, the email provides proof that the Internet is accessible from the newly installed laboratory. The form should be printed and stored in a client's file at the centre, as a backup measure. Faxing the form is another option.

Summary

- ➔ A few simple techniques simplify the straightforward task of packing, shipping and installation. Wherever possible, centres should make use of checklists to help eliminate any oversights in the packing and shipping procedure.
- ➔ A well-stocked toolkit should be given to installers to assist them with sorting out problems that develop in the course of setting up computers in their new location. A final performance assessment should provide a record of a successful installation.