ICT Development and Education with Open Source in Zambia

Diplomathesis in Computer Science
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Abstract

This thesis contains three parts:

1. An Introduction to Open Source, for those who are not familiar it.
2. A Situation Analysis of the country Zambia with respect to its eduational system and the current situation of information and communication technology (ICT). In addition to research from books, this has been done with the help of qualitative interviews with professionals in the ICT sector.
3. A concept of how to use computers with Open Source software in Zambian high schools, as input for the current discussion on computer use in education.

Zusammenfassung

Diese Diplomarbeit enthält drei Teile:

1. Eine Einführung in Open Source, für diejenigen die nicht damit vertraut sind.
2. Eine Situationsanalyse des Landes Sambia, in Bezug auf das Bildungssystem und die aktuelle Situation der Informations- und Kommunikationstechnologie (IKT). Neben der Recherche aus Büchern wurde diese mit Hilfe von qualitativen Interviews durchgeführt. Interviewt wurden Sambier, die im IKT-Sektor tätig sind.
3. Ein Konzept zur Benutzung von Computern mit Open Source Software in sambischen Sekundarschulen, als Beitrag zur aktuellen Diskussion um den Einsatz von Computern in der Bildung.

Contents

1 Introduction

1.1 Preface

This thesis in computer science combines a number of topics: the country Zambia; information and communication technology (ICT); education; development cooperation; Open Source; and last, not least, social research as part of the analysis. The reader may wonder: how did all these things come together? Why are they all part of *one* thesis?

Computer science today[1] can partly be seen as the science of developing information and communication technology solutions for people - for working in offices, for business, artwork and leisure activities. Social sciences help to connect people and technology: sociology is used firstly to discover and elaborate the problem or the task, and secondly to aid in an interaction between the computer specialists and their customers when a solution is designed.[2] Education is needed to teach people to use the technology.

Computers are also a subject of development cooperation - bridging the "digital divide" between the more and the less technically developed is an objective of the United Nations World Summit on the Information Society, and agenda of many organisations.

Open Source now is, among other things, a computer science development model which has very social principles. It has brought up questions and new approaches on many levels and has gained significant momentum. Since Zambia, like many other African countries is in the process of building up its ICT sector, a natural question would be to ask in what way Open Source can be beneficial in this process. And as education is a key to any development, the potential of Open Source for education is of special interest.

Out of this -very short- roundup, many questions will arouse, from many different perspectives. A thesis that includes a range of topics also addresses a diverse audience: Zambians with computer and education background or concern; people in development cooperation; the Open Source community; and generally speaking, computer scientists, teachers and sociologists, and the students of these disciplines. One goal of this thesis is to create a common knowledge basis for all of these people. In this way, it can be seen as a collection of articles that can be read independently of each other:

- There is an introduction to Open Source to those who are not familiar with it (including its influence on society, the current development state in Africa and its applications in education.)
- There is an introduction to the country Zambia as background for anyone interested in the country (which mainly focuses on the history.)

[1] It used to be, not too long ago, that computers were only used by large organisations and in science.

[2] The part of exploring the area where technology is applied is called "system analysis", while the part of designing the solution is called "software engineering" - and both make use of social science methods.

- Proceeding from this general introduction, overviews of Zambia's education system and current situation in respect to information and communication technology are given. Answers about what is done with computers in Zambia, and what is projected for the future may be found here.

- In order to found this thesis on first-hand experience, the author conducted interviews with Zambians working in the ICT sector. A selection of these interviews is printed in this document.

- Quick readers may also jump straight to the concept for the use of Open Source in Zambian schools, which has been developed on the basis of the above preparations.

On the other hand, this thesis has the structure of a development process that is commonly used, not only in computer science:

1. A *situation analysis* of the subject area - the country Zambia and its education system. In addition to research from books, this has been done with the help of qualitative interviews with people from Zambia who work in the ICT sector. (Qualitative interviews are a method of social research which focuses on complete stories by individuals, rather than on large collections of comparable figures that can be used for statistics.)

2. The *design of a concept*: based on the analysis, a draft curriculum for Zambian secondary schools is given. The idea to create a concept for the use of Open Source software in education emerged during the course of the interviews. It contains material as input for the current discussion about computer use in the education system: a guideline on which steps should be taken, and a range of teaching methods and equipment choices that can be used.

Before concluding this preface, the term "ICT" should be defined more precisely[3]:

"Information technology (IT) or information and communications[4] technology (ICT) is the technology required for information processing. In particular the use of electronic computers and computer software to convert, store, protect, process, transmit, and retrieve information from anywhere, anytime." [Wikipedia]

Thus, in essence "ICT" means computers, software, networks, and telecommunications technology. It is used synoymously with "IT" (and to some, even the term "computer" means the same in the broader sense.)

[3] Other terms have been defined or explained where it seemed appropriate.

[4] In the original definition, the plural "communications" is used; however, since in most places it is used in the singular form, it has been used in the singular form in this thesis as well.

1.2 Introduction to Open Source

The following introduction is addressed at people unfamiliar with the Open Source phenomenon. The interviews conducted prior to writing this document have shown that this is, at the moment, still the case with most people in Zambia (and they will hopefully forgive me for taking note of it here.) The following topics shall be covered:

- What is “Open Source”?
- A short history of Open Source
- How is Open Source Software developed?
- What impact on society is projected for the introduction of Open Source Software?

Before the explanations start off, a word about terminology: The terms “Open Source” and “Free Software” are used synonymously by most people. In this paper, the term “Open Source” is used because it has become a well-known name. The difference between the terms is being overlooked. Among the people who are deeply involved in the Open Source or Free Software world, however, the terms do make a difference. A short discussion of the issue is given a bit further down.

“Open Source Software” is frequently abbreviated as OSS, or sometimes even as FOSS or FLOSS, meaning “Free (Libre) / Open Source Software”.

1.2.1 What is Open Source?

There are a number of aspects which need explanation to understand “Open Source”. These aspects are technical, legal, commercial, social and philosophical, all of which will be addressed briefly. A quick answer to the question “What is Open Source?” perhaps can be given by explaining its legal and philosophical aspects. To understand the social and the commercial aspects however, some knowledge about the history of Open Source is required beforehand.

Technical and Legal aspects The legal model of Open Source can be explained best by a comparison to the legal model of “traditional”, proprietary software[5]. It is linked closely to the technical foundation of how computer software is created: The basis of any computer program is a text in a programming language, for example C++. This text is written by computer programmers and is (more or less) human readable. It contains instructions how the program should behave, how it should calculate something or display text and graphics on the screen. This text is called “source code”, and this source code is then translated into machine language by a compiler program. The output of this process

[5] sometimes referred to as "Closed Source"

is the program, which can be run on the computer. The source code thus is essentially the basis of any software, and it can be read (and modified) by people.

In proprietary software development, the source code is kept secret from anybody outside the company which produces the software. Creating computer programs is very expensive, because it is a time consuming process, requiring programmers with college or university degrees. If anybody was able to read the source code of a program, say a word processor, another company might just make a copy of the code, extend it and create a new word processor which uses part of the original code. This other company would then sell a program which they did not produce entirely on their own, and they would save the investment made by the first company. Moreover, the new word processor would compete with the old word processor, reducing the first company's revenues. To prevent such misuse, the source code is kept secret and protected by copyright. Noone is allowed to use or modify this code.

The Open Source model now has a different approach. The idea behind it is that once something has been coded by a computer programmer, there is not really any need for another programmer to code the same thing again. Instead, programmers should help other programmers by showing them how they wrote a particular program. This would mean faster development in the entire computer world - but it is not possible with the legal model of proprietary software. A new model was created: the code of an Open Source Software includes a *license* which says that the code may be read and extended by anyone, provided that they allow anyone else to read and modify their extensions as well. Thus any extensions of code which is "Open Source" will also be "Open Source". No company can extend a piece of Open Source code and declare it their own, which would then prevent further Open Source extensions[6]. This implies also that Open Source Software *cannot be sold*. It is possible to create closed software that uses other open source software and then sell this closed software, but Open Source and its extensions must be published, and anyone must be allowed to use them freely. (It is still possible to earn money with Open Source, as will be explained shortly.)

Philosphical aspects This reveals the philosophical aspects of Open Source. One of them is that many Open Source developers regard the benefit of society as valuable. Richard Stallman, founder of the Free Software Foundation and author of the GNU Public License[7]wrote about the idealistic philosophy of Free Software in 1998:

[6]The legal aspects of software are as subtle as they are far-reaching: The code of the UNIX operating system, which was developed in the 1970s by the University of California, was orignially open. The license however did not include a clause which said that anyone making extensions of the code would also have to open their new code to anyone. The result was that companies like SUN, IBM and HP started developing their own proprietary versions of UNIX (which means they kept their changes secret from others.) These different versions became increasingly incompatible with each other, and this led to the decline of UNIX' importance.

[7]which is one of the most important Free Software / Open Source licenses

> "Every decision a person makes stems from the person's values and goals. People can have many different goals and values; fame, profit, love, survival, fun, and freedom, are just some of the goals that a good person might have. When the goal is to help others as well as oneself, we call that idealism. My work on free software is motivated by an idealistic goal: spreading freedom and cooperation. I want to encourage free software to spread, replacing proprietary software that forbids cooperation, and thus make our society better." [Stallman 1]

This idealistic view resembles the attitude of those belonging to the Free Software movement. Others simply think of Open Source as a better way of developing software. This view is pragmatic rather than idealistic, and the difference between these two aspects is essentially the difference in the terms "Free Software" and "Open Source". Richard Stallman writes:

> "The fundamental difference between the two movements is in their values, their ways of looking at the world. For the Open Source movement, the issue of whether software should be open source is a practical question, not an ethical one. As one person put it, 'Open source is a development methodology; free software is a social movement.' For the Open Source movement, non-free software is a suboptimal solution. For the Free Software movement, non-free software is a social problem and free software is the solution. [...] We disagree on the basic principles, but agree more or less on the practical recommendations. So we can and do work together on many specific projects."

1.2.2 History of Open Source

The history of Open Source is influenced to a great extent by the Unix operating system on the one hand, and the biggest supplier of commercial software, the Microsoft Corporation on the other hand. The internet then played an important role as infrastructure for the community-based software development of Open Source. The roots of Open Source date back as far as the 1960s, when computers and software were almost exclusively developed in the United States. With the rise of Linux and many other Open Source projects, the development has spread to many countries across the globe.

"In the early days of computers, all software was open source and free." (translated from [Grassmuck, p. 202]) Even in the commercial computer world, the source code was publicly available, simply because software was not yet an independent market. Software and computers were then only used by experienced programmers, not by everyone else like today. These users would write the programs themselves according to their needs.

There were no distinct sotware companies. Instead, software was produced by the computer manufacturers, and was delivered in combination with the hardware. Then in 1969, one of the big computer manufacturers - IBM - was forced by the U.S. government to unbundle their computer and software products. The intention was to enable other companies to produce software commercially. The software market developed soon, and as software became a product which was sold to customers, its source code had to be protected from competitors.

Microsoft and the PC The software industry experienced a major push when IBM invented the Personal Computer in the early 1980s. It was probably more of an accident that IBM published the architecture of the PC: other companies were now able to produce PCs as well, and the competition which arouse led to declining prices. Computers became affordable for small business and ordinary people, and all of them became customers for software products. There were two winners in this process: Intel produced the processors which, at that time, ran in every PC. Microsoft on the other hand managed to obtain a monopoly for the operating system of the PC. Its founder, Bill Gates, had little love for the idea of free software: In 1976 he published his view in a short "Open Letter to Fellow Hobbyists"[8] in which he accused fellow programmers of theft and stated that sharing source code would prevent the development of quality software. By coincidence, his company was chosen for the PC's operating system: MS-DOS[9]. Microsoft talked IBM into supporting only software that ran on MS-DOS, and the competitor Digital Research was soon put out of business. Microsoft's strenght lay not in producing better software but in clever strategy: they knew how to put pressure on hardware vendors (a similar example is the creation of a new license model by which PC vendors had to pay a fee for *every* new PC they sold, no matter if MS-DOS was installed or not.) Another strategy was to bundle operating system and application software. With the release of MS Windows, Microsoft's possibilities of selling applications increased even more. Office programs like Word or Excel were established as standards before the competitors were able to gain a significant market share. Many small programs were integrated into Windows so there would be no market for others companies to sell their alternatives any more. By granting special licenses to schools and universities, Microsoft then was able to control which technology future software developers and computer users would learn about.

