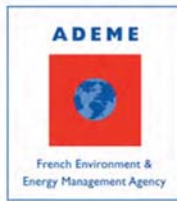




United Nations
Educational, Scientific and
Cultural Organization



The Entrepreneur's Guide to Computer Recycling

Coordinated by Benoit VARIN

VOLUME 1
Basics for starting up a computer recycling business
in emerging markets



with the support of :



THE ENTREPRENEUR'S GUIDE TO COMPUTER RECYCLING

Volume 1

**Basics for starting up a computer recycling business
in emerging markets**

by

Benoit VARIN and Pierre-Etienne ROINAT

in collaboration with
UNESCO and ADEME

with the collaboration of
Emmaüs Ateliers du Bocage, UNEP and UNIDO
in support of UNESCO's Work

ENTREPRENEUR'S GUIDE TO COMPUTER RECYCLING

Volume 1: Basics for starting up a computer recycling business in emerging markets

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FOREWORD

by Abdul Waheed Khan and Daniel Béguin

The development of Information and Communication Technologies as major pillars of the emerging knowledge societies has led to a significant increase in demand for computer equipment worldwide. As a result, countries - including those in developing regions - are facing an increasing volume of computer equipment waste from both new computers and second-hand equipment.

While the increase in computer equipment significantly contributes to the reduction of the digital divide and supports economic growth, it will also have detrimental consequences for both the environment and public health and safety if it is not handled in the most professional way. Developing local capacities to manage end-of-life equipment in an environmental manner is therefore paramount. Not only should computer recycling be complementary to computer delivery but it should also help to provide business opportunities for small and medium enterprises, particularly in emerging markets. Capacity building is a major concern for UNESCO and ADEME, as it plays a strong part in the sustainable development of inclusive global knowledge societies. That is why UNESCO and ADEME have called upon experienced partners, such as HP, to join forces in the development of a blueprint guide which will provide local entrepreneurs with the knowledge and capability to collect refurbish and recycle computer equipment. The guide will provide a pragmatic answer to this ever increasing environmental challenge and will help to generate opportunities for small businesses and entrepreneurs at a local level.

This document is the first in a series of pedagogical materials produced by UNESCO and ADEME to train entrepreneurs in emerging markets in computer waste management, with a strong emphasis on the basic rules of environmental health and safety. The first volume provides an introduction to important background information and discusses issues to be considered when setting up a recycling business. The second volume, to be produced, will focus on recycling practices and will provide concrete, practical advice for entrepreneurs. It will also be accompanied by a website which will provide information on regional and national legal contexts, key players in computer recycling activities (particularly in Africa), and offer an open forum for sharing expertise in this field.

We hope that this guide will contribute to international cooperation in computer recycling, mobilizing stakeholders towards capacity building for sustainable development.

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IMPORTANT ISSUES FOR CONSIDERATION IN RECYCLING



This chapter introduces issues relating to computer recycling initiatives and gives general information required for starting such an initiative. It discusses the growth of the computer market, the challenges and opportunities associated with reuse and recycling, and the international regulatory framework. In addition, it furnishes arguments for the creation of recycling companies and describes the value chain of a computer hardware recycling business.

CHAPTER 1

INTRODUCTION

Information and Communication Technology (ICT) continues to bring new opportunities to individuals and communities which are able to harness the potential of such technology as an empowering and life enhancing tool. One opportunity associated with ICT is the potential for local entrepreneurs to develop businesses for the refurbishment and recycling of used ICT equipment. This guide is intended to provide local entrepreneurs with a blueprint for the establishment of a business capable of receiving used PCs and related equipment. It will also provide guidance on how to manage such equipment in a profitable and environmentally sound manner, while ensuring worker health and safety.

Global technology revolution

Countries around the globe are rapidly gaining increased access to information technology, spurred on in part by surging domestic economies and the recognition by consumers of the benefits of access to information and global communication. Annual global mobile phone sales first topped one billion in 2006 and are likely to do so again in 2008. It is 27 years since the advent of the personal home computer and one billion PCs will be in use worldwide in 2008. Remarkably, over the next five years, this number is estimated to increase to two billion. According to a study (Forrester Research Inc.), Brazil, Russia, India and China will have more than 775 million new PCs by 2015, with China going from 55 million in 2007 to 500 million by 2015.

Cycle of use and disposition

As countries gain the benefits of increased access to information technology, they also face challenges in managing electronic products at their end-of-use. While recent studies have shown that ICT equipment makes up a small percentage of the overall compositional breakdown for

waste electrical and electronic equipment in many countries (e.g. 8% in the EU in 2005), there are significant opportunities to capture value in used and end-of-use PCs and related equipment. Awareness and interest from consumers in efficient new technologies will continue to drive inefficient and old equipment into disuse, opening opportunities for recycling entrepreneurs.

Social and economic benefits of reuse

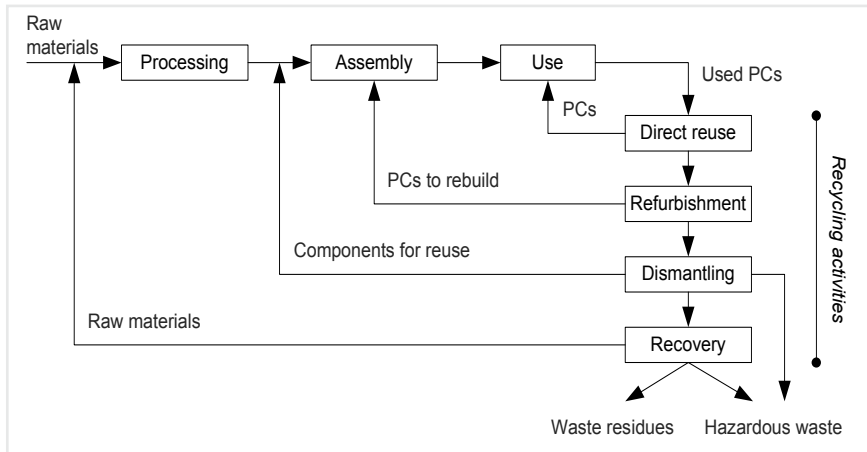
There are significant opportunities for local businesses seeking to recover the value in used and end-of-use PCs and related equipment. When old ICT equipment becomes obsolete, or is simply broken, ineffective or no longer wanted, it could still have economic value and should be managed appropriately at end-of-use. After a used PC is collected from its former owner, reuse is the preferred first treatment option, as it can allow for more users of the device at a lower cost, extend the return on the energy and resources involved in the manufactured product, and prevent the device from entering the waste stream. Reuse may require repair, refurbishment or upgrade if necessary.

Direct reuse and refurbishment have numerous social benefits as they allow the poorest people to have access to ICT at a lower cost. The United Nations Millennium Development Goal (MDG) Number 8 identifies the need for cooperation with the private sector to «make available the benefits of new technologies, especially information and communication». ICT can serve as a powerful tool for poverty reduction and the overall achievement of the MDGs, accelerating development progress through (i) increased market access, efficiency and competitiveness, (ii) improved social inclusion of isolated populations, and (iii) political empowerment. In the field of education, ICT can provide distance learning, teacher training, greater availability of educational curriculum and improved administration. Greater access to ICT can provide remote health care services, improved patient information systems, and access to research and training. ICT can combat gender inequality and improve environmental sustainability, when harnessed and used effectively. However, when exporting used ICT equipment to developing countries or countries with economies in transition, consideration should be given to the need to ensure that environmentally

sound solutions for the final disposal of end-of-life equipment are in place in the destination countries. For example, used ICT should be tested and certified to be really functional before they are exported and a control and testing system must also be available in the importing countries to prevent the transfer of ICT equipment that is not functional and therefore is a waste product.

Recycling opportunities

Devices not fit for reuse, or unused components from repair, refurbishment or upgrade operations, should be disassembled and processed for recovery of raw materials in an environmentally sound manner. Scrap metal prices have soared in recent years due to shortages caused by increased consumption of raw materials. PCs contain valuable ferrous (e.g. iron), non-ferrous (e.g. aluminum, copper) and precious (e.g. gold, palladium, silver, indium, gallium) metals that can be obtained from dismantling computer cases, frames, wires, cables and other components. The rising value of these materials makes recycling more economically viable and attractive.



Life cycle of a PC (adapted from OECD and King et al., 2004)

CHAPTER 2

INTERNATIONAL REGULATIONS

A

INTRODUCTION | INTERNATIONAL REGULATIONS

The Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is a global agreement that establishes the international legal regime governing the transboundary movement of hazardous wastes destined for disposal or recycling. The Convention was adopted in 1989 and came into force in 1992. Currently 169 countries and the European Community have become Parties to the Convention. Parties meet their obligations through domestic regulations that implement the Convention.

The Convention aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements, and disposal of hazardous and other wastes. In the spirit, intent and purpose of the Basel Convention, each country needs to establish and operate an effective control on the import of hazardous and other wastes; this includes end-of-life equipment. Unless such control is in place and enforced, the massive transfer of uncontrolled e-wastes to developing countries in particular, will continue to generate an ever-growing health and environmental burden for these countries. Of the 170 Parties to the Convention, Afghanistan, Haiti and the United States have signed the Convention but have not yet ratified it.

Transboundary movements

The Convention imposes prior notification and consent controls on cross-border shipments of covered hazardous wastes between Parties. When the Basel Ban Amendment, adopted in 1995, comes into force, trade in hazardous wastes between Parties is not allowed. Transboundary movements of hazardous wastes between Parties and non-Parties in the absence of an appropriate “Article 11” agreement are also prohibited.

For example, OECD members have completed an Article 11 Agreement that governs hazardous waste classifications and notice and consent procedures for shipments of waste for recycling among OECD states. Governments are obligated to ensure that waste shipments only proceed where the wastes can be managed in an “environmentally sound manner” in the countries of import. Waste trafficking is penalized and sanctions vary according to each party’s legislation.

Basel Convention definition of waste

End-of-use electronic equipment that meets the Basel Convention’s definitions for “waste” and “hazardous waste” would be subject to import and export controls and shipment prohibitions under the Convention. The Basel Convention defines wastes broadly as substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law». The Convention then defines disposal by reference to lists of disposal operations, such as landfill or incineration, including recycling operations. Repair of computer equipment, however, is not a listed operation, and so computer equipment that is truly intended to be repaired is not defined as waste.

Basel Convention hazardous wastes

Equipment classified as waste that is derived from waste streams or contains a constituent listed in Annex I of the Convention (e.g. lead, cadmium, mercury, beryllium) is presumed to be hazardous, unless it can be demonstrated that the waste does not possess any hazardous characteristics provided under Annex III. The Basel Convention does not provide any guidance on the development of testing protocols, leaving their design and implementation to national governments. However, for specific waste streams technical guidelines have been adopted for implementation by Parties.

The Convention provides further classification guidance on the classification of electronic equipment. Under Annex VIII the following wastes are categorized as hazardous wastes when they contain Annex III characteristics:

- (i) A1180, waste electrical and electronic assemblies and scrap (“e-scrap”) are presumed to be hazardous if they contain one or more of the following components: batteries listed under Annex VIII; mercury switches; CRT glass; other activated glass and PCB capacitors; and any additional component that contains an Annex I constituent;
- (ii) A1150 - precious metal ash from incineration of printed circuit boards not included in Annex IX;
- (iii) A1170 - waste batteries not specified on Annex IX that contain Annex I constituents to an extent to render them hazardous; (A1190: waste metal cables coated or insulated with plastics containing or contaminated with coal tar, PCB, lead, cadmium, other organohalogen compounds or other Annex I constituents;
- (iiii) A2010 - glass waste from cathode-ray tubes and other activated glass. Wastes defined as hazardous in domestic legislation (Article 1(1) (b) of exporting, importing or transit countries) are also covered by the Convention. Companies handling electronic waste should be mindful of national legislation implementing the Basel Convention to ensure compliance with applicable country requirements.

Other regulations

The European directive 2002/196/EC related to the WEEE (Waste Electronic and Electrical Equipment) published in January 2003 signaled a first step in the political management of used computer equipment. This directive defines the concept of Extended Producer Responsibility (EPR) concerning the collection of WEEE, the systematic treatment of hazardous parts, the recovery of all the WEEE collected, with priority given to reuse and recycling, and also to eco-design. In countries with EPR laws like the EU, some US states and Japan, electronics manufacturers are financially responsible for dealing with the waste from their products, meeting collection and recycling targets and other obligations. However, EPR only applies to domestically generated wastes.

Some developing countries are also starting to establish their own policies in order to ensure the quality of inbound shipments of used e-equipment. For instance, in August 2007, China adopted a bill on the “Circular

Economy” based on a system of fines and bonuses. An entrepreneur in the business of repairing used computer equipment should be sure that the laws of his country, and of any country from which the used computer equipment has been imported, have been followed.