Unix The Unix operating system developed in a different area - it spread to the PC world only later, with the creation of BSD Unix and Linux, and when Microsoft used

[8] http://www.blinkenlights.com/classiccmp/gateswhine.html
(The internet location of Bill Gates' letter seems to be changing frequently)

[9] Microsoft bought MS-DOS from a company named Seattle Computer. The vendor of the competing product, Digital Research accused Seattle Computer of having stolen the code of their CP/M operating system, thus having based MS-DOS on CP/M.

large portions of the FreeBSD-code in Windows [Grassmuck, p. 299]. At first however, Unix began as an operating system developed at the Bell Labs of AT&T. Its basis was the Multics operating system, which had been developed in a joint effort by AT&T, the Massachusetts Institute of Technology (MIT) and General Electrics in 1964. The design of Multics was to incorporate all functions of an operating system in a single program, the "macro-kernel". This architecture was not successful, and two programmers at the Bell Labs, Ken Tompson and Dennis Ritchie created a new operating system with a different approach: Unix. The design of Unix was a collection of many small programs, each only completing a single task. These small tools then could be combined to accomplish more sophisticated tasks.

By 1971, Unix was the standard operating system of the huge AT&T company. AT&T was under scrutiny of the U.S. anti-trust authorities (because they had a monopoly over the telecommunication sector) and was not allowed to sell an operating system. Instead, they gave it to the universities for free. This enabled a lot of people to write their own programs and extensions for Unix. In 1974, the University of California at Berkeley started developing their version of Unix, to be used for research and teaching. In 1977, the Berkeley Source distribution (BSD) of Unix was compiled and released to the public.

In parallel, the networking of computers had developed. Networking became closely linked to Unix: On the one hand networking enabled many Unix programmers to share code and learn from each other. UUCP (Unix-to-Unix-Copy), developed in 1979, was the first method to copy files from one computer to another via a telephone line. Based on UUCP, the Usenet was created. The Usenet is an online news-system where people can post messages, to be read by anyone interested in the same topic. The Usenet soon had hundreds of groups, discussing a broad range of topics. And as the Usenet was computer-based, computers and programming were naturally discussed to a great extent. On the other hand, Unix was used for network infrastructure. In 1983, Unix was chosen as standard operating system for the ARPANET, out of which the internet developed.

When in 1984 AT&T was split up by the U.S. government, the newly formed sub-companies were able to sell Unix, and the Unix code became proprietary. The Berkely Unix came under pressure because it contained a lot of code from the original AT&T Unix, and to use it people would have had to pay an expensive license fee. The only way around was to re-code all parts which belonged to AT&T. Berkeley programmers achieved this by 1989 and published the code for free. In 1992, a fully functional Unix for the 386 PC was released as free software.

GNU and Linux During the events of Unix variants becoming proprietary software, a change in culture among computer programmers took place: when software was still open, programmers were used to making changes to their specific needs. If they found a problem, they would simply fix it themselves, or write a new program for the feature

they wanted. To do this, they needed access to the source code of existing software. With proprietary software now this was not possible any more. Programmers at companies had to sign nondisclosure agreements which prevented them from giving source code to their fellows of other institutions.

The MIT computer scientist Richard Stallman had a particular grudge against this new attitude. He chose to devote his work to no lesser goal than to create a free software project that would eventually make all proprietary software obsolete. To do that, he quit his job at MIT (because else, all software written by him would have belonged to the university) and started the GNU[10] project. In essence he wanted to re-write the entire Unix system[11]. He started with his editor "Emacs" and the GNU C Compiler[12], and invited others to join his efforts. The Free Software Foundation (FSF)[13] was created in 1985 to promote the GNU project and free software in general. Funds came by selling copies of programs like Emacs[14] and by donations (today's list of sponsors of the Free Software Foundation include many open source companies, as well as large IT corporations like IBM, HP, Novell and Cisco[15]). In 1990, Richard Stallman "received a $240.000 MacArthur 'genius' grant which allowed him to devote all his time to the FSF." [QinetiQ, p. 2] Many programmers voluntarily wrote programs, each representing exactly the same functionality like the original Unix components. There was a tasklist of all the things which still needed to be done. To prevent other companies from incorporating GNU source code into proprietary software (as it was done with BSD Unix), all GNU code was licensed by the GNU Public License (GPL)[16]. The GPL was created in 1989 by the GNU project's lawyers.

By 1990, every component of Unix had been re-written except for the kernel - the "kernel" is the central component of the operating system and controls the computer's resources: memory, files and processes. However, before the GNU project finished writing their own Unix kernel, another person had written a free Unix kernel all by himself. That person was the student Linus Torvalds from Finnland. He wrote a Unix kernel, called "Linux" for the 386 PC, which was to become so widely used that today "Linux" is almost a synonym for Open Source. It was based on Minix, which had been developed by the Dutch computer science professor Andrew Tanenbaum for university teaching. Linux Torvalds published his kernel on the internet, inviting other people to help him (like Stallman had done with the GNU project.) To his own surprise, a lot of people became interested - today, hundreds (if not thousands) of people are involved in the ongoing

[10]The acronym GNU stands for "GNU's not Unix" - a joke which is most likely to be understood by computer scientists (the acronym is part of itself.)

[11]which was a mammoth task: The 1992 BSD-Version of Unix for example had 18.000 files.

[12]In those days, text editor and compiler were the most important tools for creating software.

[13]http://www.fsf.org

[14]Even though the GNU software is "free" in the sense that anyone is allowed to copy the source code and work with it, the GNU project did need money to live, and people were willing to pay a price for the free software .

[15]The list can be viewed at https://www.fsf.org/donate/patron

[16]The GNU License can be viewed at http://www.gnu.org/licenses/gpl.html

development of the Linux kernel, contributing their work via the internet. To prevent confusion and a branching into different incompatible versions of the Linux kernel, it is still Torvalds who decides which changes should become part of the kernel. Eric Raymond, who coined the term “Open Source” wrote: “In fact, I think Linus’ cleverest and most consequential hack[17] was not the construction of the Linux kernel itself, but rather his invention of the Linux development model.” [Raymond]

As a kernel alone cannot not be put to any use, the Linux community used the Unix software developed by the GNU project to create a fully functional operating system. The GNU Public License was also used for the Linux kernel to keep it free software. In 1994, version 1.0 of GNU/Linux was released. From this point of time, Linux gradually became famous - and profitable as well. Beginning in 1993, some commercial vendors like SuSE, Caldera and Redhat began to compile their Linux distributions: selling diskettes and CDs at low prices, bundled with books and support service. By 1995, there were 500.000 people using Linux. 1996, the number had risen to 1.5 million, 3.5 million in 1997 and 7.5 million in 1998. Today, there are an estimated 30 million installations of Linux worldwide (translated from [Grassmuck, p. 229].) “In particular we are starting to see significant growth coming from Eastern Europe, the former USSR, China, the Indian subcontinent, the Pacific Rim and the poorer third world countries.” [QinetiQ, p. 5]

There are now many different Linux distributions. The biggest one in Europe is SuSE, in America there is Red Hat, and Turbo Linux had grown large in Asia. But there are many others, and each has its own special features. Debian Linux for example is created for high stability and is used mainly by software developers and universities. It does not have a fancy graphical setup tool like for example SuSE, which is designed for home use. Skole Linux has been developed especially for school use, and Knoppix is a special Linux which does not have to be installed on a computer to run: By inserting the CD in a computer, it will start without touching the computer’s harddrive.

1.2.3 How Does Open Source Development Work?

Organisation Open Source Software is created in a different way from a commercial software product, where management issues a goal, choses a project manager and a developer team. A traditional software project has a deadline by which the code has to be written, tested and released to the public, and is marketed with a large advertising budget. An Open Source project on the other hand is typically initated by a computer programmer for personal reasons: he or she may face a computer problem and attempt to solve it. To quote Eric Raymond: "Every good work of software starts by scratching a developer’s

[17] A “hack” is a computer programmer’s solution to a problem; “hack” implies an ad hoc idea that is blessed with genius. A “hacker” is a person who finds computer problems and their solutions as part of his job or in his spare time. It used to be a term associated with respect, until “hacker” became synonymous with “computer criminal”.

personal itch" [Raymond] The Linux kernel was started by an individual, as was the GNU project, and many others[18].

When these individuals choose to publish their efforts on the internet, they may attract others who have experienced the same problem. As in many Open Source projects, soon many people will contribute to the project by writing additional features or by testing the existing software and reporting errors. When the number of people involved grows, there are some who put in a lot of quality work. These people then form the **core team**, while many other people might just put in ideas now and then. The core team will stay small enough for efficient teamwork. The **developer community** of all the contributors can grow to hundreds of people. The Debian Linux project for example has a community of about 500 developers, the XFree86 project[19] has 600. (Yet it is generally difficult to get exact figures about the community size: some people might only write one bugfix[20] of three lines of code once in their lives, and never contribute again.) The main “coding” of the software is done by the core team. Their job is also to perform administrative tasks, such as coordinating sub-projects and groups of the community. The tasks completed by the community are mainly testing and fixing the software and writing documentation, or translating documentation into other languages[21]. The community members may also propose new features to be added, and everyone can enter the discussion whether or not to accept these new proposals.

The final decisions about the future of an Open Source project are usually made by the core team. Decisionmaking comes in a variety of flavours. In the Linux kernel project, for example, Linus Torvalds is advised by five or six trusted lieutenants, and in the end the decision will be up to him. This has prevented a number of incompatible kernels to spawn. In the GNU project, it was Richard Stallman who created a list of things to be done, so this project was planned from the top. In the Apache webserver project, the core team consists of some of the initators and some representatives of large corporations like IBM or Siemens. The decisions are made by democratic vote - though decisions are hardly made if there is no consensus. It is also ensured that the companies cannot push or prevent an option, and they can’t take over the core team.

It may happen that too much dissent occurs in an Open Source project. If this is the case, projects often split up into independent ones - if many people in an Open Source community wish for a different route, there is no way to hold them. This practice also prevents that communites grow too large.

[18] The World Wide Web for example was initated by Tim Berners-Lee in 1990, who wanted to bring order to the mass of information produced at CERN, a European physics center.

[19] a graphics library for Unix

[20] A “bug” is an error in a computer program. A “bugfix” is a change in the code that fixes the error.

[21] A documentation is very important for any software, for both people using the software and for developers who enhance it. And while it is easy to find good coders, it is hard to find people who make good documentation.

Means of Developing Software projects often consist of hundreds, if not thousands of files. These files are worked on by many people across the globe. These people need to communicate about their work, and the work itself has to be in a place that everyone has access to. Moreover, it has to be ensured that no confusion occurs with so many people working on the same software (imagine a hundred cooks from five continents preparing a humongous meal with a thousand pots and pans over the telephone.)

For communication, a development community uses email and newsgroups (newsgroups are internet message boards where everyone can leave their opinion to be read by others.) The communication system can be somewhat more complex - for example, upon change of a file, the person who is ultimately responsible for that file may get an email notification. Since for most projects the premier communication method is the internet, the developers may never have met personally. But there are also projects that do have funds for telephone calls and travels to meetings and conferences.

The source code of a project needs to be accessible by all members and is thus stored on a public internet server. To coordinate software development with hundreds of files and large developing communities, the code is stored in a database which keeps track of all changes, and who committed these changes. Such a system is called "Versioning System". A commonly used one is *CVS* (Concurrent Versions System), which itself is free software. With CVS, every developer can get a copy of the latest version of the code, make a modification in some file, test his modification and then send the changed file back to the database. Only when two people change the file at the same time, there may be a conflict - which these developers will notice at once, and solve the conflict.