Future implementation

Under its Strategic Plan adopted in 2002, Parties to the Basel Convention have identified used and end-of-use electronic equipment as a “priority waste stream”. This higher profile has promoted a number of WEEE-focused initiatives under the Convention, such as the Mobile Phone Partnership Initiative (MPPI), a private-public partnership addressing the environmentally sound management of used and end-of-use mobile phones. At the G8 level, Japan’s proposed “3Rs Initiative”, which explores options for recycling of used equipment and materials, particularly in Asia, is gaining in importance in this connection.

At the Eighth Conference of the Parties (COP), held in late November 2006 in Nairobi, the Parties adopted the Ministerial Declaration on e-waste (known as the “Nairobi Declaration on the Environmentally Sound Management of Electrical and Electronic Waste”) and a formal COP Decision on e-waste, establishing the priority e-waste management issues for governments and other stakeholders, calling for the development of a work plan on e-waste for the next biennium. Future partnerships may include a Partnership for Action on Computing Equipment (PACE), which could address the development of recycling guidelines and pilot projects for shipments to pre-certified recycling facilities.

In addition, the Parties are considering a series of options raised under the aegis of the MPPI to address issues and ambiguities associated with the classification and management of mobile phones for the purpose of facilitating increased collection and the environmentally sound management of mobile phones.

CHAPTER 3

SOCIAL AND ENVIRONMENTAL CHALLENGES

Generally speaking, equipment dismantling and refurbishment activities, pose little or no threat to human health or the environment when they are carried out properly, taking into account all human health and environmental requirements. PCs and other ICT equipment do contain minimal amounts of potentially harmful substances (e.g. lead, cadmium, beryllium), but they are in solid, non-dispersible forms, and thus pose no concern for human exposure or environmental release in ordinary use or handling of whole equipment. Activities relating to handling, including manual disassembly and most repair, refurbishment or upgrade activity can thus often be safely undertaken by workers in developing countries, provided they are carefully monitored and safeguards are in place. However, currently in most developing countries such activities are carried out by the informal sector without regard to safety and environmental concerns. Therefore, there is an urgent need to improve existing conditions before imports of WEEE to these countries are initiated.

Formal versus informal recycling practices

Certain recycling processes, including shredding, grinding, burning and melting of components, may release harmful fumes or dust that, when emitted or leached into the soil, can have harmful health and environmental impacts. In many developing countries, an informal network of waste processors employs techniques such as open burning, without adequate safety protocols necessary to protect workers' health. Moreover, recycling is often done at or near waste dumps which are not equipped to prevent harmful leaching into soil and groundwater. By definition, the "informal" network of waste processors is not regulated, and so it has proven to be difficult for many countries to monitor harmful practices and implement controls to protect workers' health and the environment.

A

Modern recycling facilities are equipped with technologies that can handle these processes with minimal risks to the environment and worker health, while also ensuring the added environmental benefit of optimal recovery of materials. These treatment methods, however, are expensive and lend themselves to economies of scale. Financial constraints for electronics recycling, both in terms of the quantity of available recyclable material and profit margins, will prevent the construction and operation of a state-of-the-art facility in all countries. It is therefore often necessary to move certain materials to countries having the capacity to provide environmentally sound management. A challenge facing many countries is how to develop an appropriate framework to ensure that the materials that cannot be managed by the informal sector in an environmentally sound manner are sent to countries with the capacity to do so in a way that is attractive and profitable to all stakeholders.

Imports

In developing countries, informal sector businesses often import containers of ICT equipments of variable quality. Some equipment may not be suitable for repair, refurbishment and reuse. These containers often come from donations or large secondhand sales, and importers have limited means of controlling the quality of this equipment. Imports of equipment not suitable for reuse can increase the challenge of ensuring environmentally sound management and may present added risks to human health and the environment.

CHAPTER 4

ECONOMIC OPPORTUNITIES

The potential economic opportunities associated with the recovery of materials are also responsible for the advent of informal markets in developing countries not equipped to process used and end-of-use computers efficiently and safely for workers' health and the environment. From an economic perspective, informal material recovery processors lose significant amounts of metals that could be more effectively recovered through the use of existing state-of-the-art technologies. More importantly, these informal markets employ recycling and materials recovery techniques that expose workers and the environment to potentially harmful pollutants.

The second-hand market

In developing countries, refurbished computers from the second-hand market provide opportunities for people who cannot afford to buy new equipment. Growing demand for refurbished equipment in these countries is matched by the need for spare parts for maintenance and computer repair. Recycling businesses can provide repaired and refurbished computers to this rapidly growing market at affordable prices.

The growth in the price of raw material

A local recycling business may also profit from the sale of components and recovered materials to facilities equipped to provide environmentally sound recycling. The rise of raw material prices has made recycling used computer components an economically viable enterprise for environmentally sound facilities, creating a market for properly disassembled components and scrap parts. This can be a profitable alternative for entrepreneurs, while preventing harmful practices such as dumping, open burning and incineration.

Benefits of setting up local recycling companies

Local businesses interested in computer recycling and reuse can play an important role in local and national authorities' efforts to manage used and end-of-use PCs and related equipment in an environmentally sound manner. These businesses may protect against possible leaching of harmful materials and prevent unsafe practices common to the informal market. Businesses that repair, refurbish and upgrade PCs and related equipment for reuse provide the market with good products at affordable prices, thus bridging the digital divide. Finally, businesses can take advantage of valuable raw materials contained in PCs by extracting them in an environmentally sound manner, or if not possible, by selling certain materials to facilities that can do so properly. Governments can regulate formal businesses better under this process and ensure that movements of waste are properly monitored and controlled.

As local communities continue to access technology, more recyclable material will become available locally. Opportunities exist, and will grow over time, for local businesses to take advantage of the value contained in used and end-of-use PCs and related equipment. This guide provides a suggested blueprint for creating such a business, and for doing so in a sustainable and environmentally sound manner in conformity with national and international laws and regulations.



BUILDING THE PROJECT



This part of the guide provides information on the different stages to follow before launching a recycling business: learning about the recycling procedures and the risks they pose, choosing a legal structure for the company, planning the organisation of the premises and the workshop, estimating the operating costs and the budget, ensuring the supplies of equipment and the processing of ultimate waste and preparing communication plans.

CHAPTER 1

LEGAL STRUCTURES

Different countries have several different types of legal structures for new businesses and it is the responsibility of the entrepreneur to choose the structure that is most suitable for the relevant organisation.

Common legal structures

Natural person

Asset ownership, in this case, is not shared, and therefore, personal property is not protected. The natural person is responsible for all risks relating any commitments made. Therefore if, for example, a client goes bankrupt, the sole trader will suffer as a result. In most countries, a simple registration to the adequate authorities is sufficient to create this structure.

Sole proprietorship

By creating a sole proprietorship or opting for a general corporation, the founder will have control. There are many advantages to sole proprietorship: it is flexible, reactive and it satisfies the customer's needs and requests; it will emphasize the quality of service. It should be noted that companies can benefit from government assistance, in the form of loan guarantees, tax exemption or reduction of certain fees or taxes.

Association

A non-profit association differs from a for-profit association partly because its earnings and profits are indivisible and belong to all its members. Associations may also receive grants. In an association, the board of directors is responsible for the structure and major decisions are often made collectively.

Cooperative

A cooperative is a collective enterprise in which each member is both an employer and an employee. This presupposes that the members are willing to undertake activities in groups and to accept the collective distribution of profits. The main aim is to develop the company's own procedure rather than to make personal profits. This does not, however, prevent the company from ensuring its viability, and from ensuring its viability by way of expanding and generating profits as any other company.

Partnerships

This type of company can be seen as a legal entity having one or more partners. This structure is recommended if two or more cofounders bring contributions, either in cash or in industries (for example a business or a vehicle). This type of structure can boost banking relationships, as well as access to certain markets. However, there are several disadvantages to this kind of legal structure. First, the general partner has huge responsibilities. Second, the enterprise can be difficult to manage, because all decisions must be made in meetings. Lastly, partnerships often have to resort to consultants on accounting and administrative issues.

Common models of recycling structure

Model 1: creation of a new activity

The creation of a new recycling business is often initiated by an entrepreneur seeking to undertake a different activity. The entrepreneur is generally advised against starting such a business alone. It would be better if he associated himself with other, close entrepreneurs or small business owners who have complementary skills. At the beginning, the entrepreneur will use the local market both for supplies and sales, and will quickly create three to seven jobs to support development.

As the new business leader, the entrepreneur will have to be versatile and be ready to take up various tasks, technical as well as administrative. Therefore, he should have skills and experience in trade, logistics and, if possible, the treatment of used computer equipment.

Several legal structures could be used for such a business: association, natural person or sole proprietorship.

B

BUILDING THE PROJECT | LEGAL STRUCTURES

Model 2: creation of a partnership or an association

When an entrepreneur belongs to an international or national network of associations, businesses or governmental agencies, he will have the opportunity to provide solutions that bridge the digital divide. With the support of this network, he can create a business that specialises in putting used equipment back on the market, at a lower cost so that it can be used by low-income people, libraries, schools and other local associations.

To create such a business, the entrepreneur will have to be very versatile. In the early stages of the project, he will be in charge of presenting it to his partners, and will have to provide them with a relevant economic model and market research. If he works on an international level, for example if he receives foreign containers of used equipment, he will also have to know how to assess the value of this equipment and to determine to what extent it could be put back on the market. He will also have to master logistics and management.

Model 3: development of activities

Some businesses already involved in computer science and computer technologies can choose to distinguish themselves, using their existing activity to take up computer recycling. Such a business has several advantages: the entrepreneur already knows the market and the recycling issues, and the profits generated by other activities can ensure rapid development. Moreover, the project manager can take advantage of an already existing customer base.

In such a business, the project manager will be responsible for assessing the profitability of this new activity and for bringing about synergies within. In this case, logistics skills are also a valuable asset.

With this model, the project manager will not have to set up a new legal structure, as the new activity can take place within the existing structure.

Afterwards, the new activity can have its own structure, such as a partnership or an association, in order to motivate employees as much as possible.

CHAPTER 2

HUMAN RESOURCES MANAGEMENT

B

BUILDING THE PROJECT | HUMAN RESOURCES MANAGEMENT

The success of a computer recycling business depends on good human resources management, as well as on the professional skills of its employees. However, in some countries, it may be difficult to find people qualified to meet the specific requirements of a recycling activity. Therefore, the entrepreneur will have to see to it that the employees are carefully recruited, properly supervised and, above all, well trained in order to acquire new knowledge and technical skills. At first, the entrepreneur will also have to ensure that the staff has complementary skills and a good sense of responsibility.

Business and administrative staff

Entrepreneur

As the executive director, the entrepreneur is the main manager of the enterprise. He guarantees the smooth running of the company and is responsible for its development and global strategy. He will have to prepare the business plan, define the positioning on the market, create partnerships and represent the enterprise. Therefore, he must be specially versatile and master all management techniques extremely well, as well as the technical aspects of his job. The entrepreneur will greatly benefit from being assisted by a business manager and a supply manager to ensure the expansion of his activity.

Business manager

The business manager is in charge of organizing sales and exploring the market in search of new clients. At first, the business manager may be responsible for all the commercial aspects. But later, as the company gets more and more clients, the entrepreneur may consider employing more business managers, each of them in charge of a particular area or a certain client type.

Supply manager

As the name suggests, the supply manager's job is to manage supplies and stocks. He is in charge of prospecting to identify new sources of equipment. He is also responsible for taking delivery of the equipment and for ensuring its proper storage.

The supply manager plays a strategic role, since he has to assess the value of equipment purchased, and to determine the quality and the type of equipment to buy, in order to make sure that the activity can run continuously. He can also be in charge of planning collection rounds in the most efficient and time saving possible manner.

Other administrative jobs

To enhance the performance of the activity, the entrepreneur may consider creating other jobs. For instance, a secretary can be put in charge of a number of administrative tasks, such as document writing, mail management or the classification of records. Such a job requires method and organizational skills.

To improve communication, the entrepreneur may call on a marketing and public relations officer who organizes marketing campaigns and works to improve the corporate image. And finally, as the activity grows, an accountant will become required to manage the company finances.

Technical staff

The number of technicians working on site varies greatly. It mainly depends on the quantity of equipment to be processed, on the employees' productivity and on the workshop's organization. Although there are several specific parts to play in a workshop, many employees are versatile and their training enable them to change posts to meet specific needs.

Drivers and packers

Drivers and packers operate logistics and collect equipment. They have to sort and load pallets, while ensuring that the equipment is not damaged.

When collecting, they may also be responsible for listing the various equipment and their main characteristics (serial number, condition, etc.). This job does not require any specific qualification. Nevertheless, drivers and packers must be in good physical condition, and be trained to face occupational hazards. They have to be provided with protective equipment preventing cuts, dust inhalation, or spinal injuries.

Once back on site, packers will have to unload vehicles and to direct equipment to the right place, according to the storage used by the company. Packers may also be responsible for providing work stations, collecting sorted components and preparing them to be dispatched to the appropriate industry.

Electrical and mechanical technician

The electrical and mechanical technician is in charge of maintaining devices, vehicles and the electrical installation on the recycling site. When recruiting, the entrepreneur must make sure that the technician is competent and experienced enough to perform these tasks: the smooth running of the activity often depends on him. As any other employee, the electrician must be provided with protective equipment to prevent possible injuries.