An Open Source project then needs a website, for advertising the software and for offering a download to the public. Here, anyone will find the latest news about the project, the source code and the compiled software for a range of operating systems, the so-called "binaries"[22]. Usually there is also documentation offered, and some projects have online support. Here users may enter questions that will be answered by other users or the developers.

There are some websites, called "mediators" that host many Open Source projects. The most well-known one is Sourceforge. A mediator provides everything that is necessary for a project: a CVS database for keeping and updating the source code, a newsgroup for the developers, a website for each project and an ftp server for offering downloads of the binaries.

[22] A "binary" is a file which can be run as a program on a computer. It is the output of a compiler, which translates the source code (that was written by a human) into machine language.

For different operating systems, there need to be different binaries A binary for Linux for example can't be run on a Windows computer, and vice versa. Even the source code differs - such different versions of source code for various operating systems are called "portations")

How does an Open Source project make money? Since the software which is created by an Open Source community itself is free, the question arouses "Do these people do all this work in their spare time, just for the benefit of society, or for ... fun?" The answer is yes and no. Certainly, the voluntary motivation is high (some details about this will be given shortly), but creating free software does not mean that you can't do business with it.

Traditional commercial software is sold as a product. You can go into a shop and buy a program, and you get a CD with the compiled program (not the source code), and a license to use it (but not copy it for your friends.) The key now to understanding why "giving software away for free" does not imply that you can't make money is to see software not as a *product* but as a *process:*

Using software does not stop when you have acquired the installation CD. After getting the software, it needs to be installed (and in a company with a large network and many employees, installing new software can take weeks.) Then people will start working with the software, but before they can do quality work, they have to get used to the new software. They may need some weeks of training, for example. Apart from getting used, people may also find errors in the software, or just complain about features which they don't like. In this case, the software may need to get updated, which may be done either by the company that produced the original software, or by others. This *process of working with the software* can take months or even years - until management chooses another type of software, or the market brings a new generation of computers and software.

Thus, aside from writing the software itself there are a lot of other services that can be offered: teaching workers and management of institutions which use a software, writing books and documentation, helping people to install the program on their systems and to configure it to fit their business, helping when problems occur, and programming special features that extend the ordinary functions of the program. Jim Kingdon, who has worked at Cygnus Solutions and the Free Software Foundation wrote an article about the Open Source business model in 1997: "Five successful ways of making money are by providing custom work for ports and new features, support contracts, training, consulting/customization, and telephone support." [Kingdon]

In contrast to companies that sell proprietary software as a product, Open Source companies work as service providers. Instead of selling a product once, they give the product for free and make a long-term deal with the customer. And generally, the need for service will require larger expenses than aquiring a license for software (even proprietary) anyway. Gerhard Wohland, a German business consultant wrote in his study about failures of IT projects in corporations that the investment in human resources training and business re-organisation should be four times higher than the investment in hardware and software.

Free software has moved from the idealistic beginning in the 1980s into the business world, which is adapting Open Source practices:

> "Free Software companies that were founded in the first half of the 1990s, often by students, were built on idealism and a good idea. The managers of these companies were beginners as well. [...] Today, knowledge about business plans, evaluations and marketing are essential requirements for success. [And he quotes Rudolf Strobl, founder of the German Linux Magazine:] 'The decisive factors for success used to be technical know how and a lot of enthusiasm. Today, I'd say that the keys are good management capabilities, and ideas and capital are becoming increasingly important.'[23]" (translated from [Grassmuck, p. 347])

The software industry which uses Open Source has proven that they are doing business only too well. Volker Grassmuck assumes that there is in fact a danger that the Open Source movement will meet a fate similar to many social movements before, because of its success and because traditional companies adopt aspects of the free software model. [Grassmuck, p. 249] Open Source companies experience exorbitant growth rates: "A study by the investment broker WR Hambrecht + Co in May 2000 had the result: '[...] The revenues from the market for Linux-products and services will shoot up with an annual growth rate of 90 per cent, starting from $2 billion in 2000 up to $12 billion in 2003. [...] we consider these estimates to be only the beginning.' " (translated from [Grassmuck, p. 338].) Companies like IBM, Intel, Dell and Compaq invest millions of dollars into Linux startups like Red Hat and SuSE. SuSE was bought by Microsoft's competitor Novell for $210 million in November 2004. And the Open Source company Red Hat bought the Open Source company Cygnus for $674 million in November 1999, just after their initial public offering (IPO) at the stock exchange in August of the same year had turned them into a $3 billion company.

Social Motivations of Open Source Workers Apart from making money, however, there is something else that keeps Open Source projects alive. It is the idealistic motivation of people like Richard Stallman, or the enthusiasm of an engineer, like the "hacker" Eric Raymond, whose premier concern is to produce a well-designed solution to practical problems. Then it is the strange power of computers that keeps programmers fixed to writing code until they fall asleep with their heads on the keyboard. In addition to these personal motives there is also the community factor: the history of Open Source shows that it is the good feeling of producing something large together with a lot of people that gives many a sense of responsibility. And being recognized by the community as a good coder or a special personality is the biggest reward. Some people even go as far as to consider the promise of money as hazardous for the true Open Source spirit.

[23] http://wizards-of-os.org/index.php?id=438 (in German)

1.2.4 Open Source Products

Before turning our eyes on the impact of Open Source on society, it is time to introduce some of the more important Open Source projects. There are many websites which supply Open Source Software. The most common places are Freshmeat and Sourceforge. A list of web addresses for all the named products is given in the appendix.

- Operating System Software:
  - **GNU/Linux:** the most prominent Open Source Software. As an operating system, it is used on servers, IT infrastructure (e.g. firewalls, routers) and Desktop computers. As noted before, there are many different Linux distributions, and Open Source communities in a number of countries have compiled "their" Linux distributions. There are Linux distributions for special purposes, e.g. for schools, higher education, home use, IT infrastructure, file and email servers, digital image and sound processing, to name a few.
  - **XFree86** is a free version of the X Window system, which is a "windowing system for bitmap displays. It is the standard toolkit and protocol to build graphical user interfaces on Unix." [Wikipedia] XFree86 is used on all Linux and most Unix versions.
  - **KDE** ("K Desktop Environment") and **Gnome** are the most well-known and sophisticated Desktop managers for Unix and Linux[24]. Gnome is part of the GNU project. KDE is developed as a separate project (and has produced a wide range of applications, such as the web browser "Konqueror", and even some educational software)
- Infrastructure / Server Software
  - **BIND** (Berkeley Internet Name Domain) "is the de facto standard DNS[25] server for the internet."
  - **Apache** is the most commonly used webserver[26] worldwide.
  - **Squid** is a proxy server[27] which is used by large Internet Service Providers.

[24] When working with Linux, KDE or Gnome are responsible for moving your windows around, for offering menus to configure your system and for the general appearance - KDE "looks different" from Gnome. Both make use of the XFree86 library.

[25] DNS, the Domain Name Service is necessary to find a computer by its name. By DNS, the name (such as "www.bind.org") is converted into an internet addresses, the so-called "IP-address" (which at the moment is a sequence of four numbers, e.g. 201.133.45.199)

[26] A webserver is a program that distributes web pages across the internet. Typically, webservers are used at internet service providers to "host" websites for many customers. The University of Zambia for example has a website, which is hosted on the webserver of the ISP Zamnet.

[27] A proxy server keeps copies of often-used webpages; if a web page has been stored in the proxy server and someone wants to access it again, the page is retrieved from the proxy server instead of reloading it from a remote place in the internet. Often used in conjuction with firewalls (those are computers that protect a network from unauthorized intrusion.)

  - **Sendmail**, developed by the Berkeley University, handles 90% of the world-wide email traffic.

- Software for Linux / Windows interoperability

  - **Samba** enables Windows computers to use Linux file- and printer services
  - **WINE** enables Linux computers to run Windows software
  - **rdesktop** enables a Linux computer to access a Windows Terminal server (which means that Windows applications that run on a Windows server can be used from a Linux client)

- Software development tools: the GNU C Compiler, the programming languages Perl, PHP and Python; the Concurrent Versions System (CVS); the text editor GNU Emacs; and many others

- Database

  - **MySQL** is a relational Database Management System, which is stable and fast. It is frequently used in combination with the programming languages Perl or PHP and the Apache web server for maintaining dynamic websites.

- Desktop Software

  - **Mozilla** is a web-browser project which descended from the Netscape browser (Netscape chose to open its source code when Eric Raymond published "The Cathedral and the Bazaar", in which the Open Source community model is explained.) Today, the project has a modern browser (Firefox) and an email client (Thunderbird.)
  - **Open Office** is the largest Open Source project in the world and over 30 million downloads of the Open Office desktop software have been made. It has been derived from the Star Office suite, which was bought by Sun Microsystems (and which is now also Open Source.)
  - **Tex / Latex:** the Tex package was created by the computer science professor Donald Knuth of the Standford University, and is used mainly to write academic publications and books (like this one, for example.)
  - **Gimp** (GNU Image Processing) is a digital image processing software, which has gained some maturity (and whose layout is similar to Adobe Photoshop)

1.2.5 Impact on Society

Governments of many European and American governments have conducted extensive research on Open Source Software (OSS) in the past five years. The British Government has carried out several studies - the two main papers are the “Analysis of the Impact of Open Source Software”, written by the private defense technology company QinetiQ in 2001, and the case study “Open Source Software Trials in Government” by the Office of Government Commerce (OGC) in 2004. Their findings shall be summarized here as an example. There is a list of similar reports that were prepared in other countries, e.g. in the U.S., in Canada, Germany, France and many other European countries, and by the European Union [OGC, p. 20/21].

The quoted reports advise the British Government in two ways. One is if and how Government should influence the adoption of Open Source in the country, for example by encouragement or by funding research. The other is more practically if and how Open Source Software should be used in Government institutions and offices. The reports consider *Future Trends of Open Source, Advantages and Disadvantages of its Adoption* and analyze *trials of Open Source Software* in several governments institutions.

A discussion of pros and cons of OSS for Zambia is given at the end of the Situation Analysis, in the Summaries and Conclusions (see 2.5.3.)

Future Trends of Open Source [OGC] separates Open Source Software (OSS) into “three main potential areas of implementation - on servers, desktops and business applications”:

- “OSS server infrastructure products, generally based on Linux, are now perceived by the market as mature, gaining increasing acceptance, and delivering significant value for money opportunities.” [OGC, p. 3] And [QinetiQ, p. vi] estimates that “within five years, 50% of the volume of the software infrastructure market could be taken by OSS.”

- “OSS Desktop products (including desktop platforms such as Linux, and ’office’ personal productivity suites[28]) are developing but there still has been little significant widespread implementation, though these are currently starting to be rolled out in public sector bodies in other European countries.” [OGC, p. 3] The QinetiQ report compares Open Source alternatives to the market leader Microsoft’s products Word, Excel, Powerpoint, Internet Explorer and Outlook and finds the Open Office products generally to be mature and comparable in features. A drawback is that the import of the Microsoft file formats does not work all the time - which is due to “the complexity and limited docutmentation of Microsoft’s file formats” [QinetiQ, p. 27]

[28] such as Microsoft Office or Open Office

- "OSS Business Applications generall are still immature, and the scope of business applications available as Open Source software is limited. Those applications that do exist as Open Source are currently more appropriate for small or medium-sized businesses than for large public sector bodies, as they generally lack 'industrial strength' ". [OGC, p. 3]

Advantages and Disadvantages of Open Source Both reports list a spectrum of advantages and disadvantages, which can be associated to various areas: impact on society, on business using the software, then influence of the Open Source development model on the quality of software, and the process of software development itself.