Workshop manager

The workshop manager manages and organizes the workshop: he plans work, establishes targets for every technician, but also motivates and stimulates the employees. The workshop manager must not only have leadership skills, but also sound technical knowledge, to be able to intervene in the event of any technical problem. Finally he has to see to the respect of safety regulations and to the individual safety of every technician.

Dismantling technician

The dismantling technician plays the leading role in the processing activity: he is in charge of the dismantling of equipment into spare parts or

homogeneous material. This technician must be diligent, skillful and able to identify components to be recycled from those fit for reuse. Dismantling technicians are usually independent from one another, i.e. they dismantle equipment entirely. In most cases, they are mainly trained on site. They must be particularly protected, as dismantling is one of the most dangerous activities. They have to wear protective equipment against burns, but also gas or dust inhalation. The entrepreneur must ensure that these employees know and respect the various techniques of handling hazardous products.

Refurbishment technician

The refurbishment technician is in charge of updating the equipment fit for refurbishment. He must be diligent and methodical, but above all he must have perfect knowledge of technical and application-oriented functioning of the equipment. He is responsible for the whole computer refurbishment process. First, he has to technically update the computer, testing, cleaning and replacing its components, before installing a new exploitable computer system. The computer can then be put on sale.

Team management

Welcoming new employees

Each new employee must be able to benefit from a structured orientation programme. This programme consists of a presentation of the team and a basic description of the employee's future missions. The entrepreneur may also welcome the employee to discuss targets and schedules. Once the new employee is working, he may be given a manual to help him understand and perform his tasks. Such a manual may consist of a description of the assigned tasks, some tips to perform them and a description of the tools to be used.

Training

To improve the competence of new employees, the enterprise may set up a training programme. The first aim of this programme is to enable,

and encourage, the sharing of experience, through demonstrations and exercises involving both newcomers and more experienced employees. This programme must also define a progression plan for the new employee to follow. It will help him to estimate his level and his evolution. For example, this plan can at first appoint the employee to simple cleaning tasks, then to testing operations, and finally to computer refurbishment operations.

Dealing with occupational hygiene and safety

Employees must be informed of the occupational hygiene and safety issues relating to transportation, handling of materials and equipment, personal protective equipment (PPE), and exposure to pollutants. The enterprise is responsible for both occupational hygiene and safety. It is also responsible for emergency preparedness.

Motivating the team

To motivate the team and improve productivity, the entrepreneur may resort to the attribution of realistic work objectives and to the posting of results. The enterprise can post the quantities of equipment treated and to be treated weekly, monthly or quarterly.

CHAPTER 3

FACILITIES AND UTILITIES

B

BUILDING THE PROJECT | FACILITIES AND UTILITIES

The location

The choice of location of the recycling site must be one of the entrepreneur's main concerns. The site should preferably be set up near trading hubs and main highways, in order to facilitate exchanges with suppliers and clients. It should also be relatively close to urban and commercial zones, so that all people, even the poorest, can have access to the resale shop.

Moreover, the entrepreneur is advised to consider the place in order to find a local treatment of ultimate waste as soon as the business is set up. He must study beforehand the various methods available and the offer proposed in the local area. A good way to find such a location is to ask real-estate agents or local authorities for information.

The infrastructure

The recycling site must be divided into several areas, separating activities from one another. Ideally, the site should have (at least) a storage room, a courtyard, a workshop and an office to welcome clients and manage the activity. The dimensions required for those various areas may vary according to the production volume contemplated. For instance, if most supplies come from abroad, the site must provide space to sort and store the contents of containers. Also, the subsets potentially fit for reuse must be stored in closed premises, where they are protected against bad weather.

The plan below shows a site with a 300 m² storage room, a 200 m² courtyard and a 100 m² workshop. Ten to fifteen employees can work in such premises.

The storage area

The recycling centre must have a storage room for materials in transit, i.e. equipment waiting to be treated, sold or dispatched to another industry. To face the irregularity of supplies, the organization of the storage room should be easy to modify.

The storage room also enables the enterprise to keep running even when equipment supplies are low. The storage area is generally the biggest, and should be at least three times as big as the dismantling and sorting area. This part will be equipped with shelves, racks and areas of weighing with a scale of 1 to 500 kg. If the storage space exceeds 250 m³, a fork-lift may be needed.

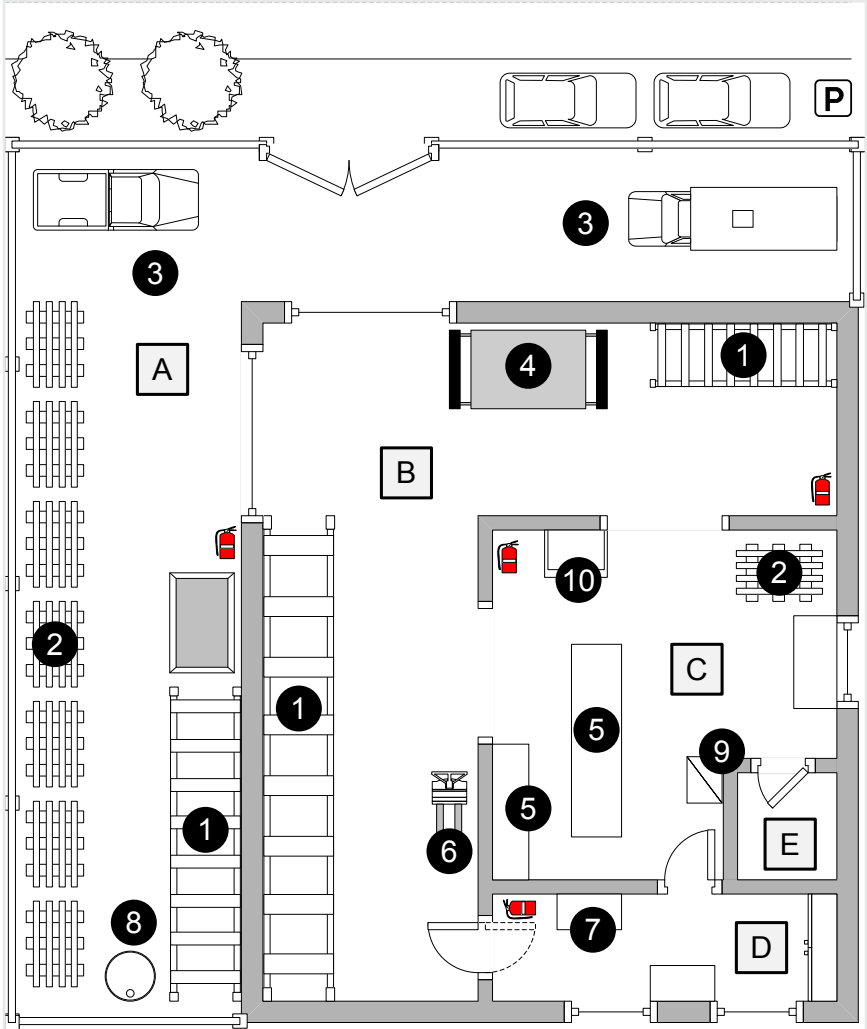
It is recommended that a classification system be defined (using numbered sections) to make the handling and locating of material easier. Depending on the reclaiming industries existing in the area, it is also possible to use a shredder or a compactor in order to reduce the quantity of plastics and to put them into bundles. In this case, an appropriate solution must be considered for the treatment of waste.

The workshop

Testing, dismantling and refurbishing operations are carried out in the workshop. This area must be organized in order to optimise the efficiency of these operations. The workshop must include several test beds and dismantling stations. As assembly-line work is not efficient for manual dismantling operations, each workstation should function independently. In some cases, it would allow the most efficient operators not to be slowed down by less experienced employees. The workstation must also be arranged so that a trolley can move around in the workshop to bring equipment and pick up components and material resulting from the dismantling operation.

The courtyard

The recycling site should have a courtyard to carry out loading and unloading operations, park vehicles and store equipment temporarily (when the appropriate precautions are taken). The courtyard is also the



CAPTION

- | | | |
|-----------------|-------------------|-------------------|
| A. Courtyard | 1. Storage space | 6. Pallet truck |
| B. Storage area | 2. Pallets | 7. Desk |
| C. Workshop | 3. Parking area | 8. Water storage |
| D. Office | 4. Weighting area | 9. Electric meter |
| E. Bathroom | 5. Work station | 10. Tool box |

Example for fitting out a recycling area

area in which equipment is sorted, before being sent to the storage room.

B

The parking area should be able to accommodate a small delivery van or a pickup, a convenient access to the collection truck must be arranged and a sufficient area for the unloading operations must be cleared.

The courtyard must be properly maintained and should not draw the neighbourhood's attention to any unattended equipment. This area should be swept daily to remove nails, glass splinters and other debris that can damage vehicle tires. Waterproofing surfaces is recommended for two reasons: it helps the collection of rainwater and prevents the infiltration of polluting substances in case of leakage. If the recycling site has several courtyards, each of them should be equipped with an independent water disposal system; so that pollution risks could be limited by the closing of gates. This courtyard should be secured with wire fencing.

The sales area

The entrepreneur may choose to open a sales area. This space dedicated to welcoming customers (about 30 m²), should face the street and some equipment should be put in the window. It is usually equipped with a reception desk and shelves to arrange reconditioned equipment. It must always be tidy, clean and well lit.

These areas are socially important, because they enable computer science fans to meet and different generations to mix. They are also educational places that help to reduce the digital divide.

Health and safety

Different devices can be used to ensure security: security bars, a volumetric alarm, smoke detectors, video surveillance, fire extinguishers under a maintenance contract and pharmacy. Static water supply and fire extinguishers should be easy to get to, in order to intervene quickly in case of fire. Premises must also be secured to reduce the risk of theft. Moreover, they must be well ventilated and clean, to allow employees to work in healthy conditions.

Utilities

Electricity

A reliable mains electrical supply is essential to the operation of a refurbishment workshop. Without a reliable source of power, it is impossible to use a test bed. Therefore, priority in operating expenses must be given to the security of the power supply. Workshops must be equipped with an Uninterruptible Power Supply (UPS), more commonly called inverters. This device provides a stable power supply to electronic or electric components. The minimum requirement for an inverter is 650mVa. In most extreme cases, the recycling site should resort to the installation of its own generator.

The power cables coming from the electric meter must be of sufficient size to support the total power of the workstations in test (power of the central processing unit + power of the monitor) which are connected simultaneously to the cable. There should be an upstream cutout or a circuit breaker for each power cable in the electric meter. To ensure the safety of individuals, it is preferable to have ground fault circuit interrupters. Each test bed should be equipped with a 10 to 15 amp fuse. A professional workshop must have electrical emergency stop buttons at every workstation.

Water

Within the context of environmental protection, it is imperative to avoid wasting water, especially when its supply is uncertain. It also is imperative to recover and recycle the water used by the activity. Best practices include saving water by using it more than once and collecting rainwater in tanks thanks to gutters.

As it is not drinking water but “industrial” water, it needs to be sieved and clarified. In these operations, water is filtered with a membrane, or with sand or carbon filters.

Telecommunications

B

BUILDING THE PROJECT | FACILITIES AND UTILITIES

The centre must be equipped with effective means of communication (phone, fax, Internet connection) to be able to communicate efficiently with customers, suppliers and subsidiaries. A low-bandwidth Internet connectivity may not be sufficient to run an active centre. It is recommended to have a high-speed Internet connection.

In areas not covered by cable or ADSL, there is the possibility to establish a high-speed Internet connection via satellite, which guarantees a rapid, reliable and permanent Internet access. This type of connection requires specific outdoor equipment (satellite dish, cable, etc.) as well as a computer (with DVB-s card). There are several types of subscription offers for satellite connection, providing different bandwidths. The transmission/reception material required is generally specific to the provider. Advantages for each type of subscription must be carefully considered, in order to select the best offer with the best bandwidth.

Tools

To perform sorting and dismantling operations, several pieces of equipment are required, all of which need to be purchased before launching the enterprise. The most important are workbenches, shelves, small tools, containers (boxes, roller bins, etc.) and a set of scales (mechanical or electronic).

The minimum set of tools per workbench recommended consists of:

Minimum set of tools per workbench

- | | |
|---|--|
| <ul style="list-style-type: none"> • 1 cutter • 1 set of cruciform screwdrivers • 1 set of flat screwdrivers • hex head keys • torx screwdrivers • 1 screw gun • 1 hammer • 1 sledgehammer • 1 chipping chisel (or air chisel) • office lamps | <ul style="list-style-type: none"> • 1 drilling machine • 1 grinder • security goggles and gloves • 1 kitchen scale • 1 tape measure • cutting pliers • 1 multimeter • 1 set of keys • 1 table for internal communication • various pliers |
|---|--|

CHAPTER 4

COST ANALYSIS

Before launching a business, the entrepreneur must establish a budget, identifying the various costs the company will have to take into account. There are two parts to the budget: a start-up budget, which gives the breakdown of the one-time costs necessary to set up a recycling centre, and the operating budget, which details the on-going costs of running the centre. This analysis will also enable the entrepreneur to plan the activity and to establish the prices, in order to be profitable and able to sustain the centre over the long term.