- **Society (Advantages)**
  - *Interoperability:* Open Source projects aim to be compatible with proprietary software. The Open Office suite for example aims for the capability to process documents that have been created with Microsoft Office. A benefit of interoperability is noted by [QinetiQ, p. vii]: "many of the Government's risks arise from over-dependence on proprietary protocols and data formats, for interoperability can be controlled by the selective use of open data standards. [...] The Government can develop its own standards for use within communities-of-interest (e.g. MOD, Health etc.)"
  - *Use in Research:* "Open Source is an obvious subject for projects in Universities" [QinetiQ, p. 7] - for one, because it is the nature of students to take a closer look at the source code of programs and to develop new things, an then because the Open Source model of software development fits the unbound status and free attitude of researchers.
- **Business and Institutions Using Open Source (Advantages):**
  - *Lower Licensing Cost:* "Although, in reality, software licensing costs are not a major part of the Total Cost of Ownership (TCO) of IT, the attraction of the software being free should not be underestimated." [QinetiQ, p. 7] This is especially the case in developing countries where expensive corporate software licenses for many computers may be unaffordable.
  - *Supplier Independence:* "If OSS is used then the source is already available to the purchaser (as well as the wider community) and Government could simply take that code to a new supplier, should the original supplier disappear or withdraw support for whatever reason." [OGC, p. 7]
  - *Avoidance of proprietary lock-in:* Another risk posed by proprietary software is that companies like to design their various products to be dependent on

each other, which means buying one of them implies having to buy the others as well. “OSS tends to be written to be independent of any other related product.” [QinetiQ, p. 7]

- *Portability:* “Even where a particular platform is not currently supported, the open availablility of the source code allows the community to port that software to a new platform[29] relatively quickly. Platform independence gives the purchaser a wider choice of hardware in any procurement." [OGC, p. 7]

- **Business and Institutions Using Open Source (Disadvantages)**

  - *Uncertainty about the future:* though Open Source software has grown too large to be just a hype, it is hard to predict in which areas it will grow even further. This is not a disadvantage of Open Source itself but it comes with any kind of new possibilities. In order to make strategic decisions, it is however necessary to know what “everyone else” is going to use in the future.

  - *Negative Perceptions of Open Source:* Although “most of these perceptions [by senior managers] have little actual substance, it will require lots of additional publicity [...] to overcome them.” [QinetiQ, p. 9]. Negative perceptions include (quoted from [QinetiQ, p. 9]):

    * Senior managers are likely to equate “free” with “unreliable”.
    * There is no commercial organisation you can sue if something goes wrong.
    * Because I don’t pay the software developer I don’t have control over them.
    * Because the developers are motivated by recognition rather than by money, they are unpredictable; for example, they might rush off and work on a new, more exciting Open Source project.

  - *Difficulties in identifying appropriate OSS applications for particular business problems:* Because OSS is not advertised in quite the same way as is proprietary software, public sector bodies may not be aware that a particular OSS product is available to meet their needs. [OGC, p. 8]

  - *Lack of experience and support for migration from proprietary software installations to OSS:* “Purchasers must be able to integrate OSS with their existing installed base and must understand how to migrate from a single supplier product to a more diverse product set.” [OGC, p. 8] This situation is certainly true for many OSS projects; some however are marketed by large companies, like for example SuSE by Novell, or Red Hat that do provide support.

[29] a platform is usually a specific combination of a computer type and an operating system - for example, “Windows XP on a PC” is a platform, “Debian Linux on a Sunfire Server” another.

- *OSS lags behind in support for new hardware:* "Largely this is a result of the hardware suppliers not releasing new drivers to the OSS community on time. But, as with the issue of maintenance and support, that problem is diminishing as the hardware suppliers themselves begin to use and market OSS on their platforms." [OGC, p. 8]

- **Quality of Software (Advantages)**
  These are of advantage to society and business as well.

  - *Large developer community:* "We would estimate that there are many tens of thousands of active Open Source developers; hundreds of thousands of active beta testers[30]; and a non-commercial user base of about 5 million Open Source supporters (and many more millions of users). [QinetiQ, p. 6]
  - *Attraction of experienced developers:* "The Open Source community attracts very bright, very motivated developers, who although unpaid, are often very disciplined. In addition, these developers are not part of corporate cultures where the best route to large salaries is to move into management, hence some Open Source developers are amongst the most experienced in the industry." [QinetiQ, p. 6]
  - *Reliability:* Because security leaks are found and patched quickly by many testers, "much OSS becomes highly robust at a surprisingly early stage of its development, and mature Open Source products are setting new industry standards for bulletproofness." [QinetiQ, p. 8]
  - *Fast Updates:* The large number of people participating leads to quick responses to user requirements, and quick update cycles: "The upgrade cycle for Open Source is usually much faster than the typical 12 - 18 months cycle of commercial products." [QinetiQ, p. 8]

- **Quality of Software (Disdvantages)**

  - *Quality of Documentation:* "Documentation can be idiosyncratic [i.e. non-understandable by non-technical people] or sometimes non-existent. Many OSS developers are primarily motivated by software development rather than producing documentation which is expected by commercial buyers." [OGC, p. 8]
  - *Ease-of-Use Features are Implemented Later:* Since there is no funded product development budget, OSS "products" tend to get ease-of-use features and

[30] A "beta version" is a software release that has not been tested sufficiently. A "beta tester" then is a person who tries to find bugs in the software (by using it) and reports them to the developers.

user-oriented documentation significantly later in their lifecycle than commercial products.

- **The Process of Software Development (Advantages)**
  - *Ease of "Crossing the Chasm":* When products fail to establish a sustainable market share, commercial companies have to push the product with capital - or they drop it to cut losses. Open Source products on the other hand can cross the chasm because they have a "zero cost base [...] as long as the group of developers maintain their interest they can keep on going." [QinetiQ, p. 6]
  - *Well written code:* "Open Source is often better structured and with better program documentation than commercial software - after all, everyone can see an Open Source developer's code so personal pride (and the need to maintain the respect of one's peers) usually ensures it looks pretty. Indeed large, geographically dispersed teams can only work well if the software design is highly modular" [QinetiQ, p. 9]
- **The Process of Software Development (Disadvantages)**
  - *There is no marketing budget to push the product:* An OSS project can only rely on its developers and on users and software magazines finding the product interesting. A good project thus may not find a large group of users and not be developed any further.
  - "Open Source developers tend to be very passionate about technical issues. Consequently, without a project leader with good people skills an Open Source project can break up in acrimony." [QinetiQ, p. 7]

Open Source Software in Public Institutions [OGC] states that Open Source has been used by overseas administrations to a greater extent than in the U.K. Their report lists[31]

- The city of Munich (which is migrating 14,000 desktops to a Linux platform, and is expected to complete by 2009)[32]
- The cities of Bergen (Norway) and the City Council of Barcelona (Spain)
- The region of Extremadura in Spain (whose intent was to overcome the region's peripheral situation, and has introduced internet as public service and stimulated technological literacy; currently, over 100,000 users are connected)[33]

[31] and there are many more case studies of European institutions listed at http://europa.eu.int/idabc/en/chapter/470

[32] http://europa.eu.int/idabc/en/document/3223

[33] http://www.linex.org/linex2/linex/ingles/index_ing.html

- The French Ministry of Equipment (which is replacing 1500 office and infrastructure servers with Linux servers)
- The Indian Department of Information Technology (which has developed a strategy to introduce Linux and OSS as de facto standards in academic institutions)
- The People's republic of China (which plans to install at least 200 million copies of an Open Source-based desktop solution throughout the country, following an agreement in 2003 between Sun Microsystems and the China Standard Software Co. Ltd.)

The report then lists a number of British public institutions of varying size (up to 5,000 users) that tried Open Source. Most of them attempted to replace Windows Desktop computers with Linux and Open Source office software, or they attempted at streamlining their IT infrastructure (i.e. changing the structure of many servers with mixed operating systems to having less and more powerful servers, all running Linux.) Most of these trials were successful, which means that the new system was accepted by the workers after a training period. The Desktop replacement generally kept 10 - 20% of Windows machines, because some "power users" need to work with Microsoft Office, or because the exchange of data with other institutions requires the use of Microsoft file formats. The report notes that in some cases there was resistance against the change. This can be regarded as normal - when people are used to working with a system, they fear that the new system may not work as well, or they may not be inclined for undergoing training and adapting to new work routines.

On the list of the Europen Union, there are also many reports on the use of **Open Source in education**. In this paper, the use of Open Source on education is discussed within the draft ICT curriculum for Zambia (see section 3.6.6 on school software.) The concluding chapter in this introduction now shall be a short roundup of Open Source activities in Africa.

1.2.6 Open Source in Africa

Open Source is still new in Africa. It is relatively new in Europe, America and Asia as well, but Open Source has only in the past few years spread to some of the African countries. In the past five years however, there has been a lot of activity on the continent for promoting Open Source. The Wired magazine for example called Africa the potential "Linux continent" in September 2000 and wrote: "The Linux User Project rates South Africa as having the 24th-largest user base in the world. Kenya, Algeria, Egypt and Botswana are trailing behind. There are several registered users, even in the most remote parts of the continent." [Wired]

The leading country in the advance of Open Source is, naturally, South Africa as the technologically most developed country (apart from Mauritius and the Seychelles, perhaps.) South Africa has two local Linux distributions, Impi and Ubuntu (released in November 2003 and October 2004, respectively) which have turned the attention of the international Open Source community towards Africa. The South African Government has even started viewing Open Source with interest and has prepared an OSS Strategy[34] as well as an OSS Policy Framework[35] to analyze the benefits of Open Source and to prepare a roadmap to use OSS as government software.

The Open Source community in Africa ist still small. Kwindler Kramer, the CTO (chief technology officer) of the online newspaper allAfrica[36] met an Open Source developer from Ghana on the "Africa Source" conference in 2004. This developer estimated "based on an extrapolation from Accra and a back-of-the-envelope population density calculation that there are only about 500 'real hackers'[37] in sub-Saharan Africa outside of South Africa" [Kramer] And they face a lot of obstacles against community-based software development. There are few of them; the prices of PCs are still unaffordable for most Africans; additionally, their abilities to access information, software and mailing lists are limited by slow or non-existent internet connections.

These barriers notwithstanding there have been a number of Open Source conferences in Africa lately (as the international Open Source community is spread all over the world, conferences are the common mode of meeting in person and exchanging opinions, and they occur frequently in many countries.)

- The Linux Africa conference[38] was held in Johannesburg in 2001
- The Africa Source conference[39], which was held in March 2004 in Okahandja, Namibia. Africa Source II will be held Sept. 2005 in Uganda.
- The Idlelo conference[40] was held in Janurary 2004 in Cape Town, and its sequel is planned to be hosted in Nairobi in February 2006. It is organized by the Kenya-based Free Software and Open Source Foundation for Africa (FOSSFA)[41]
- The FLOSS conference[42] took place just recently in Pretoria in April 2005
- At the time of this writing (May 2005), the Linux World Conference and Expo[43]

[34] http://www.oss.gov.za/docs/OSS_Strategy_v3.pdf
[35] http://www.oss.gov.za/OSSPolicyFrameworkV1.pdf
[36] http://www.allafrica.com
[37] by which he means skilled programmers that are hopefully involved in Open Source
[38] http://lwn.net/2001/0308/a/sa-event.php3
[39] http://www.tacticaltech.org/africasource/
[40] http://www.fossfa.net/idlelo2/
[41] http://www.fossfa.net
[42] http://meta.wikimedia.org/wiki/Conference_reports/FLOSS%2C_South_Africa_2005
[43] http://www.linuxworldexpo.co.za/

will have both discussions on Open Source and exhibit new projects and software in Johannesburg.

- And the World Conference on Computers in Education[44] will take place in Cape Town in July 2005

The impression may now arouse that Open Source and Linux are mostly bound to South Africa. But there is at least some activity in other countries, which can be seen by the activity of the "Linux User Groups". Linux User Groups (LUG) exist in most countries - in countries with large Open Source communities, there are even LUGs for the major cities[45]. LUGs are portals for people of an area who wish to exchange their views on Linux. As a matter of fact, there are Linux User Groups in a lot of African countries[46]: Algeria, Botswana, Eygpt, Gambia, Ghana, Kenya, Libya, Madagascar, Mauritius, Namibia, Nigeria, Rwanda, South Africa, Uganda, Zambia[47], Zimbabwe.