Start-up budget

Investments

The start-up budget comprises all costs necessary to launch an activity. It includes spending related to capital and to the creation of the legal structure, but also all the expenses and investments essential for the opening of the premises, i.e. renovations, purchase of equipment and furniture, and guarantees paid to phone and electricity providers.

Contributions in cash and in kind

The entrepreneur and his partners have several possible ways to contribute to the capital: they may put money into the business thanks to personal loans, microloans, aids and grants. These are contributions in cash. The entrepreneur and his partners may also provide equipment: vehicles, materials, furniture, premises, etc. These are contributions in kind.

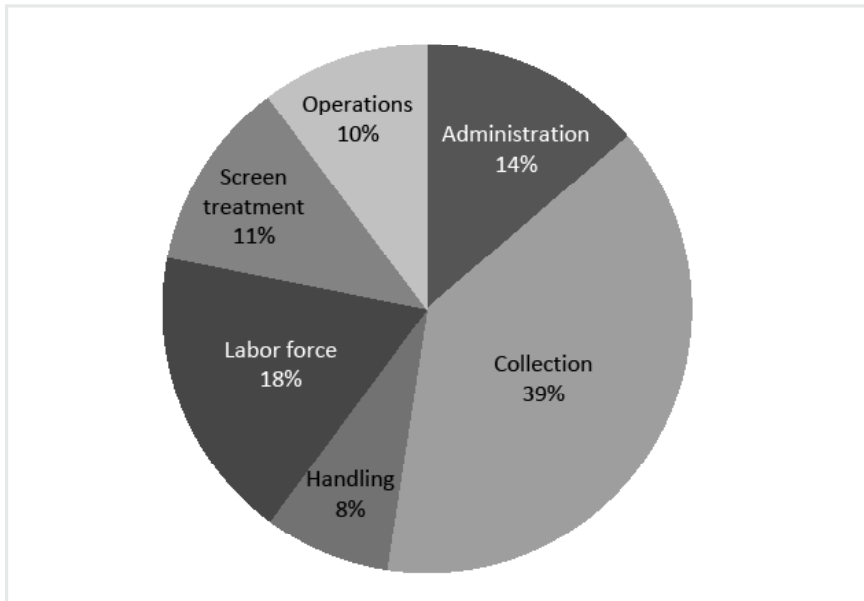
Operating budget

The operating budget includes all recurring expenses, such as rent, salaries, insurance and supplies. In the case of a pilot project of creating

a recycling site, conducted by the CFER , the budget was distributed as presented below.

B

BUILDING THE PROJECT | COST ANALYSIS



Example of budget distribution

The distribution of costs varies from site to site, but this chart gives a rough estimate. It is important for the entrepreneur to assess these costs before starting a business, in order to determine the break-even point of the company.

Running costs

Running costs comprise fixed expenses (administration costs) and variable expenses (operating costs). Generally, administration costs account for 13% to 15% of the global expenses. They include renting costs, standing charges, telecommunication costs, and a part of the salaries devoted to the management of the company. Operating expenses include maintenance costs, heating and electricity charges, the amortization of equipment, etc. To estimate these costs, the entrepreneur can try to find out what another business or organization of a similar size pays. It is best to over-estimate these costs at first.

Collecting costs

Expenses devoted to the collection and transport of equipment account for a large part of the charges borne by the company. However, these expenses vary greatly from one enterprise to the other, as they depend mainly on the type of supplies, but also on the region, the collection type, the price of fuel, the distance of the collecting round, the volume of material collected, etc. In some cases, there may not be any collecting costs, if clients or partners bring the equipment directly to the site. Therefore, assessing these costs before starting the company is a complex task. It is recommended these costs be monitored carefully once the activity is running: the company can save a substantial amount of money at this level, by optimizing collecting rounds or by renting trucks to reduce fixed expenses, for instance.

Labor force and handling costs

Adding up all the employees' monthly salaries is enough to know the global amount of labor costs. The hardest task for the entrepreneur is to evaluate the number of employees he needs, according to the production volume of the company. For instance, the entrepreneur has to estimate the number of computers a technician can dismantle in one hour. This ratio goes from 4 computers an hour to more than 20, if the technician is competent and is used to working on the same type of equipment.

Treatment costs

Usually, refurbishing and dismantling operations generate income when the equipment and subsets are resold. However, some components (such as faulty CRT screens) and polluting residue represent an added cost, since in most cases the enterprise will have to pay a service provider to take care of the collection of this material. The entrepreneur must find the most profitable and environmentally sound way to get rid of this material, in order to reduce the company's expenses. Before the collecting stage, the entrepreneur should negotiate the logistical and financial management of the expenses devoted to the final treatment of waste with the client.

The entrepreneur is advised to consider the treatment of ultimate waste as soon as the business is set up. To this end, he must study beforehand the various techniques available and the offer proposed in his country. He may also examine the possibility to let his clients and suppliers take care of the treatment of ultimate waste. In some cases, if the entrepreneur cannot have waste treated in his own country, he may call on foreign importers who will carry out the treatment of this waste.

Income

Refurbishment is the main source of revenue. The sale of unusable components to dismantlers or raw material recovery firms is only a secondary source of income. If the company cannot obtain enough used equipment for refurbishment, it will be financially at risk. In this case, the entrepreneur can establish partnerships with the local authorities, to compensate for losses: the authorities will pay the recycling company as much as they would for the burning or dumping of waste.

Before starting up, the entrepreneur should be able to secure 6 months of supply. This will ensure the durability of the future enterprise. Ensuring supply is more important than all the various contributions from the entrepreneur or his associates.

START-UP BUDGET	
Setting-up expenses	\$
<ul style="list-style-type: none"> • Setting-up costs • Registration fees • ... 	
Establishment expenses	
<ul style="list-style-type: none"> • Lease of premises (bond provision and potential agency fees) • Phone, electricity and internet fees • Insurances • ... 	
Fitting-out	
<ul style="list-style-type: none"> • Renovating premises (painting, electricity, and sanitary facilities) • Securing premises (alarms, extinguisher, smoke detector, etc.) • Weighing area • ... 	
Furniture	
<ul style="list-style-type: none"> • Test bed • Static water supply point • Tables, desks and chairs • ... 	
Equipment and tools	
<ul style="list-style-type: none"> • Computer • Small tools and portable equipment • Vacuum cleaner, air blow gun • Soldering iron • ... 	
Storage are vehicles	
<ul style="list-style-type: none"> • Hand-operated pallet truck • ... 	
Vehicles	
<ul style="list-style-type: none"> • Pickup • ... 	

.....
 Example of a start-up budget

CHAPTER 5

SUPPLY MANAGEMENT

B

BUILDING THE PROJECT | SUPPLY MANAGEMENT

When seeking sources of used computer equipment, the enterprise must first look for the most accessible ones and must implement assessment methods to control the quality of supply. A manager must cultivate relationships with suppliers and also acquire a good knowledge of the market, to properly evaluate the value of supply.

Origins of inflows

When creating the enterprise, the entrepreneur should, as a priority, look for local sources of computer equipment and establish partnerships with local institutions (municipalities, local enterprises, etc.). Later, the enterprise may find sources on wider national or international markets. Collection requires prior arrangements with local authorities and the retail sector and needs to be incorporated into the overall waste management of the region.

Local supply

To get local supply, the entrepreneur may encourage the neighborhood inhabitants to leave their used equipment at the recycling centre. If the company has a sales area, it may offer to return used equipment from customers when they are buying newly refurbished equipment. Household waste is generally managed by local authorities. The entrepreneur should get in touch with them to see if he could get equipment through them, or if they can spread information about the recycling centre.

Local retailers

It may be interesting for the entrepreneur to form partnerships with computer equipment retailers to collect used equipment. Indeed, these stores can suggest that their clients should return their former equipment

which could then be dispatched to the recycling centre to be processed. The entrepreneur will have to operate a profit-sharing scheme with these partners. It is also possible to offer a discount or a credit note to the clients returning used equipment. The partner store will have to have enough space to temporarily store the equipment received.

Recycling industry

Within the waste recycling industry, outsourcing is common practice. Major recycling companies outsource collecting and waste processing activities to small firms. Thus, a large volume processed by small recycling companies can come from larger recycling companies. Therefore the entrepreneur may try to get in touch with other recycling companies to find equipment fit for refurbishment.

Corporate clients: enterprises and administrations

When they replace their computers, some enterprises and administrations rely on small businesses to rid them of used equipment and take care of the recycling. The choice of this service provider is often made through competitive bidding. The entrepreneur will therefore have to prospect and make his company known if he wants to be chosen directly by these enterprises. The dispatching of equipment towards the recycling centre is often paid for by the recycling company, but in some cases transportation may be provided or paid for by the owner of the equipment.

Non Profit Organizations

Several international non-profit agencies (local authorities, international non-governmental organizations, etc.) from Europe and the United States focus on providing used computers and other ICT equipment to computer recycling centres. In some cases, the computers gathered are loaded and shipped overseas without being refurbished. These exports are illegal if they do not respect national and international regulations. The majority of computers donated to these agencies come from corporations who renewed their ICT infrastructure and got rid of old computers. The entrepreneur may try to form a partnership with these organizations to get access

to new sources. However, he would have to pay particular attention to the quality of these supplies, which may turn out not to be profitable enough or hard to put back on the market if they are not chosen carefully.

B

Assessment of inflows

Before collecting equipment, the entrepreneur must estimate the operation's profitability, the potential of equipment fit to be reclaimed and, above all, the cost of processing, which may vary greatly from one inflow to the other. Therefore, the entrepreneur must have several criteria and methods to distinguish between good and bad supplies and to know how much the refurbishment operation is going to cost.

Homogeneity of inflows

One of the most important criteria to consider before choosing a source of supply is the homogeneity of the equipment provided by that source. Indeed, in the long term, it is more profitable to process homogeneous batches of equipment than to maintain and repair computers of different configurations and brands.

A supply of homogeneous equipment offers several advantages. First, large volumes of identical computers reduce the time needed by a refurbishment technician to reconfigure each machine, i.e. download drivers and BIOS updates. Then, the possibility to exchange parts between computers extends the global potential of the supply, since technicians can extract working parts from unusable machines, and build one working computer out of two or three unusable ones. Moreover, clients may prefer a uniform set of equipment which can be used as a thin client in a network architecture. However, batches of identical equipment are likely to be overvalued.

Brand, chip speed and age

The entrepreneur can get an idea of the value of his supplies by assessing their potential longevity. With the brand name, the processor speed and the age of the equipment, he can make a good estimation of its condition and its potential to be reused. Indeed, each brand uses different components

with different life spans, and some of these components are more appropriate for prolonged use than others. Therefore, it is not recommended to purchase unbranded computers, which have been assembled by computers retailers, because they are generally less reliable in the long term.

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 lifespan: the computer in which it is installed will last longer. This indicator, which often coincides with the age of the equipment, enables its potential for refurbishment and the probability to find spare parts to be estimated. In practice, before purchasing computers over five years old, the entrepreneur must think about their possible use (thin client, etc.), about the feasibility of their refurbishment and about the market on which they could be resold.

Administrative guaranties

Customs controls may be implemented (in EU countries, for example) to detect illegal waste exports. Therefore, flows of equipment coming from those countries are theoretically more reliable. The EU uses the following elements to distinguish computer equipment from waste: the invoice and contract relating to the sale or transfer of ownership of the computer, which states that the equipment is for direct reuse and fully functional; the evidence of testing in the form of a copy of the records (certificate of testing – proof of functional capability) on every item within the consignment and a protocol containing all record information; a declaration made by the holder who arranges the transport of the shipments that none of the material within the consignment is waste; and a sufficient packaging to protect it from damage during transportation, loading and unloading operations.

CHAPTER 6

COMMERCIAL STRATEGY

B

BUILDING THE PROJECT | COMMERCIAL STRATEGY

The entrepreneur must pay particular attention to the company's positioning on the market (in terms of location, activities and products), to optimize his pricing policy and to improve relations with his clients and partners. A study of demand allows the entrepreneur to get a better appreciation of the market: he is then able to analyse and remove the obstacles to computer purchase (such as price or lack of easy terms). Feasibility and market studies also enable the entrepreneur to identify his potential clients and to learn about the means to be implemented in order to meet demand. Once the market has been fragmented and priority targets have been determined, the entrepreneur must define a communication plan, to make his offer known and find clients.

Marketing and communication

Beforehand, a market analysis should be conducted in order to categorize customers, according to their purchasing power. The entrepreneur must always look for creative ways to promote the recycling centre.

Marketing plans should mainly focus on field missions, e.g. prospecting, tracking quotes, follow-up and development of customer loyalty. In the shop, the enterprise may prepare and use selling devices such as advertising and technical documents or sales pitches. The sales area and the store window may also be arranged in an attractive way. Even in a small organization, communication issues are important. The entrepreneur must promote his products and has to maintain and develop his reputation. In order to get good exposure, the entrepreneur needs to use various types of media. To communicate the entrepreneur can resort to press conferences, advertising, television, telemarketing, emails, etc.

Action plans

The commercial strategy must be written in a concise way. The entrepreneur must summarize the main procedures of the company's policy.

The written form meets two needs: it clarifies ideas and synthesizes key elements which constitute the company's competitive advantage. This is the reference document the entrepreneur must align his strategy on. It enables decisions to be explained and to make them understood and accepted.

The entrepreneur must prepare in detail the action plans he is going to set up to achieve the goals set out in the business strategy. The next phase consists in describing in practical terms the different stages and means implemented to achieve these goals. For each step, the following aspects are detailed and planned: actions, costs, timing and human resources. These action plans should be aligned with the business and the objectives set. Actions are prioritized according to needs. Depending on the situation, their implementation may be simultaneous or sequential. Every action must be validated before moving to the next.

Partnerships

Before making his business known, it is in the entrepreneur's interest to get in touch with networks of businesses and institutions involved in computer science and which are committed to the reduction of the digital gap. By establishing partnerships with the key members of these networks, the entrepreneur will secure regular clients for the company and will extend its scope of action. Partners may contribute to the communication strategy: they can spread the word about the company and act as free advertisements.

By getting in touch with governmental authorities, the entrepreneur may also gain access to certain information (e.g. about the expansion of the power system or the launching of a plan to finance computer equipment in schools) which will enable the company to enter new markets. In the same manner, a partnership with an Internet access provider may be beneficial: the latter could advise his clients to purchase their computers at the recycling site. Finally, the entrepreneur may try to create partnerships with businesses which could sell his products on other markets.

CHAPTER 7

INVENTORY MANAGEMENT AND TRACEABILITY

B

BUILDING THE PROJECT | INVENTORY MANAGEMENT AND TRACEABILITY

Recording in and out movements

To be accountable to his clients, partners or financiers in case of dispute, the entrepreneur must be able to relate the movements of the equipment flow. Therefore he must keep a register, listing all the supplies of computer equipment (date received, provenance, quantity and weight) and all the movements of equipment, materials and components leaving the processing site. In some countries, keeping such a register is mandatory. Thus, the entrepreneur must know the national and international regulations he might be subject to, so that equipment will be properly listed during collection, transport and temporary storage.

Doing the inventory

In addition to the keeping of this register of movements, the keeping of an inventory on spreadsheets of all treated equipment is essential to a computer recycling activity. The inventory enables the entrepreneur to control stocks, to organize production more efficiently and to increase productivity. Thanks to the inventory, the entrepreneur can professionalize the relations he has with his partners and suppliers and it fosters a greater openness between them. The inventory is also very useful to keep the accounts of the company.

Producing an inventory mainly consists in identifying precisely each piece of equipment, and listing its characteristics and location. This helps to determine the provenance of equipment and its destination once it has been treated. An advanced inventory will enable a piece of equipment to be followed throughout the transformation process conducted on the treatment site.

It is important that the inventory system can be easily used by technicians and managers. This system has to meet the company's needs as far as follow-up and production analysis is concerned. It is often more profitable for the company to computerize this system with specialised software.

Identifying equipment

In case of refurbishment, equipment can be identified on arrival: each piece of equipment is identified by its serial number and a unique identifier, set up by the company. This internal identifier will enable the piece of equipment to be followed during the whole treatment process. The choice of identifiers must respect a certain logic and structure: the technician should be able to recognise the type of equipment just by reading the identifier. For example, the identifier could be conceived as follows: manufacturer code/on-site arrival date/registration number. To help the creation, management and reading of those identifiers, the entrepreneur can invest in a barcode management system, but this may represent a substantial financial investment for the company.

Using track sheets

Product sheet

The simplest form of inventory system remains the paper sheet. The product sheet (one per piece of equipment) indicates the identifier and keeps up with the piece of equipment at every stage of its treatment process. The sheet is filled in as the recycling process goes by. The product sheet gives the main characteristics of the equipment: serial number, processor speed, hard disk capacity, RAM capacity, etc. It also records the equipment status (i.e. non-tested, tested, configured, ready for sale, etc.). It may also indicate the name of the technician in charge and the name of the final client.

Stock sheet

The stock sheet enables the quantity of equipment in stock to be known, but also the number and the location of each kind of spare part, thus making the refurbishment activity easier. The stock sheet may regularly

be compared to the product sheet, in order to detect possible problems, such as fraud or the chronic shortage of a certain type of part (due to the acceptance on site of computers lacking components).

B

Traceability sheets for outgoing flows

When equipment is sold, the invoice is generally enough to keep up with the outgoing flow. It must indicate the transfer date, information about the equipment (serial number and description), and the buyer's identity. In some cases, a certificate authorising transportation may be required.

When outgoing flows are dispatched to a recycling business, it is recommended that a track sheet be sent along with the batch in question. This sheet may give the following information: holder and producer of the waste, carrier transporting the waste, destination, date of shipment, means of transport, name and physical description of the waste, composition and tracking numbers, method of packing, quantities on departure and on arrival, etc. After having processed the waste, the final recycling company may send the entrepreneur a certificate testifying to the reclaiming or destruction of the pieces dispatched.

Computerizing management

To save time and improve reliability, the entrepreneur may computerize the inventory management. It suppresses the storage of paper sheets, it standardises input data, it reduces the risk of making mistakes (by automatically creating the internal identifiers) and it enables the stock condition to be known in real time. However, a qualified employee is required to manage the database.

The company can develop its own management tool, using software such as Microsoft Access® or Adobe FileMaker®. But some free computer population management tools may also be used. For instance, the free software GLPI enables a precise inventory of all existing technical, material and software resources to be kept.

CHAPTER 8

HUMAN AND ENVIRONMENTAL RISK ASSESSMENT

B

BUILDING THE PROJECT | HUMAN AND ENVIRONMENTAL RISK ASSESSMENT

Human health and safety

As far as occupational health and safety are concerned, the most important things to know are the potential risks of an activity and how to implement measures controlling and reducing these risks. In a recycling centre, employees are particularly exposed, because of the sometimes hazardous contents of the material they handle. Equipment may contain hazardous substances and metals, as well as toxic gas and dusts. In addition to these risks of exposure, there are those inherent in workshops, where employees have to handle heavy loads and are exposed to machines vibrations and noises. Therefore, important measures must be taken to reduce these risks. The entrepreneur is bound by national and international laws to anticipate and reduce the occupational risks his employees are exposed to.

Minimum protective equipment

Even though manual dismantling operations generate few contaminants likely to be absorbed by the respiratory route, dismantling technicians are advised to wear a mask. Contamination happens mostly indirectly, by ingestion of contaminants present on hands and clothes. Employees must therefore respect the following minimum safety instructions:

- Wear protection suits, or regularly clean these suits by washing separately;
- Do not eat, drink or smoke in the workshops;
- Wash hands before meals and snacks;
- Avoid nail biting and brush one's nails regularly;
- Vacuum the premises to avoid dust accumulation.

Beforehand, when fitting out the premises, the entrepreneur must respect the following rules:

- Protective equipment must be stored away from contaminants;
- The screen shredding area must be confined;
- Sanitary facilities must be provided in the workshops.

Training programme

The recycling centre must work out a training programme that will teach employees to properly identify and handle hazardous materials. Employees must be able to safely handle equipment and materials, to anticipate high-risk situations and to deal with emergency situations. The training centre must define the roles and responsibilities of the employees carrying out activities potentially hazardous to other employees or the environment.

Employees must know the risks they could bring upon the environment in case of mistakes during the handling of hazardous materials (water, energy) as well as the risks to their own health. They must also be reminded of the various types of pollution: visual pollution, noise pollution, odour pollution, etc.

Emergency preparedness training

Employees must be prepared to cope with any kind of emergency situation. For example, they must know fire fighting plans in case of fire or explosion and the contingency plan in case of pollution. The emergency preparation training may include instruction on first-aid measures, safety code and evacuation plan. Safety literature must be displayed or accessible. Technical information must be presented in a way that enables staff members to comply with regulations.

For more information, refer to the list of hazardous products in annex.

Environmental protection

ESM Principle

The recycling centre should implement an environmental management system. According to the OECD, Environmentally Sound Management (ESM) is “a scheme for ensuring that wastes and used and scrap materials are managed in a manner that will save natural resources, and protect human health and the environment against adverse effects that may result from such wastes and materials”. For more information, the OECD and the United Nations Environment Programme (UNEP), through the Basel Convention, have developed specific work programmes to enhance ESM.

Environmental management system

The entrepreneur who implements environmentally sound practices may apply for the certification of his company, which will then be recognised as environmentally sound.

To obtain a certificate, the enterprise must be able to provide measurable objectives for the continuous improvement of the environmental performance, including a periodic review of the relevance of these objectives. It must also provide regular monitoring of progress towards health, safety and environmental protection objectives, and the collection and evaluation of relevant information regarding the protection of the environment as well as health and safety in the enterprise.

There are several ESM certifications, such as ISO 14001, which is used worldwide, EMAS, which is specific to European countries, and RIOS in the United States.



OPERATIONAL STAGES



This chapter presents the various operations carried out by recycling companies: collection, refurbishment, dismantling and recovery. Environmental protection and worker health and safety are discussed in this part.

CHAPTER 1

COLLECTION



The collection activity is not essential for the recycling company, as the entrepreneur can sign contracts with partners who can ensure regular inflows of quality material. Nevertheless, logistics represents a large part of the added value of the recycling activity, and very strict specifications must be followed, either by the company's staff or the external provider.

Preparing logistics operations

Prepurchase service

Before the collection operation is carried out, the entrepreneur or the representative in charge of trade relations must define the financial and logistical aspects of this operation. The pricing of the service will have to take into account the quantity, the nature and the weight of the equipment to be collected. It will also take into consideration other factors, such as the ease of access to the equipment (wide doors, wide stairs, elevators, access wide enough for vehicles, availability of parking and manoeuvring area, etc.) and the geographical distribution of the collection places (several batches to collect at a single site, multiple sites to visit, etc.). A company representative will often have to go to the collection sites to gather information. These pieces of information will help define the organisation of the collection team and to choose the mode of transportation.

The entrepreneur may also try to sell extra services to his clients, e.g. the disconnection and removal of their computers or the disposal of computer data.

Organisation of the rounds

To optimise logistics and reduce costs, collecting rounds must be planned and scheduled according to constraints such as distances, volumes and

weights. A round is composed of either a single collecting stop or multiple stops. If the enterprise has several collecting vehicles, it must use the most appropriate one for each specific round. The company can determine fixed dates for collecting rounds.

Preparing logistics

The collecting team is composed of a driver (who is the team leader) and one or two packers. The driver will prepare the round and check that materials and tools are ready. The driver must know the details of the route and have the business records with him (clients' products list, copy of client's orders).

Health and safety

Before collection starts, the entrepreneur or the trade representative must try to detect hazardous materials or potentially dangerous situations, in order to prepare the collection team and anticipate the reception of the equipment.

Handling and transportation

Handling

In most cases, equipment is scattered and stored in bulk. The first operation to carry out is the gathering and a basic sorting of equipment. Handlers may sort material by type and possibly by brand to make up pallets. Pallets may also be composed of homogeneous equipment or materials.

The typical range of containers includes pallets (for CUs, monitors and printers), double fluted cardboard cartons on box pallets (for hard disk drives and various optical readers) and plastic containers or drums (for memory boards, microprocessors and batteries).

Then, the truck can be loaded, in the following order:

1. Big bulky pieces such as photocopiers, etc.

2. CUs: Cardboard should be inserted between CUs to protect the front of their cases.
3. Monitors: Monitors must be arranged screen downwards and separated by cardboard. The first layer should be isolated from the floor by blankets.
4. Printers: Printers must lay flat, to prevent cartridges and toners from leaking.

Then cartons filled with documents, CDs, peripherals, accessories, as well as big bags of cables and connectors will be used as wedges to fill the rest of the truck. It will prevent other batches from moving during transportation.

Transportation

Any sturdy and reliable vehicle is suitable for transportation, as long as it is not overloaded. Even vehicles drawn by animals or people may be considered. Nevertheless, it is recommended to use a motor vehicle on which the trailer is equipped with stakes and a pallet collar to ensure better safety. For a small company, the standard vehicle is a 3.5-ton truck with a 20 m³ (7000 ft³) bin and possibly a tailgate. A double axle vehicle can carry 1.5 tons without overload; that is to say six pallets weighing 250 kg (550 lbs) each on average. Every vehicle must be in good working order, in order to prevent any air pollution. Indeed, they must reflect the image of the company and should therefore convey an environmentally-friendly message.

Health and safety

Staff must be trained to perform handling activities relating to transportation and these activities must be carried out with appropriate handling equipment in order to limit the risk of injuries. Handlers may use two-wheel hand trucks, caster-wheel carriages or pallet trucks. To avoid injuries, it is important to prevent breakage by fully filling containers and securing equipment before transportation.