[44] http://www.sbs.co.za/wcce2005/
[45] A list of most Linux User Groups worldwide is kept at http://www.linux.org/groups/
[46] There is also a list of African LUGs at http://www.tectonic.co.za/default.php?action=ug
[47] The Zambian LUG's address by the way is http://www.dgroups.org/groups/zlug

2 Situation Analysis

A diploma thesis about ICT development and education in a country should also include a general introduction to that country. An introduction to Zambia may not be needed by Zambians themselves (however they might be curious about a German student's view of their country.) This introduction is intended for everyone else: computer science and educational science students and organisations from other countries.

Information technology can be an aid in many fields - business, education, science and in any type of organisation - and all of these are influenced by the conditions of their country. Thus a general introduction is given about the geography, history, economy and culture of Zambia. This general introduction is followed by more specific descriptions of the current ICT situation in Zambia and the Zambian education system. The interviews then give a more lively impression of computer use and education in Zambia.

The rather large quantity of information has been summarized in the final part, which gives recommendations to ground the draft ICT curriculum in section 3.

2.1 The Country Zambia

2.1.1 Geography

Zambia is a country the center of the Southern African region. With 750.000 square kilometers, it is a bit more than twice as large as Germany. Zambia has no connection with the sea. As a landlocked country, colonisation took place relatively late, and today this position has a great effect on the economy. Zambia has borders with eight countries: The Democratic Republic of Congo, Tanzania, Malawi, Mocambique, Zimbabwe, Botwana, Namibia and Angola. Burundi can be reached via ferry across Lake Tanganyika. Zambia is a tropical country, between 10 and 18 degrees south of the equator, and the average level of altitude is at a relatively high 1300 m above sealevel. Zambia lies on a plateau rather than being mountainous.

The country is blessed with a lot of water. In the West and South, it is bordered by the mighty Zambezi River (which gave the country its name.) Near Livingstone are the famous Victoria Falls, one of the premier tourist attractions in Africa. At the border to Zimbabwe, the Zambezi is impounded by the Kariba Dam to form Lake Kariba. In the North-East, it has a small coastline with Lake Tanganyika, the second largest lake in Africa after Lake Victoria, and there are many other rivers and lakes. Most of the country is covered by bush, and there are many large nature reserves where the typical African animals[48] can be watched.

The climate is warm, but not as hot and dry as for example Botswana or Namibia,

[48] the Big Five: Elephant, Rhinoceros, Giraffe, Hippo and Lion; but there are also parks where birds can be watched.

which are partly deserts. There are rainfalls during 6 months, the most heavy from late October till early March, when it rains every day (but not constantly.) There are three major seasons: The rain season, followed by the cold season, and then the hot season. The country's colors become somewhat brown and yellowish during the hot season (though most trees keep their green leaves.) In the rural areas, Zambians burn the dry grass, and fires and blackened soil can be seen along the road. When the rain starts, however, the whole country turns into a green paradise.

Roughly estimated, Zambia has about 11 Million people, with an annual growth rate of 1.4%. Exact figures about the size of popluation and growth rate can hardly be found, as resources for statistical research are limited. For the growth rate, the high rate of HIV infected persons has to be taken into account. There are no exact figures about the HIV rate, either, but it is estimated between 15 and 20 per cent (on the African average, the rate is high but not the top. South Africa's rate is estimated at about 20 percent, and Botwana even more than 30 per cent. Congo, Uganda and Ghana on the other hand have estimates below 5 per cent). The average life expectancy in Zambia has dropped to 48 years due to poverty and HIV.

Zambia is divided into eight provinces, which are further divided into districts (this organisation was adopted from the British colonial administration.) About 40% of the people live in cities, the highest urbanization rate in Africa. [Migura, p. 1] The major cities and urban areas lie along the "line of rail", which goes from Livingstone in the South through the capital city Lusaka in the center towards the Copperbelt region in the North. **Lusaka** has an estimated one and a half million inhabitants. "Generally disliked by visitors and residents, it's a bustling, energetic city perhaps too gripped by mercantile and bureaucratic fervour to have ever taken much care of its appearance. Yet, it is not without a certain shambolic charme and its people are friendly and cosmopolitan. [...] Today, a modern skyline rears up to proclaim the city's metropolitan stature over the surrounding bush. During the latter years of socialist rule and the financially difficult years that followed Lusaka slipped with the rest of the country into appalling decay. However, while hardly a fin de siecle renaissance, the turn of the millenium finds the city beginning to replace some of its shabbier clothes with new ones. [...] Potholes that once seemed capable of swallowing whole vehicles have been filled." [Dooley, pp. 57-59]

Kitwe and **Ndola** are the largest cities in the **Copperbelt** (about half a million people each.) The Copperbelt, a region only 50 km wide and 100 km long is the main industrial area in Zambia. In the beginning of the 20th century, copper was discovered here. Zambia inherited the copper mines from the colonial administration[49] and became the biggest exporter of copper worldwide. The provincial administration of the Copperbelt is in Ndola, as well as the airport. Zambia's second university, the Copperbelt University however is in Kitwe.

[49] actually the Zambian goverment bought the mines from the mining companies and nationalized them

2.1.2 People

Many Zambians like to proclaim with pride that there are 73 languages in Zambia. The official language is English, but people generally talk in Zambian languages, with many of them speaking (or at least understanding) a number of them. As English is taught in school, there is however hardly a place where an English-speaking person cannot be found.

There are seven major tribes in Zambia, and many other tribes, some of which are not bound to Zambian territory. The Tumbuka for example live in Zambia as well as in Malawi, and so do the Chewa. The major groups are

- the Tonga and Ila tribes , who live in the Southern Province and have lived there for almost a 1000 years
- the Lozi, who live in Barotseland in the Western Province and pledge allegiance to their king, the Litunga
- the Luvale, who live around Lake Tanganyika and are made up of the smaller Valuvale, Valuchaze, Vambunda, Vachokwe and Vaviye tribes
- the Kaonde in North Western Province
- the Lunda in North Western and Luapula Province
- the Bemba, the most numerous people in the Northern Province, who have also spread to the Copperbelt
- the Ngoni of the Eastern Province, who originated in South Africa and today speak Njanja.

Since the beginning of copper mining around 1900, Zambia has become an industrialized and urbanized country. The culture of independent and migrating tribes has been changed to a great extent:

> "Exploitation of the reserves required a large labour force and Zambians from all over the territory were drawn to the Copperbelt. While the migratory system of the past tended to disperse people, the Copperbelt concentrated them so that a permanent population of African miners, working in a modern, technically advanced industry soon took root. They were essential to the production of up to 800 000 tons of refined metal a year. Even when 'tribal' affiliations remained in force, they became increasingly irrelevant in this new situation: a miner was primarily a miner, not a Tonga or a Bemba, and the same applied to workers in the enterprises that sprang up around the mines.

> As much as colonial authorities promoted 'tribalism' in their system of direct rule through the chiefs, the Copperbelt broke it down, creating a unity of interest that was eventually to be expressed in the state motto 'One Zambia One Nation'." [Holmes]

However, although Zambia is highly urbanized, the majority of the people still live in rural villages, which means that they live in a more traditional way.

There are many more things that could be said about the people of Zambia, about their humor or their way of clothing, their favourite dishes and leasure time activities, but there is a high risk of sliding into stereotypes, especially as the author's three months of personal experience are not sufficient to be representative. A final note can be that there are few white people in Zambia, some with roots in the colonial period, and there is also a small Asian community. As far as religion is concerned, Zambia was proclaimed a "Christian nation" by Frederick Chiluba, Zambia's president during the 1990s. There are churches of many different denominations, and like in many other African countries, people believe strongly but are able to coordinate Christian beliefs with traditional ones.

2.1.3 Economy

Infrastructure "The infrastructure of Zambia is in total collapse," writes the retired businessman Andres Sardanis [Sardanis, p. 319] "The local farmer as well as the local businessman has to put up with bad or sometimes impassable roads, constant vehicle breakdowns, high fuel prices and transportation costs, high telecommunication costs and poor service, high electricity charges and frequent power cuts etc. All of these factors add to his production costs and make his products uncompetitive."

The road network was mainly developed by the British during the colonial days of Northern Rhodesia and extends throughout the country. The decline of the economy has caused the road conditions to deteriorate for a long time, but still they can accommodate traffic to all bigger towns. Areas that are off the main roads however can often only be reached with robust four-wheel-drives, as only the main roads are tarred. The dirt roads to remote areas often become upassable during the rain season.

There are two railway lines: one going from Livingstone to the Copperbelt, and one going from Kapiri Mposhi in the center through the border town Tunduma towards Dar es Salaam in Tanzania. The Tazara railway line was built by the Chinese in the early 1970s. There is also an oil pipeline from Kitwe to Dar es Salaam, which was build soon after independence in 1966.

Additionally, there is a lot of relatively cheap electricity produced by hydroelectric power stations. The biggest ones are at Kafue river (capacity 900 MW) and at Kariba Dam, where two power stations are installed, one on the Zambian side (600 MW) and on one the Zimbabwean.

For those who are curious, there is more information about the build-up of the Zambian infrastructure in the history section (2.1.4).

Sources of Income Zambia's economy is heavily reliant on copper mining: Copper accounts for about 80% of Zambia's export earnings. Other sources of income are tourism and agriculture. Tourism is steadily growing, but is not nearly as developed as for instance in Kenya or South Africa. As Zambia has vast areas of untouched nature and many national reserves, there is a lot of potential for tourism. However, the infrastructure for to accomodate many tourists has not been built yet. As for agriculture, Zambia's main produce is maize, most of which is produced by peasant farmers. Cash crops produced in Zambia include groundnuts, wheat and tobacco.

If you look at Zambia from the macro-economic perspective, it is one of the poorest countries in the world. More than 80% of the population live below the national poverty line and have to get by with less than one dollar per day. Zambia used to have an extraordinarily high foreign debt of more than $7 billion, the highest debt per capita in the world. However, as Zambia followed the rules of the International Monetary Fund and the Worldbank, it has been approved for a debt relief of $3.8 billion in 2005 through the HIPC-Program[50] of the Worldbank.

In the last five years, Zambia's economy has experienced a steady growth of 4 - 5 per cent, compared to no economic growth at all during the 1990s and a population growth of 3 - 4 per cent. The latest growth may be due to a slight increase in mineral demands and good results in the agricultural sector.

2.1.4 History

Much of what goes on in Zambia today can be understood by knowledge of history. Most people, other than Africans themselves, know relatively little about African history (Joseph Ki-Zerbo, an African historian pointed out that Africa used to be shrugged off literally as having no history at all.) Therefore, a longer chapter has been dedicated to the history of Zambia - or rather, of the people that live in the area which is called "Zambia" since 1964.

Pre-colonial History The oldes signs of life in the area of today's Zambia date back to the Early Stone Age, at the Victoria Falls and at Kalambo Falls near Lake Tanganyika. The movements of the Bantu people however, which still live in Zambia today, began from

[50]The Highly Indebted Poor Countries (HIPC) program, funded with about $50 billion is an attempt to grant a number of countries a debt relief. The HIPC-Program ties possible debt reliefs with certain conditions, e.g. privatization and following a poverty reduction strategy. It has been criticized of arbitrariness in the choice of countries, not reducing poverty effectively and being under-funded - the global debt of the developing countries in 2003 amounted to $2,430 billion. Yet, in some cases the HIPC-Program has shown success.

the third century (after Christ) on, in the Early Iron Age. As most of Zambia's population are "Bantu people", a short history of their journeys is given here:

The word "**Bantu**" is plural of "human being" and thus means "people". It is not a name for a "tribe" but describes a family of about 800 languages, which have a lot of common words and are traced back to a common source by linguists.