Traceability

Once the truck is loaded, the owner of the equipment must sign a handover certificate to the recycling centre. Thus, the centre manager can prove that he is in possession of the said equipment. If the equipment is donated the certificate must provide a list of the pieces of equipment given up. If the equipment is sold, the invoice established by the owner and listing all the pieces of equipment serves as the handover certificate.

If the certificate (or the invoice) has been established before the actual collection, the person in charge of collection must make sure that the document corresponds to the equipment collected. In case of differences, the handover certificate must be modified.

Unloading and gathering operations

Unloading

It is recommended the vehicle is unloaded as soon as possible. Once at the recycling site, handlers sort material if it has not already been done. They weigh equipment by category (e.g. monitor, mixed electronic equipment, miscellaneous) and store it provisionally. If possible, the weight of pallets or cartons must be deducted from the global weight, in order to know the net weight.

Traceability

The weight, the quantity and the type of incoming equipment must be written down in an inflows register. This document will be the first element enabling batches to be traced within the premises. Each pallet or piece of equipment may also carry a unique identifier, to help with the inventory and the follow-up of batches.

Preliminary assessment and dispatching

Thanks to a preliminary visual assessment, the pieces of equipment can be dispatched towards the appropriate processing workshops, according

to their condition. The functioning pieces do not need to be processed, except for cleaning, and can be reused as they are. If some pieces of equipment or their spare parts can be fixed, they can be refurbished in order to be reused. If the equipment is out of order or outdated, it is routed towards the dismantling workshop in order to be disposed of and valorized as recycled material. Following the preliminary assessment, materials are processed directly, following the LIFO method (Last In First Out) or stored, awaiting intervention.

Health and safety

Facilities must be protected and must not create any visual pollution. It is recommended shelves or racks should be fastened to the wall and ground, and to avoid overloading racks. Bays of routers must remain stored on the ground.

FOCUS - COMPUTER MATERIAL HANDLING UNIT (CMHU)

The *Computer Material Handling Unit* (CMHU) can help to estimate batches and to optimize logistics. This unit is used as a tool to simplify calculation and assessments of logistical means needed.

The use of the "Handling Unit" chart presented below is advised:

Equipment considered	Average weight	Volume
Central Unit (CU)	10 kg	0.04 m ³
Monitor < 20"	14 kg	0.07 m ³
Keyboard and mouse	0.8 kg	0.02 m ³
Laser printer	15 kg	0.06 m ³
Cables	0.2 kg	0.01 m ³
Total = 1 CMHU	40 kg	0.2 m³

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Composition of a Computer Material Handling Unit (CMHU)
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This unit enables volumes and weights to be estimated. In order to assess a batch of equipment to be disposed of, it is sufficient to count either the number of monitors or the number of central units before sorting. With the list of equipment given by the previous owner, the handlers can calculate the number of CMHUs. An equivalence table is used for this purpose (see below).

For instance, three monitors are worth one Computer Material Handling Unit. This calculation enables the firm to get an estimate of the volume and weight of the batch. Therefore, it is possible to adjust logistical means to specific situations.

Equipment	Average weight	Average Volume	Equivalent number of units
CRT Monitor	14 kg	0.075 m ³	0.375
Central Unit (CU)	10 kg	0.04 m ³	0.25
Laser printer	15 kg	0.06 m ³	0.3
Equipment in bulk in a big bag container	240 kg	1 m ³	6
Photocopier	80 kg	1 m ³	2
External bay (routers, servers, racks)	120 kg	1.25 m ³	3
Routers rack	40 kg	0.3 m ³	1

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 Equivalent in Computer Material Handling Unit for principal computer equipment

CHAPTER 2

REFURBISHMENT



In a recycling centre, the refurbishment activity is the most important in terms of income and added value.

Cleaning

It is important to carefully clean the pieces of equipment, first to be able to present clean equipment to potential clients, but also to prevent damage while the pieces are being tested. Indeed, when used, transported and stored, the equipment collects dust which must be removed before testing, as it may cause short-circuits or malfunctions possibly resulting in the destruction of components as soon as the equipment is switched on. The entrepreneur will also have to make sure that the plastic cases are cleaned before being shown to clients.

Cleaning methods

As it is impossible to use a dust cloth because of the numerous slots, pins and corners, it is recommended to resort to compressed air to remove dust. An electrically powered handheld blower generally delivers enough compressed air to blow dust out of circuit boards and other components. It is also highly recommended to set up a station specially devoted to this operation, equipped with a dust extractor. This enables the employee to work in better conditions, and also prevents dust from spreading to the rest of the workshop. This workstation should be closed on its three main sides, and equipped with an air blow gun and an aspirating hood running continuously. To remove stains, glue traces and encrusted dust from the plastic cases, it is possible to use a cloth moistened with water.

When using chemicals, workers must follow safety instructions and wear equipment to protect their hands and respiratory system. The disposal of cleaning products must also be monitored, as they must not be discharged with waste water.

Health and safety

It is highly recommended to isolate the cleaning area from the workshop, so that technicians cannot be bothered by dust, and equipment in the process of being repaired cannot be damaged. It is also recommended not to use solvent during this operation to protect worker health, as water is usually enough to clean properly.

Testing

Testing is one of the main stages of the refurbishment activity, as it is at this point that the decision is made whether to reuse the computer as it is, to refurbish it or to dismantle it. Tests are generally focused on the condition of the hard drive, the screen, the motherboard and the RAM.

Computer testing

Before opening the computer and individually testing its parts, the technician must try to switch the computer on. If it starts, the technician will be able to run tests directly on the machine to assess the condition and capacity of the various components. To test components such as the motherboard or the RAM, the technician will often have to use programmes specific to the brand of these components. For this reason, the entrepreneur is advised to provide his company with a programme library, where technicians can quickly find the appropriate software.

If the equipment does not work, it is important to determine if it would be worthwhile repairing it or using it for spare parts. If it is the type of equipment often asked for by clients, its subsets should be tested either to identify the failure or to extract spare parts.

Hard drive testing

It is recommended to set up a workstation devoted to hard drive testing, equipped with a computer in perfect working order. To assess the condition of hard drives (up to four at the same time), the technician must connect them to the available IDE connectors. Once connected, the technician

uses specific software to test hard drives and repair them if need be. Once a hard drive has been tested, it is either sent for dismantling (if it is faulty), or stored to be used later as a spare part.

RAM testing

It is usually recommended to test the RAM modules on their original motherboard, due to important risks of incompatibility between the different models. The module testing process is similar to that implemented for hard drives. It requires the use of a functioning computer, equipped with a motherboard compatible with the modules to be tested. The technician must install these modules in the computer, switch it on and run tests thanks to the appropriate software. If the RAM modules are faulty, they are sent for dismantling. If they are fit for reuse, they are stored once their characteristics have been carefully registered.

Monitor testing

Contrary to the other components testings, monitor testing is based only on the tester's own assessment. His job is to evaluate the quality, the brightness and the contrast of the monitors. He must also detect potential problems, such as image distortion. Therefore, the technician in charge of these tests must have a lot of experience. He may use a working computer as a point of reference.

If the monitor is in good working order, it is stored, waiting to be resold. If the case is damaged, it is sent for repair. Finally, if the monitor is out of order, it is sent for dismantling. The technician may sever the cables of faulty monitors, so that they cannot be mixed up with monitors in working order or those waiting to be tested.

Traceability

Once a piece of equipment has been tested, its track sheet must be updated, indicating its condition, the possible repairs and the name of the technician who carried them out, and lastly its next destination (i.e. the refurbishment workshop, the dismantling workshop or the sales area). If

the equipment is broken up into spare parts, it is recommended to create a track sheet for these parts.

Data security

When equipment is collected, the owner may want the data which is written on the hard drives to be disposed of. This operation can be carried out either on the collection site or on the recycling site. Even if the owner does not specifically request the data disposal, in numerous countries, the recycling centre is legally obliged to do it, in compliance with regulations on private and intellectual property. The company may communicate about the reliability of its data disposal methods, to reassure the equipment suppliers.

To remove data from a computer, the recycling centre carries out several hard drive formattings, either at the hard drive test bench, or directly on the computer. There are various software programmes on the market enabling the retrieval of data erased from the computer by the user or during the formatting. Therefore, the recycling centre must be equipped with efficient data disposal and formatting tools, and must repeat the operation several times on each hard drive to make sure that no trace of former information remains on the hard drive. There are several data disposal software products available on the market, among which the free software Root Boot, under Linux.

If hard drives are pierced to secure the data disposal, this operation should be carried out under an aspirator, as the smoke resulting from it may contain harmful substances.

Assembling

Choosing a hardware configuration

Before assembling a computer, the technician must choose the configuration to give to the computer. Once this is done, he can decide which pieces are going to make up the computer so that its performance can be sufficient to run the operating system and the required applications.

The hardware configuration depends on the future use of the computer and on the operating system installed in it. Therefore, the clients' needs should be carefully examined beforehand, in order to identify the appropriate technical configurations for the equipment.

There are two types of configuration: stand-alone computers and thin client. Stand-alone computers require a hard drive big enough to host the operating system and the applications files. They may also include a network interface card, to access the Internet or be connected to the network they are intended to be a part of. Thin client computers have neither hard drives nor operating systems, and require very little RAM. Nevertheless, they include a network interface card, enabling them to be connected to a central server on which the operating system and several software programmes are installed. The thin client configuration allows the use of relatively old equipment that would not have been fit to be refurbished as standalone computers. A network equipped with a powerful central server (2 Ghz) can use about twenty thin clients.

Assembling the central unit

To assemble a central unit, the technician first puts in the motherboard, the processor and the RAM. Then he installs the expansion boards, the drives and the peripherals (e.g. various optical drives). Several guides or websites give more detailed information on this process. It is recommended to start with the original configuration in which defective components are replaced. The risks of incompatibility between brands or versions increase when the computer is made up of spare parts from different origins.

Installation

Once the computer has been assembled, a technician must carry out the installation of the operating system and of the drivers enabling the computer to communicate with its peripherals. Then, the technician has to install various software programmes, in order to make the computer fully operational. To save time, the entrepreneur may implement systems enabling these operations to be performed on several computers at a time.

Installing the operating system

The most popular operating systems are Microsoft Windows and Linux. For both, several versions exist. The installation of Linux is free, whereas the installation of Windows is subject to license fees. However, Microsoft has developed a free licensing programme and a low-cost licensing programme (MAR). This programme applies to computers destined for educational establishments and computers coming from refurbishment centres.

The main versions of these operating systems are:

- Microsoft: Windows 98, 2000, XP, Vista;
- Linux: Debian, Knoppix, Mandriva, Suze, Ubuntu, XUbuntu.

According to their editors, these operating systems require the following minimum configurations:

	Windows 2000	Xubuntu	Windows XP	Ubuntu	Debian
CPU	133 MHz	166 MHz	233 MHz	300 Mhz	512 Mhz
RAM	64 MB	64 MB	128 MB	64 MB	64 MB
Hard Drive	2 GB	2 GB	2 GB	4 GB	5 GB
Monitor	yes	yes	yes	yes	yes
CD-ROM	yes	yes	yes	yes	yes
Keyboard	yes	yes	yes	yes	yes
Mouse	yes	yes	yes	yes	yes

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Examples of minimum hardware configurations
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With these specifications, the operating system should run, but probably not as well as it could. For good visual effects and smooth running, it is advisable to improve these configurations.

The Microsoft Authorized Refurbisher Programme (MAR)

Recyclers can become members of the MAR community as long as they meet the criteria and conditions listed on Microsoft's website. The MAR programme allows companies to use a wide variety of eligible software applications on computers of eligible beneficiaries. Windows 2000 OS can be installed on all computers participating in the programme. Windows XP is available for computers that were previously configured with Windows.

Throughout the programme, Microsoft provides the authorized refurbishment companies with technical support, specific certificates of authenticity (COA) and agreements with eligible beneficiaries. The MAR programme helps to reduce costs paid by the recycling company to license refurbished computers. It also allows eligible beneficiaries to obtain equipment at an affordable price. This programme enables technicians to install a variety of software applications with certificates of authenticity. For additional information on the MAR programme, see www.microsoft.com/mar.

Installing drivers and applications

Drivers are software applications thanks to which the operating system recognises and communicates with hardware components. They are specific to the hardware and depend on the manufacturer, the model and the operating system. They often have to be downloaded, usually from the manufacturer's website. To avoid spending too much time, the entrepreneur must make sure that the company's programme library contains the most frequently used drivers. The older the equipment and the operating system, the harder it is to find the appropriate driver.

The technician can also resort to CD-ROMs and Internet downloads to install software applications.

Simultaneous installations

To save time, the entrepreneur can implement methods of installing several computers simultaneously thanks to imaging software applications. These programmes copy the image of a computer (i.e. its exact

contents) into one or several other computers at the same time, via the network or a CD-ROM. This way, the operating system, the drivers and the applications are copied directly into the new pieces of equipment. However, this method has one important limitation: the computers must be identical and equipped with the same components (motherboard, network interface card, video board, CD-ROM drive, floppy disk drive, etc.). This is another reason why the equipment collected must be as homogeneous as possible: it enables the recycling centre to save a lot of time during the installation stage.

Secondhand resale

When the equipment collected is in good condition and operational, it may be put back directly onto the market. Nevertheless, most pieces of equipment will have been refurbished prior to resale. It is also possible to sell refurbished spare parts.

Traceability

It is important for the recycling centre to be able to keep track of the equipment until its final destination. This is why a handover certificate must come with the equipment, to certify the transfer of ownership.

The centre may address a certificate to the initial owner, to let him know that the equipment has been refurbished and put back on the market.

CHAPTER 3

DISMANTLING



At the end of the sorting operation, equipment fit for dismantling (i.e. equipment that cannot be refurbished nor repaired) is put together and sent to be processed. The dismantling operation consists in extracting reusable spare parts, removing all polluting substances from the equipment and sorting materials so that they can be sent to the proper recovery industries.

It is essential to conduct this activity in accordance with the regulations, to ensure worker safety and environmental protection. All handling operations are potential sources of injury. To avoid accidents, it is recommended that a procedure is established to describe all movements appropriate to every operation. Meanwhile, staff must be trained in issues relating to the hazardous equipment that they work with. Safety notices should be pinned up in the premises to remind employees of all hazards and the instructions to be followed. The risks of being cut or of inhaling dust must be monitored, and emissions must be controlled to avoid damaging the environment and the health of the handlers.

Dismantling a central unit

The dismantling operation consists in extracting the various materials used in the CU, to put them into homogeneous batches that will then be recovered by the appropriate industries. However, it is not always necessary to dismantle all the components of the computer. Indeed, some components may be recovered as they are, if they are sent to the appropriate industry.

CU cases

When dismantling a CU, the first thing to do is to open and remove the case, to get access to the internal components. The case, mainly made

of plastic or metal, is then sorted according to the type of material (plastic or metal). However, due to the complex composition of plastics, it is often difficult to identify the types of plastics and to sort them out to make homogeneous batches. Since the enactment of the ISO 11469:2000 standard, plastics composing new pieces of equipment can be identified thanks to pictograms. According to a study carried out by the ADEME, CU cases are mainly composed of either ABS plastic (acrylonitrile butadiene styrene), of ABS/PC (polycarbonate) plastic composite, or of ABS/HIPS (high impact polystyrene) plastic composite.

Power packs

The power pack consists of a radiator, a fan, some cables and connectors, a printed circuit and a transformer. Several colored cables go from the power pack to various parts of the computer. To dismantle a power pack, the technician disconnects all these cables and removes the few screws holding the pack to the computer. Then, he has to sever the white connectors with cutters, and cut the bundle of cables to recycle each of them separately. Afterwards, the various components must be put into homogeneous batches. Some components, such as printed circuits or external electric cables, are classified as hazardous waste by the WEEE Directive and must therefore be treated accordingly.

Hard drives

The hard drive is made up of a lid, a metal case, a data disk and a printed circuit. The technician undoes six to eight screws to remove the little aluminum lid and the computer board which is beneath it. The other parts of the drive may be dispatched into containers of mixed aluminum. If hard drives are pierced to secure the data disposal, this operation should be carried out under an aspirating hood, as the smoke resulting from it may contain harmful substances. Some other drives (CD-ROM, etc.) have a similar composition and can be dismantled in the same manner.

Computer boards

There are numerous printed circuit boards in a computer. The most important is the motherboard, as all the components of the computer are

connected to it. Three types of pieces must be removed from this board: the memory modules, the microprocessors and the batteries. Batteries are considered to be hazardous waste and must undergo specific treatment. The other boards are smaller and are inserted into the motherboard and are called daughterboards. They include video boards, network boards, sound boards, etc. They all have at least one connector and golden contacts. All these boards must be collected into homogeneous batches to be recovered separately.

Microprocessors

In a computer, there is usually only one microprocessor, inserted in the motherboard. A microprocessor is generally two inches long, two inches wide and half an inch thick. In most cases, it is beneath an aluminum radiator and a fan, which must be removed before the microprocessor can be recovered. When removing these pieces, the technician must be careful not to cut wire connectors, or the pieces would become unusable.

Extraction of pollutants

According to European regulations, there are three particularly polluting components in a CU: the coin cell, the small electrolyte capacitors and the LEDs. The coin cell is often inserted into a mechanical holder or sometimes soldered to the board. It should be removed from the motherboard because otherwise, during the shredding operation, the cell could be opened, thus exposing the lithium anode. Small electrolyte capacitors can be found on old printed circuits of larger computer equipment, such as mainframes and large printers. They have to be collected separately because they can be considered as hazardous. Indeed, capacitors may contain corrosive liquids. Therefore, the removal of capacitors larger than 25 cm² must be carried out prior to shredding and recovery because printed circuits are considered hazardous waste. LEDs present on some printed circuits may need to be removed from the printed circuit boards, due to their gallium arsenide content.



Dismantling monitors

Content of a CRT

Old CRTs can contain 2 to 3 kg of lead, whereas new models generally contain no more than 1 kg. CRT screens consist of a plastic case (ABS/PC), a cathode ray tube, an electron gun, a printed circuit and cables. The CRT contains by far the greatest amount of all substances of concern in a PC.

The inner side of the faceplate is covered with a fluorescent coating, also known as luminophore, which emits light radiation when excited by electron impact. The composition of this fluorescent and phosphorescent coating varies from one manufacturer to the other. The luminophore is generally made of materials which are difficult to recycle, such as rare earth oxides, phosphorus, iron oxide, graphite, lead, silicates, cadmium sulphides and cadmium tungstates. According to the OECD, the cone glass (or funnel glass) contains about 20-24% of lead, the neck glass about 28-30% of lead and the glass frit about 80% of lead. The screen glass may contain encapsulated lead that can be released when the glass is broken.

CRT screen dismantling

Apart from the removal of the plastic cases, no dismantling operation should be conducted on monitors without adequate facilities. Only industrial channels that have adequate facilities should process cathode ray tubes. Such facilities can isolate hazardous materials contained in tubes in a confined environment.

To dismantle CRTs, the technician must recover the plastic cases and sort them according to their hazard symbol, and recover the electronic boards. Once the lid has been removed, all the internal cables must be cut so that the internal components can be removed (display adaptor, metal components, screen cable, etc.). Once sorted, the plastic cases are assembled in batches. To remove the electron gun, the dismantling technician has to take out the screw holding it to the end of the CRT. The technician continues to remove components one by one until only the CRT remains.

CRTs are then processed in a treatment unit specially designed to meet the strictest requirements regarding environmental protection and occupational health and safety.

Dismantling sites may consider investing in the installation of an industrial unit specialising in the mechanical separation of the cone glass containing leachable lead and the panel glass containing lead in its matrix. Such an installation enables the tubes to be dismantled while protecting technicians from dust they might inhale, and efficiently controlling air emissions. The installation should be equipped to clean the glass and to remove the phosphor coatings. Once it has been separated from lanthanides, the cleaned lead and barium glass (with assayed lead concentrations), can be sent to a specialised industry for recovery. Moreover, the staff must be protected against inhaling the phosphorus contained in the fluorescent coating. This is why wet processes are often used to remove the phosphorus.

Flat screen dismantling

LCD screens are progressively replacing CRT screens on the market. Flat panel displays consist of a plastic case and a coat of liquid crystal contained between two glass panels covered with conductive materials. The liquid crystal is derived from butylaniline, and can be considered as harmful to human health and the environment if handled improperly. There are few existing technologies to process them, but flat panel screens containing liquid crystal displays could still be sent for recovery operations. There is mercury in flat screens and therefore they should be handled and treated with particular precaution.

Peripherals et cables processing

Insulated wires

There are two kinds of cables in a computer: flat cables and small colored cables which come from the power pack. Connectors should be extracted prior to separating cables. Black plastic connectors are collected separately, and cables are recycled to recover non-ferrous metals (copper,

aluminum), which are then sent to refiners. If possible, insulated electrical wires (e.g. power cables) should be separated from PCs. Insulated wires require particular treatment because their PVC coating contains chlorine and therefore they are classified as hazardous waste.

Batteries

As batteries used in portable computers are recognised as hazardous waste, they must be manually removed and sorted according to their category: nickel-cadmium (Ni-Cd), nickel metal hydride (NiMeH, corrosive), or lithium ion batteries (recyclable). Some lead-acid batteries are also used. Batteries must be handled carefully, to avoid short circuits and untimely external current flows. It is advised not to keep too many batteries in stock and to send them to specialised metal recovery facilities. Once sorted, batteries should be stored in small quantities, and physically separated from each other, to avoid any risk of explosion or fire.

Keyboards

A keyboard is composed of several printed circuits. The keyboard's frame and keys are made either of ABS plastic or of ABS/PC plastic composite (about 1 kg, or 2.2 lbs).

Directing materials to the proper recovery channel

This stage comes after dismantling and sorting. It requires heavy industrial investments to be carried out in the best conditions of safety and environmental protection. It is generally outsourced, as the recycling centre does not have the appropriate technologies. If pieces of computer equipment are dumped or incinerated, the hazardous substances they contain may pose risks for human health and the environment. These risks can be reduced thanks to appropriate work practices, the control of combustion and the use of air emissions control devices. As far as occupational health and safety matters are concerned, the most important thing is to be aware of the potential risks of the activity, and to implement measures to control and reduce these risks. To prevent these risks the entrepreneur must find

the most appropriate companies to treat and recover the batches of homogeneous materials resulting from the dismantling operation. He must find companies that offer economical and ecological advantages.

Plastics

To reduce logistics costs, once plastic has been extracted, it is possible to reduce volumes by using tools such as a mechanical press or shears for iron or balers for plastics and master cartons. This can be secondhand equipment. For larger volumes, it is possible to use comminuting machines such as pelletizers. After identification and homogenization, plastic will be sent for recovery in the form of plastic batches weighing about 150 kg. This operation requires neither specific skills nor expensive equipment. The operation is interesting for the recycler as it generates homogeneous materials that can be negotiated with scrap dealers and industrial traders.

Even though there is a plastic recovery market, it is hindered by a number of obstacles. First, recovery is complicated by the presence of flame retardants (bromine) in plastics which are therefore non-homogeneous. Then, the presence of labels and metal pieces reduces the homogeneity of plastic batches. And finally, plastic recovery requires large quantities of homogeneous plastics to be a profitable activity. Therefore, it is in the entrepreneur's interest to carefully carry out the dismantling operation, to form high quality batches of homogeneous plastics that will be sold at the best prices to industries.

Metals

To maximize profits, it is in the entrepreneur's interest to sell metal batches which are as homogeneous as possible. The iron in the structure of the CU represents the largest quantity of metal used in a computer. It can be sold to iron and steel industries or to scrap dealers. Computer equipment also contains non-ferrous metals, such as copper (up to 1.5 kg) and aluminium, or lead and pewter in smaller quantities. However, these metals are often mixed to form other components, such as printed circuits. In these cases, the separation of these metals requires advanced technologies.



The recovery of these materials is very interesting to the entrepreneur, as he can sell them as they are (mixed) or in homogeneous batches.

Circuit boards

In a used PC, printed circuit boards are among the most valuable components. Firstly, they may contain chips that can be removed and sold for reuse. But above all they contain valuable metals that can be sold to a smelter. Electronic boards that cannot be reused as spare parts still have value. To optimize the value of these boards, it is necessary to sort them according to their precious metal content. The boards are then sold to refineries. Their price depends on the market price of precious metals, on the homogeneity of batches and on the quantity. The recovery of circuit boards must be carried out by specialised industries, to avoid any health or environmental risk.

Some circuit boards (such as power supply boards and electronic boards found in monitors) contain on average less than 100 g of gold per tonne. They are «low grade» boards. However, some boards (e.g. graphic boards, audio boards and network boards) contain a lot more precious metal. «high grade» boards contain between 400 and 500 g/tonne, and are found in laptops and mobile phones. «Very high grade» boards, containing more than 500 g/tonne, come from large mainframe computers or phone centres.

Once at the smelter, the different metals (gold, copper, silver, selenium, tellurium, lead, palladium, etc.) are recovered through complex processes. Due to the complexity of the technologies used and given that recovery practices can be highly polluting, the entrepreneur must sell the printed circuits to appropriate industries that can conduct recovery operations in an environmentally sound manner.

Batteries

Batteries and accumulators are not necessarily hazardous as they are. However their content can have an impact on the environment. Therefore, the enterprise must be careful to ensure the security of the storage area

before disposal. In a PC, the coin cell is often composed of a lithium anode. If some of the lithium is exposed, it may react with oxygen or moisture, generating heat and possibly hydrogen gas. A fire can occur during the shredding operation. A lithium coin cell can be recovered, after it has been fully discharged to eliminate potential reactivity, by shredding and gravity separation. The entrepreneur is therefore advised to resell these batteries to industries that possess the equipment and technologies necessary to recover them. However, some batteries do not have any value and the entrepreneur is responsible for having them recycled by a specialised industry.