There are only guesses about the early history of the Bantu people, but it is believed that their origin was in the area of eastern Nigeria and western Cameroon. This area is called the Pre-Bantu area. From the 3rd century on, and for reasons not exactly known, the Bantu people started moving southwards. A possible explanation is the advance of the Sahara desert. About a hundred years later and after a long journey through the forests of Congo, they reached a savannah region south of the rainforests, where today is the Shaba province of the DR Congo. The area is now called "Proto-Bantu" or "Nucleus" area. From here, variations of the language started to develop. People moved away from the Proto-Bantu area during different centuries and settled elsewhere in Southern Africa. Depending on the stage of social development in the Proto-Bantu area at the time of migration, different styles of societies developed elsewhere.

The **Tonga** people of Zambia, for example, moved out of the Proto-Bantu area about 600 A.D. This was the time of the Early Iron Age, when societies were not yet centralized, and thus the Tonga people had a de-centralized system of government. There were chiefs, but independent of each other and not following a central government. They settled in a very fertile land which gave them economic power. They traded over long distances with the Swahili and the Portuguese, but eventually, their society proved weak against attacks by centralized societies and the slave traders.

The Luyi (later called **Lozi**), on the other hand, moved out of the Proto-Bantu area in the 16th century. At that time, two highly centralized kingdoms had been established there, the kingdoms of Luba and Lunda, and those were societies of the Late Iron Age. Apart from the Luyi, many other groups migrated from there to areas in Southern Africa[51], and where they settled, they established centralized systems of government as well. The Luyi had a queen, to whom the chiefs paid annual taxes. They had an army, well organized local trade and a law code which secured property[52] and thus raised motivation for hard work. The Luyi were conquered by the Kololo in 1840 (this was an effect of the disturbances which the Zulu and their king Shaka had set in motion) but they managed to regain control after a generation or so, and inherited the superior military techniques of the Kololo, which had originally been developed by Shaka.

[51] The Zambian people of the Kaonde, Lenje, Luvale, Luyi (Lozi), Lamba, Ushi, Bemba, Bisa and Lala moved out of Luba/Lunda from 1500 till 1700.

[52] A thief for example was given cattle out of the royal stock, so he'd not have a reason for stealing any more. Making stealing a shame must have been a successful way of prevention.

First signs of Europeans and the Slave Trade The first Europeans to settle on the southern part of the African continent were the Portuguese. Their history in Africa is somewhat of an example of European influence in general: at their arrival in 1482, they developed friendly relationships with the kingdom of Kongo (at the coast of Angola). The two countries exchanged ambassadors, and people from Kongo went to Portugal to learn about European languages and technology. In return, missionaries brought Christianity to Kongo, and even their King, named Affonso I, was a catholic. After some years, however, more Portuguese came, and not always did they respect the Kongolese people, nor their own government's policy. Slave trade started and conflicts arose, until Kongo was eventually invaded by Portugal in 1665 and ceased to exist.

The Portuguese also had settlements on the eastern coast of Africa: they settled in Mocambique (where today Portuguese is still the official language) and travelled up the Zambezi river. They wanted to compete with the Arab and Swahili slave traders, and build market places to trade goods and slaves. In the 18th century, they tried to join their Angola and Mocambique territories by gaining control over the kingdom of Lunda in the Luapula valley, but did not succeed. In this way, the slave trade in Southern Africa developed differently from the trade in Western Africa: there, the European powers only controlled the coast, and dealt with the African traders who brought the slaves from the interior. Yet, the reader shall be saved the whole horrible and sad story of the slave trade, which had a devastating effect on Africa as a whole: Millions of young and strong men and women kidnapped or killed, and their societies weakened. As for Zambia, today visitors can still view the huge so-called "Slave Tree" on the road from Kitwe to Ndola, where the traders met and the slaves were sold.

The slave trade was brought to an end eventually mainly by philantrophic and Christian activities in America and Europe. European governments agreed during the congress of Vienna in 1815 not to take part in the slave trade any more. When the British became the dominant power in East Africa in the 19th century, they succeded in abolishing slavery.

Explorers and Missionaries Besides the slave trade, the Europeans at first had little interest in Africa. They already had colonies in India and America, and Africa was much harder to colonize: deserts, forests, malaria and the tsetse fly (which kills cattle and horses) were obstacles, and they saw no profit that justified efforts to overcome these obstacles. Much of Africa - called the "Dark Continent" - was still white spots on the maps. Things changed when European explorers and missionaries arrived in Africa. They came after the dawn of the industrial revolution.

The most well-known explorer, David Livingstone travelled through Southern Africa in the second half of the 19th century. His travels through the Zambian region left many

traces: the former capital of Northern Rhodesia[53], Livingstone is just one of them. He named the Victoria Falls, discovered Lake Mweru and Lake Bangweulu, and he died in 1873 at Chitambo in Zambia.

> Livingstone's thirty years of exploration in Africa made a huge impression in Britain and Europe and kindled widespread interest in Africa. He was the first European to visit many places in Africa and his discoveries were geographic, scientific, medical and cultural. His most important contribution, however, was his deep belief that Africans would advance to European standards and eventually run their own affairs, and in this he differed from most other Europeans of his generation. For this reason his name lived on in Africa when other explorers were forgotten. [Ntalasha, p. 100]

Livingstone had also been a missionary. Him and many others that followed, sent by Christian societes, opened missions in Africa. These missionaries did not have an easy life: Many missions failed because their missionaries died of malaria. And when Robert Moffat, for example, was sent by the London Missionary Society in 1859 and opened two missions, he could not convert a single soul in 20 years. Yet, although their primary aim was to convert people to Christianity, missionaries had much more influence by being scholars. They were good linguists and wrote down African languages, and translated the gospel into the local languages. They opened schools and introduced the European education style with reading and writing. Later, during the colonial days, these schools were often the only ones open for Africans. The white settlers opposed these schools for fear that educated Africans would demand independence. And this is what happened eventually: the nationalist[54] leader of Kenya, Jomo Kenyatta for example had attended a mission school.

Some people did welcome the missionaries and their new knowlegde, as they saw in it the power to regain control over their affairs. The Tonga for example allowed missionaries (possibly because they suffered from attacks by the Ngoni and saw them as allies), and so did the Bemba and the Lunda. Others were not as appreciative: the Jesuits for example were refused by the Ndebele, and by the Lozi.

Although the missionaries' intent had been to help Africans (for the sake of Christianity), their stories raised interest in Europe. And when Africa was divided up among the European nations during the "Scramble for Africa", the missionaries helped their countries (willingly or reluctantly) and became part of the European advance.

The Scramble for Africa The reason for the Europe's sudden interest in Africa was that by 1875, population and industry in Europe had experienced massive growth, and the

[53] today: Zambia

[54] "Nationalism" in Africa means the breaking-away from colonial governments and forming African governments for independent nations.

European markets demanded resources. The exisiting colonies already provided much of those, but the explorers and missionaries had told stories and published books which put dreams into adventurous heads. Smaller European countries imagined themselves as empires like their larger neighbours. The event which lead to the "Scramble for Africa" was essentially the annexation of the Congo by the Belgian King Leopold II:

Henry Morton Stanley was another well known explorer of the Southern African region. He had led an expedition to find David Livingstone, who had been reported dead on his third expedition. Stanley had found him near Lake Tanganyika. Apart from this expedition, his greatest achievment was tracing the course of the Congo river. Stanley was a more ruthless and businesslike character than Livingstone. King Leopold convinced him to act as his agent, and Stanley travelled through Congo and acquired a huge territory on his behalf. King Leopold wanted this land to be his private colony, the Congo Free State. Other European countries realized that they might waste opportunities and started signing treaties with African chiefs as well. To protect his "property" from the more powerful European countries, King Leopold II wished to have agreements with his peers.

In 1884/85, the **Berlin Conference** took place to make such agreements. After the conference, Africa's fate was sealed: The European powers signed terms under which they would divide up all of Africa's territory. The purpose of the conference was to prevent clashes between the European nations, not to negotiate with Africans themselves (who, of course, had not been invited to the conference.) At that time, Europeans regarded mostly everyone else with arrogance, their weapons allowing them to proceed with whatever attitude they chose[55]. The terms of the agreement stated for example that "a country intending to take over a new region had to notify the other European powers. Control of the coast gave the right to control the interior" [Ntalasha, p. 119]. King Leopold's Congo Free State was protected by the conference as well. And - how else could a small country like Belgium control such a large territory - his rule was enforced with bloodshed and extreme brutality, until the Belgian parliament got aware of the terror and took control of the colony from the king in 1908.

It took the Europeans a mere 20 years to occupy all of Africa. They took the land with soldiers on the ground, and with paper to "legalize" the boundaries of their acquisitions[56]. Railways enabled them to transport troops far into the continent, and to carry out ore from mines and food from plantations. Steamships then were used to transport people and goods, and to patrol the coasts.

The Creation of Rhodesia The British had started to move into South Africa from the beginning of the 19th century, when they annexed the Cape Colony from the Dutch in

[55] Even people like the missionaries or David Livingstone regarded Africans as inferior.

[56] Namibia has a connection with Zambia, for example, because the Germans signed a treaty with the British in 1890 for a small strip of land, the Caprivi Strip, which was to connect German South West Africa (= Namibia) with the Zambezi.

1805 after the Fourth Anglo-Dutch War. When they moved north from South Africa, they accumulated territories that eventually became Southern Rhodesia, Northern Rhodesia and Nyasaland, or today Zimbabwe, Zambia and Malawi, respectively. These three territories were later united in the Central African Federation in 1953 (which lasted only ten years and was dissolved in the African nationalisation movement.) The name "Rhodesia" is derived from Cecil Rhodes (1853 - 1902):

When the Europeans marched into Africa and minerals were discovered along the way, many miners and business adventurers were attracted. The richest and most powerful of them was to become Cecil Rhodes. He created the De Beers mining company in 1880 that took control over all the newly opened mines in South Africa. He was a multi-millionaire at the age of 25, and became more interested in politics than in money. His greatest ambitions was the creation of an inter-African railway from Cairo to Cape Town. He wanted British influence to spread over as much African territory as possible before the other European powers did. To achieve this in the most effective way, he used his political influence to receive a "Royal Charter" from the British government. This charter would allow him to legally control the land which his company occupied: instead of direct rule by the British goverment, a company rule would be established. Humanitarians and missionaries were against the charter, but Rhodes had the financial power to pay for the administration of the new territories, and he got the charter in 1889. His company was now called the British South Africa company. A year later, Rhodes also became Prime Minister of the Cape Colony.

Rhodes sent out concession hunters, settlers and soldiers. They tried to persuade African chiefs to sign treaties for mineral rights. Chief Lobenguela of the Ndebele, for example, signed a number of treaties. Among those was the "Rudd Concession", by which he granted "complete and exclusive mining concessions in his territory, with full power to do all things that may deem necessary". In return, the treaty promised him rifles, ammunition and a gunboat to patrol the Zambezi (which he never received.) In the end, Rhodes simply wanted Lobenguela out of the way and provoked a war: The Matabele War of 1893/94. The Ndebele were defeated by use of repeater rifles and artillery. Chief Lobenguela however died before the end of the war, and was buried in secret. The land of the Ndebele was taken by settlers, and a system of forced labour was introduced. The Ndebele and their former enemies, the Shona then started a rebellion against the invaders. They were defeated again, and by 1897 Rhodes was in control of Southern Rhodesia.

Rhodes did not stop there: he wanted to spread the British empire further, to the land of the Lozi and the Bemba, in today's Zambia. He was not the only one interested in the region: with the Germans in the West in Namibia, the Belgians in the North in Congo and the Portuguese in the East in Mocambique, there were plenty of potential stakeholders. "By 1890 the imperial powers were closing in on this region and both the Bemba and the Lozi must have realized that their days of freedom were numbered." [Ntalasha, p.

128] A French missionary, Francois Coillard then convinced Lewanika, the king of the Lozi, that British rule would be the least evil. Lewanika reluctantly agreed and granted a concession to a rival of Rhodes'. Rhodes quickly sent one of his minions, Frank Lochner, who pretended to represent Queen Victoria, and obtained the "Lochner Concession" for the British South Africa Company (which was later accepted by the Crown.)

The same fate awaited the Bemba and the Ngoni. Though there were treaties signed, there was also a lot of resistance among them, which lead to revolts and fighting. By 1898 however, both were finally subdued. North-western Rhodesia (the Lozi territory) and North-eastern Rhodesia were combined into Northern Rhodesia in 1911, with Livingstone as the capital.

The Central African Federation The history of Northern Rhodesia took quite a different course from Southern Rhodesia's. The main difference was that Southern Rhodesia was a settler colony, like Kenya, which lead to major struggles between the Africans with their claim for more justice and the Europeans, who wanted to stay in control of land, resources, labour and politics. The whites settlers in Southern Rhodesia took land by "right of conquest" [Ntalasha, p. 144] and destroyed the existing tribal system. In Northern Rhodesia (and Nyasaland as well) there were much fewer whites - in 1924, their population was only about 4,000. Only 6% of the land had become Crown land, the rest was either "Native Reserves" or "Native Trust Land" and was to be used in African fashion like before. The reason was partly that the BSA Company had gained concessions from the chiefs for mineral rights, but not the control over the land.

Southern Rhodesia soon developed a thriving economy, which was also powered by the mines of Northern Rhodesia: from 1902, Lead and Zinc were mined at Kabwe, and in 1909 the first Copperbelt mines were opened. The Copperbelt soon became one of the greates copper-producing areas of the world, churning out 800.000 tons of copper a year. In the 1950s, after the second world war[57], Rhodesia benefited from the worldwide economic growth, bringing he whites of Southern Rhodesia one of the highest standards of living.

Yet they were afraid that the Africans, who became increasingly educated[58] and gained in political strength would eventually threaten their authority. Attempts were made before World War II to convince the British goverment that Northern and Southern Rhodesia and Nyasaland should be joined into a single Federation. Southern Rhodesia's settlers hoped to have a stronger control if the Europeans of the three territories were united. Initially, the British rejected, but after WWII the issue was brought up again, and this time, they were more successful. They argued that the three territories were natural economic partners: the

[57]The history of World War II is quickly told, as far as Zambia is concerned: the British fought the Germans in Namibia and Tanganyika, and thousands of Africans were recruited as soldiers.

[58]Even though most of the schools were reserved for whites, some Africans learned in schools, especially in missionaries.

whites of Southern Rhodesia providing the skills, the Copperbelt of Northern Rhodesia providing wealth from its rich resources and Nyasaland providing plenty of cheap labour. In 1953 the Central African Federation came into existing. It was said that there should be a partnership between Europeans and Africans. This was expressed by giving the African majority 9 seats in the Federal Assembly out of a total of 35 seats. Sir Godfrey Huggins of Southern Rhodesia became the first Prime Minister, and he was succeded by Roy Welensky of Northern Rhodesia in 1956. As for the economic side, the Federation achieved the building of Kariba Dam[59]. As for the relationship between Africans and Europeans, the following two excerpts give an insight:

> The Powers of the PA [Provincial Administration] were extraordinary. A district commissioner and his officers had the last word on almost everything that happened in their district. They were the administrators, the policemen and the magistrates, all at the same time. They had powers to investigate, to make arrests, to put people in jail. They would try the case they investigated, mainly petty crimes, and pass sentence. [Sardanis, p. 36/37]

Sardanis then goes on to describe how 18-year-old British youngsters were introduced as district officer cadets. Though they had no experience and were not needed either, they were superior to the head clerks. Head clerk was the highest rank that an African could achieve in the administration, and as the bridge between the people and the District Commissioner, "he was the backbone of every Boma. [...] But to have to accept 18-year-old kids as his bosses and teach them at the same time was adding insult to injury." [Sardanis, p. 42/43]

As this paper is about development cooperation, the efforts of the colonial administration in development are also interesting:

> Well-meaning they may have been, but the officers of the Provincial Administration were not capable of spearheading development. In theory, therefore, they could not do much harm. But they did. They were intelligent

[59] Its story shall be presented briefly, as it illustrates dependencies between Southern and Northern Rhodesia, as well as the relations of the British government and the African population. The Copperbelt constantly consumed a huge amount of electricity, which was initially supplied by coal fired power stations. The transport of coal posed problems, so other sources of electricity were looked for. Southern Rhodesia's growing manufacturing industry needed electricity as well. A decision then had do be made whether to build a dam at the Kariba Gorge at the border of the two Rhodesias, or at the Kafue River in Northern Rhodesia. The Kafue dam would have taken less time, and was thus favoured by Northern Rhodesia, but Kariba was estimated to produce more electricity. In 1953, the decision was made to first build Kariba Dam. (The dam at Kafue River was built later.) Kariba Dam was built by an Italian company from 1956 till 1959. The Tonga people who lived in the Zambezi Valley had to move away from the water, and only retreated when they were forced by military. "As Kaunda said at the time, the Government was spending more money saving impala (small antelopes) from drowning than helping people resettle."[Sardanis, p. 63] The legend says that the Tonga prayed to the river god of the Zambezi, Nyaminyami, to destroy the dam project. And indeed, in 1957 the Zambezi had the largest flood ever. The water almost destroyed the construction site, and 17 workers lost their lives, including some 11 who were buried in the concrete wall of the dam.

> people, they would read, they would get ideas and unfortunately they had the power and all the time in the world to implement them. [...] And there was a very dear friend who got it into his head to plant eucalyptus trees in Kabompo, for reasons I do not exactly know. He did it with great fervour. He cut down big old hardwood trees, which take 95 years to grow and replaced them with eucalyptus, for which the people of Kabompo had little use. In later years, huge amounts of money were invested in similar plantations on the Copperbelt. Again, the hardwood forest was cleared in order to make room for gum-trees. The World Bank provided the money. I think the idea behind it was to develop a pulp and paper industry in the future. When the plantations matured, the planners realized that the capital investment needed would have been too high and the local market was too small for the products. Export was not possible because of high inland transport costs. So the plantations were put to little use. But the indigenous forest was destroyed [Sardanis, p. 41/42]

The Way towards Independence There was much opposition against the Federation from the sides of the Africans, and in the short 10 years of its existence, it experienced a lot of political turmoil. The African nationalisation movements were advancing everywhere in Africa, and the Europeans could not simply suppress them any more. They relied on African workers, and those were able to back their demands with strikes. There were also educated Africans, if only few of them, who wrote newspapers and led African unions and political parties.

The leaders of the freedom fighters in the Central African Federation were Joshua Nkomo in Southern Rhodesia (who was replaced by Robert Mugabe when Zimbabwe finally gained independence in 1980), Dr. Hastings Banda in Nyasaland (who turned out a dictator) and Harry Nkumbula of the African National Congress (ANC) in Northern Rhodesia. Nkumbula was soon replaced as key figure by **Kenneth Kaunda**, who eventually became the first president of Zambia. Kenneth Kaunda was the son of a presbyterian priest, and he had attended Munali high school near Lusaka, one of the two high schools in the country for Africans at that time. As Nkumbula was regarded too soft for the independence struggle, Kaunda and other young leaders broke away from the ANC in 1958 and formed the Zambia African National Congress (ZANC).

The ZANC was soon declared illegal, and Kaunda was sent to prison for 9 months. During his imprisonment, another party was founded: the *United National Independence Party*, which eventually became the first goverment of Zambia. Out of prison, Kenneth Kaunda was elected its leader. He announced the aims of UNIP to be self-government and majority rule[60] by peaceful means. In 1960, the British Monckton commission assessed

[60]The constitution of Northern Rhodesia provided a biased voting system: “It intended to establish two

the situation in Zambia an recommended more participation for Africans in the government, and the option for Northern Rhodesia to leave the Central African Federation, if it was the wish of the majority. The following excerpt describes the relatively quiet way towards indepence:

> UNIP now launched a civil disobedience campaign, known as Cha Cha Cha, which spread through the northern and eastern parts of the country. It did not remain non-violent: roads were blocked, government offices were attacked, bridges were blown up and busses stopped. The British government realized that the tide had turned against Federation and in 1962 produced a new constitution, which gave real voting power Africans for the first time. The leaders of UNIP accepted this constitution and in the following elections UNIP won fourteen seats, the ANC seven seats and the white United Federal Party sixteen seats. The two African parties then formed a coalition under Kaunda's leadership and Northern Rhodesia had its first black government at the end of 1962. The Federation was dissolved on 31 December 1963 and in January 1964 new elections were held and UNIP won a huge majority: UNIP had fifty-five seats, the ANC ten seats. Kaunda became premier of a self-governing Northern Rhodesia and preparations began for independence. This was achieved on United Nations Day, 24 October 1964, when Northern Rhodesia became Zambia and Kenneth Kaunda its first President. [Ntalasha, p. 148]

Zambia since Independence The first ten years in Zambia after independence were quite successful, driven by a good economy, which was essentially based on a high copper price. Yet, distrust and corruption trickled into the young government, and when the copper price collapsed, Zambia began to stumble downwards. International politics and southern African liberation wars added to the burden, until it became one of the poorest countries in the world. Now, after a long period of decline, a slow recovery process has started.

An example of international influence started in 1965, when Zambia had just become independent. Ian Smith, the president of (Southern) Rhodesia, had declared the country independent - he would not accept the British policy of "No Independence Before Majority Rule", which would have meant the end of white government. Instead, he proceeded with a racist course much like South Africa's. The United States and the British declared sanctions against Rhodesia, which unfortunately meant for Zambia that its source of commodities, including fuel was cut off. Almost all goods had been transported from the port

voters' rolls: one 'ordinary' mainly for the whites and a 'special' roll for Africans, who had at least two years secondary education and an income of £120 ($360) per annum, or just an income of £150 ($450) and property worth £500. It offered the latter, for the first time, eight directly elected seats in the Legislative Council out of a total of 22" [Sardanis, p. 59]

of Durban through Rhodesia to Zambia, and there were no reserves in Zambia because storage facilities during the Federation had only been built in Southern Rhodesia. And as Ian Smith's regime did not collapse within weeks but after fifteen years in 1980, Zambia had serious transportation problems for a long time. These were eventually alleviated by the building of the Tazama oil pipeline (finished in 1968) and the Tazara railway line in 1975 which connected Zambia with the port of Dar-es-Salaam in Tanzania.

Zambia involved itself in international politics by becoming one of the "Frontline States", which supported African nationalisation struggles in the neighboring countries: in Rhodesia, in Angola, Mocambique and South Africa. The price for this honest engagement was high: Soldiers sent, military expenses made, and the racist regimes returned the favour in form of sabotage.

The political turmoil within Zambia began early as well. The start in 1964 had been promising: "In forming his Cabinet, Kenneth Kaunda showed himself a master of national political sensibilities. He ensured that all major groups received a fair share of senior and junior posts, a permanent feature of all his future administrations." [Sardanis, p. 147] A few years later, this division of power went out of balance and politicians started fighting to gain more influence for their tribes.

When the UNIP politician Simon Kapwepwe formed his own party in 1971, "it did panic KK [Kaunda] into a series of ill-conceived actions" [Sardanis, p. 201] Kapwepwe and his followers were arrested and in the following year the "One Party Participatory Democracy" was proclaimed. Zambia followed Eastern Block examples, and indeed some Zambian politicians began to spread Marxist views. Free elections were only introduced again in 1991.

Like in other socialist countries, key industries became state property. However, it is important to note that although the country's industry was nationalized, the aim was really to take it out of the hands of foreigners and prevent them from taking all the profits out of the country (part of which was also going to Rhodesia, Zambia's enemy.) The first wave of enterprise nationalisation, the "Mulungushi Reforms" were announced in 1968: the Zambian government bought 51% of the shares of some key industries. A year later, the copper mines were nationalized in the same manner in the "Matero Reforms". In the end, almost all business in Zambia was run by parastatal companies. Due to lack in experience, grave mistakes were made, inefficiency and corruption took over and added to the existing problems of a low copper price and the liberation wars.

For example, in 1973 the mining agreement was revoked and "Zambia lost and unnecessary $100 million for the enrichment of Tiny Rowland and many others." [Sardanis, p. 266] And "the economic decline and shortage of foreign exchange did not deter Humphrey Mulemba, UNIP's financial wizard, from pouring some additional $100 million over a four-year-period down the steel mill drain." [Sardanis, p. 293] - he chose to invest into a steel mill which the country did not need and which was not feasible either.