Cables

Cables can be shredded before being sent to specialised industries or burned in a facility where every measure is taken to prevent the formation of harmful substances, such as chlorinated dibenzofurans and dibenzodioxins. Those cables (or cable residue) can be recovered by industries specializing in the separation of copper wires from their plastic sheaths. These industries usually use various physical means to separate these materials in order to obtain perfectly homogeneous pieces of copper and plastics.

CRT glass

There are two main industries that recycle CRT glass. First, there are the manufacturers making new CRT screens from recycled CRT glass. They often require the panel glass to be separated from the cone glass, so that they can proportion correctly the quantities of lead in the glass they produce. And then there is the lead-glass recycling industry. In this case, glass is sent to lead smelters, to be used as a fluxing agent in the smelting process. Then, smelters can recover the lead contained in the glass.

Tubes

Cathode Ray Tubes are made of a faceplate (containing lead or barium) welded to a cone glass by a frit. The tubes contain lead encapsulated in glass that can be released if the glass is broken. Therefore, the entrepreneur

is advised to leave the responsibility of treating tubes to specialised enterprises. Indeed, the staff carrying out the mechanical separation of glass must be protected from inhaling the dust released when the tubes are broken, because they may contain lead or barium oxide. Moreover, the fluorescent coating on the faceplate may present inhalation risks if they are handled in a dry state. This is why wet processes are often used to remove the phosphor particles.

CRT Electron guns

The electron gun of the CRT contains a small getter plate (about 1-2 grams including frame), and bears barium and barium compounds (barium oxide is considered as a harmful substance). During the shredding operation, the CRT screen getter can release harmful barium dust. Therefore, several countries require its removal. Once removed, the getters should be stored separately, away from any source of moisture since barium is a leachable and easily solvable substance. They must be sent to a specialised industry that can incinerate them in an environmentally sound manner. The electron gun itself can be sent to a recycling facility that can reclaim the copper it contains.

Flat screen monitors

According to a document issued by the OECD working group on waste prevention and recycling, entitled “*Technical Guidance for the Environmentally Sound Management of Specific Waste streams: Used and Scrap Personal Computers*” LCD screens can be sent to a smelter for recovery of non-ferrous metals on the condition that the smelter is equipped with flue gas cleaning systems (to minimise dioxin emissions), and prepared to carry out the separation or immobilisation of mercury. Flat panel screens should be sent for either recovery operation or thermal treatment at an environmentally sound and appropriately authorised incinerator with modern flue gas cleaning systems. When discharge lamps are removed, they should be sent to a specialised mercury recovery facility or to an environmentally sound and appropriately authorised hazardous waste incinerator with modern flue gas cleaning systems that guarantees the proper separation or immobilisation of mercury. The WEEE Directive

requires that liquid crystal displays of a surface area greater than 100 cm² are managed separately, as they are back lighted with gas discharge lamps containing mercury.

Pollution control and disposal

In a piece of computer equipment, some components cannot be recycled. These components, mainly plastics and resins containing flame retardants, must be burned or buried in an environmentally sound manner. However, in some countries, the burial of waste is prohibited. According to the Basel convention, these materials should preferably be burned for energy recovery rather than buried or incinerated without energy recovery. The incinerator or the combustion unit must be designed to limit the formation and emission of furans and dioxins and must be equipped with state-of-the-art flue gas cleaning systems. Ashes resulting from the combustion of materials, or materials that cannot be valorised “should be disposed of in an environmentally sound and appropriately authorised landfill”.



ANNEXES



Substances of concerns

Bibliography

Partners

ANNEX 1

SUBSTANCES OF CONCERN

Source: BASEL CONVENTION / OECD

Substances of concern: Antimony

Antimony is a component in lead solder. CRTs may contain antimony in the screen and/or cone glass.

Possible adverse effects: Antimony contained in the screen glass may leach out under certain land disposal conditions.

Substances of concern: Barium oxide

Barium oxide is contained in the getter plate of the electron gun of CRTs; some of the barium oxide from the getter becomes deposited on the interior surface of the screen and cone glass.

Possible adverse effects: Barium oxide dust can be released during the dismantling and handling of CRTs.

Substances of concern: Beryllium

There is a small amount of beryllium, in the form of a copper-beryllium alloy (typically 98% copper, 2% beryllium) in the motherboard, in the slots used for connection to daughterboards.

Possible adverse effects: Beryllium in a copper-beryllium alloy may be released as beryllium oxide dust or fume during high temperature metal processing.

Substances of concern: Cadmium

There is a small amount of cadmium in plated contacts and switches, and a very small amount of cadmium may have been used as a stabilizer in PVC wire insulation, which may have been used in a personal computer. Laptop computers often contain a rechargeable nickel cadmium (Ni-Cd) battery.

Possible adverse effects: the small amount of cadmium in plastic may be released in the form of cadmium oxide dust if the plastic is burned prior to or in the course of metal reclamation. Cadmium in plated metal contacts and switches may be released as cadmium oxide dust or fume during high temperature metal processing. Incineration may also result in releases of cadmium to the environment.

Substances of concern: Chlorine and/or Bromine

Organic halogenated (brominated) flame retardants and inorganic flame retardants (e.g. antimony chloride) may be present in the plastic in printed circuit boards and cases. There is chlorine in any PVC insulation of wires and cables used in a personal computer.

Possible adverse effects: Bromine in plastics as brominated fire retardants, or chlorine in PVC insulation, may recombine with carbon and hydrogen in various disposal or recovery processes that involve heat, such as combustion or plastics extrusion, to form other halogenated organic compounds of environmental concern, particularly the chlorinated or brominated dibenzodioxins and -furans.

Substances of concern: Lead

There is a substantial amount of lead in the CRT, as a rough average perhaps two to three kg in older models and 1 kg in new models, encapsulated in the form of leaded glass. There is also a much smaller quantity of lead in printed circuit boards in the CU, in the form of solder. Printers and miscellaneous peripheral devices will also contain a small amount of lead in solder. Some portable (laptop) computers contain a sealed lead acid battery.

Possible adverse effects: Lead in a CRT or printed circuit board may leach out of the leaded glass under certain land disposal conditions. Incineration can result in release of lead to the air as well as deposition of lead in the ash, which is then land disposed. The lead in a printed circuit board may also be released in the form of lead fume if the board is heated to facilitate harvesting of components, or in the form of fine particulate if the board is burned or shredded prior to metal reclamation. The lead in a CRT or a printed circuit board may be released as lead oxide dust or lead fume during high temperature metal processing, such as smelting.

Substances of concern: Lithium

Lithium metal may be present in a small battery on a motherboard.

Possible adverse effects: Lithium in a battery will be released if the battery is shredded with the circuit board to which it is attached. When released, it may react with oxygen and moisture, generating heat and potentially causing fire.

Substances of concern: Mercury

In large flat panel displays, a small amount of mercury may be present in a lighting device used to illuminate the screen.

Possible adverse effects: Mercury can be released from certain flat panel displays upon the shredding and subsequent handling of this equipment. Landfilling and incineration of flat panel displays can also result in the release of mercury to the environment.

Substances of concern: Phosphors

A phosphor coating, typically zinc sulfide and rare earth metals, are used on the interior of a CRT screen to convert the kinetic energy of an electron beam to light. However, cadmium sulfide has also been used in older CRTs.

Possible adverse effects: Cadmium in the phosphor coating of some older CRT screens could present an inhalation hazard to workers in CRT glass breaking operations. Cadmium can also be leached in a landfill environment.

Although these substances can present risks in recycling or disposal of used personal computers, it is important to note that some of these substances are present in personal computers for the purpose of lowering risks to human health during product use. These include the use of lead shields in CRTs to protect users from harmful x-rays and the use of flame retardants in plastics to reduce the risk of overheating and potential fires. There is no technical substitute for lead in the CRT glass.

Source: www.basel.int/pub/UserPCen.doc

ANNEX 2

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ANNEX 3

PARTNERS

UNESCO

Within the context of emerging technology-based knowledge societies, UNESCO supports initiatives, serves as a laboratory of ideas and fosters cooperation between stakeholders in order to reduce the reduction of the digital divide on an environmentally sound manner.

The Organization has been involved in several projects in the domain of computer refurbishment through its website, experts meetings, supporting initiatives by FAIR, Schoolnet Africa, etc. It also contributed develop capacity building tools such as the on-line (and CD-ROM) training on computer refurbishment, which is part of the Online Multimedia Training Kit.

Finally, UNESCO sets up several projects promoting IT based small businesses for local development. Considering the absence of training tools for entrepreneurs in the computer recycling area, it decided to set up a group of partners and develop such a tool, thus contributing to develop local capacities, creating small business opportunities while fostering international cooperation and shared experience in this domain.

UNESCO is also UN leading agency for the UN Decade for Education to Sustainable Development.

Additional information

UNESCO website: www.unesco.org

ADEME

The French Environment and Energy Management Agency (ADEME) is a public agency under the joint supervision of the French Ministries for Ecology, Energy, Sustainable Development and Spatial Planning, and for Higher Education and Research. It participates in the implementation of public policies in the fields of the environment, energy and sustainable development. The agency makes its expertise and consultancy skills available to business, local communities, public authorities and the general public and helps them to finance projects in five areas (waste management, soil preservation, energy efficiency and renewable energies, air quality and noise abatement) and to make progress with their sustainable development procedures.

Additional information

ADEME website: www.ademe.fr

HP

HP, the world's largest technology company, provides printing and personal computing products and IT services, software and solutions that simplify the technology experience for consumers and businesses.

For decades HP has worked to manage its environmental impact by adopting environmentally responsible practices in product development, operations and supply chain. The company strives to be a global leader in reducing its carbon footprint, limiting waste and recycling responsibly. Starting in 1987, HP's recycling programme now operates in more than 50 countries, regions and territories. The programme seeks to reduce the environmental impact of IT products, minimise waste going to landfills, and help customers conveniently and responsibly manage products at their end of life. In 2007, HP surpassed its goal of recycling half a billion kilogrammes (1 billion pounds) of its products and is well on its way to reaching its new goal of recovering a cumulative weight of 0.9 billion kilogrammes (two billion pounds) of products by the end of 2010.

In September 2007, HP launched a project with the Digital Global Solidarity Fund (DSF) and the Swiss Institute for Materials Science and Technology (Empa) to address the growing problem of electronic waste in Africa. This collaboration aims to both reduce potential health and environmental hazards caused by improper disposal of electronic waste and create jobs in disadvantaged communities. The initial phase consists of a pilot project in South Africa together with an analysis of existing practices in Morocco and Kenya. More information about this project is available at www.hp.eu/e-waste.

Additional information

HP website: www.hp.com

TIC ETHIC

TIC ETHIC is a consulting firm specialised in eco-technologies, as shown by its slogan: ICTs to promote ethic. Founded in 2005 by Benoit Varin, the firm employs consultants specialised in information technologies and environmental protection. Its team has already been working on the development of various EEE recycling plants, recycling programme and business development. TIC ETHIC coordinates the PC Recycling Programme composed by volume 1, volume 2 and a training programme for entrepreneurs. TIC ETHIC provides services in consulting, engineering for design recycling branch, technical assistance, audit, evaluation, feasibility studies, setting up, expertise and training.

TIC ETHIC organizes and takes part in numerous working groups related to sustainable development and new technologies. TIC ETHIC thematic seminars on sustainable development and ICT, bring together professionals of these industries.

Additional information

TIC ETHIC website: www.ticethic.com

EMMAUS/ Les Ateliers du Bocage

The association Les Ateliers du Bocage is specialised in integration into working life of new employees through Electric and Electronic Equipment (EEE) recycling. It benefits from 5 years of experience on this market and is sister-firm of the main French solidarity organization Emmaüs. Over 170 employees are working in several plants in France and in Burkina Faso. Deeply involved in the creation of an EEE recycling plant in Burkina Faso and local infrastructures in West-African countries, Les Ateliers du Bocage are searching for partnerships with retrofitted equipments exporters.

Additional information

Ateliers du Bocage website: www.emmaus-adb.fr

Emmaüs Solidarité Ouagadougou (ESO)

The association Emmaüs Solidarité Ouagadougou, ESO, founded in 1991, is composed of 11 groups in charge of various activities: farming, weaving and seam. It also handles training for peasants and computer, mechanics and seam formation to local youth.

ESO president, Emmanuel Siambo, relays the communication with African organizations. He is a valuable key for communication with local authorities and to deal with the possible problems for the project in Africa. The project has to integrate ESO from the very beginning.

ESO has developed a workshop specialised in computer recycling.



The purpose of this guidebook is to help develop the skills required to handle the growing flux of waste generated by the new and used computer markets for the benefit of the environment and public health. Problems generated by this computer waste are affecting the world in general and

developing countries in particular. It represents the negative side of the reduction in the digital divide in a world where one billion PCs were expected to be in use this year and one billion mobile phones were expected to be sold.

It also aims to support the emergence of new business opportunities. It should prove useful for NGOs and local development stakeholders in fostering small and micro entrepreneurships.

The guidebook is available free of charge online (www.ticethic.com/guide). In addition, its open license will allow interested parties to create versions adapted to local condition and particular contexts.



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