The history of the mines is of special importance. For one because "copper and cobalt exports were almost the only source of hard currency for the country" [Sardanis, p. 292], but also because the state mining company, **Zambia Consolidated Copper Mines** (ZCCM) accumulated many other businesses, and most of the professional training in the country over the years was given to ZCCM staff. Some of Zambia's companies today once were ZCCM subsidiaries, like the internet provider Coppernet[61]. The mines suffered considerably during the Kaunda administration: "The unfettered government control of the mines had other unfortunate repercussions. The quality of the manangement declined and the CEO and most other head office executives who were appointed by the Government performed more like senior clerks, instead of senior executives of the most important industry in the country." [Sardanis, p. 297] And "for a period, ZCCM was reduced to being allocated only about 20 per cent of its needs [of foreign exchange]" [Sardanis, p. 292] Or, "revenues of ZCCM had to be raided time and again with the connivance of the IMF [International Monetary Fund] in order to reduce the gap [of the country's budget deficit]" [Sardanis, p. 310]

When a new government came to power in 1991, ZCCM had to be privatized. The privatization of the mines was part of the structural adjustment program[62], which the IMF had set up in order to stop Zambia from piling up more and more debts. "While the Government, under pressure from the international financial institutions, professed its anxiety to complete the privatization task as fast as possible, it fought a rearguard action to delay the process as long as possible. When it finally had to give way, ZCCM was on the verge of bankruptcy and its mines had to be sold at derisory prices accompanied by extraordinary generous tax and other concessions in favour of the purchasers." [Sardanis, p. 316]

The political change came upon Zambia at the end of the 1980s: There had been a coup attempt on Kaunda in 1980, which was organized with the help of South Africa. But "maybe the South Africans did not want it to succeed but intended it as a warning and an embarrassment." [Sardanis, p. 288] (The coup was not planned professionally and did not succeed.) Then "in July 1989, a junior army officer attempted a coup that shook Kaunda out of his lethargy. The coup did not succeed but protests directed at KK himself, followed

[61] there's more information about ZCCM in the interview with Patrick Mugabeni of Coppernet

[62] Structural Adjustment Program (SAP): "Structural adjustment is a term used by the International Monetary Fund for the changes it recommends for developing countries. This includes internal changes (notably privatization and deregulation) as well as external ones, especially the reduction of barriers to trade. The term 'structural adjustment' has been somewhat replaced since the late 1990s by an emphasis on 'poverty reduction', with developing countries encouraged to draw up Poverty Reduction Strategy Papers (PRSPs); the content of these is often quite similar to Structural Adjustment Programs." [Wikipedia]

The reader should note that SAPs are *financial* instruments to "help" a country in reducing its budget deficit. By means of SAPs however, problems have been introduced in many countries, e.g. destructive budget cuttings in the education and health sector, adding to the countries' weakness instead of improving. Kenneth Kaunda tried to abandon the SAP in 1987, but without the help of the IMF, the country slided even further into economic desaster, and Kaunda was forced to cooperate with the IMF again in 1989.

by serious riots and looting in the major towns jolted him into reviewing his position and made him decide to reintroduce democracy in the country." [Sardanis, p. 303]

Elections were announced, and Kaunda actually hoped to win them again, but obviously the people had lost faith in him. Instead the *Movement for Multiparty Democracy* (MMD) came to power in 1991, with an 80% victory and Frederick Chiluba as president. Chiluba's government had to cope with an extraordinarily difficult situation: Zambia's debt of more than $7 billion was at a time the highest debt per capita in the world. And another problem of the same magnitude had hit Zambia: HIV/AIDS. Estimates of today say that 15 to 20 per cent of Zambia's population have been infected with the virus. And there is not nearly enough money to fight the disease properly.

Apart from economic troubles, the Chiluba administration had a reputation of being rigorously corrupt, the politicians transferring tax money into their own pockets. Chiluba won the 1996 election again, but a lot of people wanted Kenneth Kaunda back. A law was passed which made it impossible for Kaunda to be elected again[63].

A troubled time Zambia had at the end of the 90s. The civil wars in Congo and Angola crossed borders: villages were attacked and thousands of refugees fled to Zambia. And due to poor funding of the health sector, an outbreak of Cholera hit Lusaka in 1999. In 2001, Chiluba announced that he would run for the presidential election again, which was not allowed by the constitution. This step caused massive demonstrations, and even some of his ministers boycotted his decision. Against so much opposition he quickly revoked his intentions. Instead he announced the Lusaka lawyer Levy Mwanawasa as presidential candidate for the MMD, who won the elections in December 2002.

Since then, Zambia has seen some signs of change. Mwanawasa has been described as "Mr Integrity", even by politicians of the opposition [BBC]. He promoted the Anti-Corruption Commission which in 2004 has accused former president Chiluba of theft and is currently putting him on trial. The inflation of the Kwacha has dropped to 10-20% (which is low compared to the rates of inflation before.) And the "Chiefs on the Copperbelt have hailed President Mwanawasa for having initiated policies in agriculture, education, mine and the health sectors which have proved to be tangible." [AllAfrica] Even more importantly, Zambia became part of the Worldbank HIPC-Program[64]. Even though mistakes in the privatization of ZCCM and other issues were criticized by the Worldbank and led to delays, in April 2005 Zambia has finally been approved for a debt relief of $3.8 billion. Although this does not mean the end of economic troubles and poverty, it is at least a sign of hope that Zambia is on the way to greater prosperity.

[63] The president had to be a "third generation Zambian". This did not apply to Kaunda nor to his children, because his parents were born in Nyasaland.

Kaunda was even injured by the police in 1997 and later in that year he was arrested. Yet, sending the much respected father figure of Zambia, and leader of the independence struggle to prison proved not a good idea: Nelson Mandela and Julius Nyerere of Tanzania intervened, and Chiluba had to release Kaunda.

[64] for a description, refer to page 34

2.2 Zambia's Education System

The Education System of Zambia has suffered considerably from lack of funds, especially since the Government is following the course set by the IMF rigorously. One should however bear in mind that the education system has come a long way:

"In fact, African education in Northern Rhodesia had been very badly neglected. Until the mid-1950s, there were only three secondary schools: Munali outside Lusaka, run by the Government and Saint Canisius in Monze run by the Jesuits, were both boarding schools for boys. Chibembi run by the Methodists was the only secondary school for girls." [Sardanis, p. 50]

Then, "in 1960, African education received attention. A new programme was initiated, aiming at building one full primary school in each district and one secondary school in the capital of each of the rural provinces." [Sardanis, p. 77] Today, "many dilapidated grade seven schools[65] are better than the sprinkling of grass-hut 'sub-schools' or 'standard-four' schools of the 1950s and there is now a secondary school in every district compared to just two for black boys and only one for black girls in the whole of Northern Rhodesia" [Sardanis, p. 324]

The two documents that give the most complete and concise description of the Zambian Education system are a profile prepared in 2003 by the International Bureau of Education of the UNESCO, and a report about changes of the education system's structure, prepared by the Ministry of Education in 2000. This paper will address education in schools and teacher education. It will describe the administration of the education system, including the development of curricula, and give an overview of the current problems. The use of computers in education is described at the end of the next section (2.3, Zambia's ICT situation.)

2.2.1 Structure of Education

Education in Zambia is structured into

- **pre-primary education** (which is mostly done by private schools, and shall not be discussed here)
- **primary education:** The first seven years, starting from age 7, should be spent in primary schools. Grades I to IV are called lower primary, grades V to VII upper primary. Progression from one grade to the next is automatic. Only at the end of grade VII there are common examinations, which are prepared by the Examinations Council of Zambia (EMZ). Upon passing these, a pupil receives the General Certificate of Education. It is necessary to pass with good grades to be selected for a secondary school - which results in many students repeating grade VII.

[65] primary schools

- **secondary education:** Grades VIII to IX are taught in junior secondary schools, while grades X to XII are in senior secondary schools. There are again common examinations at then end of grade IX, for selection of students for senior level. At the end of grade XII, students sit the School Certificate Examination, which are similar to the British General Certificate of Education, Ordinary level.

- **tertiary education:** Colleges and universites offer a range of degrees. The two universities in Zambia, The University of Zambia (UNZA) in Lusaka and the Copperbelt University (CBU) in Kitwe offer bachelor degrees (4 years) and other degree courses (5-6 years). There are many colleges that offer certificates (2 years) or diplomas (3 years).

The school year starts in January and ends in December. It is divided into three terms of three months duration each, and about one month vacation in between.

This structure is based on the Education Act of 1966. By this act, education (even primary) is not compulsory, which means that there is no penalty for parents who do not send their children to school. There have been some attempts to review the act, but they were not successful: As there are not enough schools to accommodate all children with a place, it has been impossible to make education compulsory.

In 1998, about 250,000 pupils enrolled for Grade I, which equals a gross enrollment rate[66] of 78%. The number of students who finished junior high school with Grade IX is less than half of that. Out of the approx. 100,000 candidates for senior high school, only 16 to 20 per cent were selected.

In 1994, there were 47,500 teachers at primary level and 10,800 teachers for secondary level. The teacher-pupil ratio at primary level was 1:45 in 1998, and 1:29 at secondary level. The average school class size at the national level was 37 at primary level and 48.4 at secondary level. The size for urban schools is usually much higher than in rural schools, sometimes reaching up to 60 pupils per class.

2.2.2 School Curriculum

According to the UNESCO profile, the main objectives of the educational policy in Zambia are

- to provide every Zambian child with nine years of schooling

- to offer quality education aimed at producing a total human being with knowledge, creative and analytical thinking skills, and the capacity to uphold civic, moral and spiritual values

[66] The net enrollment rate is less because many pupils either repeat a class, or they need to wait a year or two until they can get a place in a school.

- to offer curriculum options that include practical, technical and life skills at all levels of education
- to encourage support for tertiary education; its financing will be shared between government institutions and students
- to provide an education responsive to the needs of Zambian society [UNESCO 1]

Interestingly, the curriculum for primary schools proposes the teaching of computer literacy, as part of the literacy class. (Computer literacy teaches basic use and terminology of computers.) Computer studies however have not yet been included in the high school syllabus. As computer literacy should be taught in primary school, the list of subjects at the primary level should receive some attention:

- Literacy, which includes reading and writing in English, Zambian languages and using computers
- English language
- Zambian languages
- Numeracy (at lower) and Mathematics (at upper primary level)
- Environmental Science (lower primary), which includes education about hygiene, health, food and social skills; and Science, Environment and Home Economics (upper primary) with education in agriculure, geography and environment
- Social Studies, including history, political education, moral education, health and life skills
- Technology Studies (upper primary), which is about the Industrial Arts mentioned above: using tools in various areas.
- Expressive Arts (upper primary) to educate in music, dance, drawing and Zambian traditional culture
- Physical Development (i.e. sports)

Junior and senior high schools continue these subjects and add more academic as well as more specialized, optional subjects. Junior high schools teach English, Mathematics, Environmental Science, History, Geography, Civics, and as optional subjects Religious Education, Commercial subjects (office practice, typing and bookkeeping), Industrial Arts, Music, Creative Arts, Home Economics and French.

Senior high schools then teach English, Mathematics, Biology, Physics, Chemistry, English Literature, Geography, Zambian languages, Commerce, Principles of Accounts, Additional Mathematics, Science, Industrial Arts, Fashion and Fabrics, Food and Nutrition and Religious Education.

2.2.3 History of the Curriculum

The current curriculum has undergone a history of changes. In the beginning, when Zambia became a new nation in 1964, "it became urgently necessary to train sufficient Zambians to take over the senior administrative and professional posts [...] and the curriculum in all schools was revised to give greater emphasis to language, mathematics and science" [FINNIDA, p. 13] The schools thus laid focus on academic subjects, to train people for office jobs.

In 1977, the curriculum was revised and "Practical Subjects" were introduced at the upper primary level. Practical Subjects, called "Industrial Arts" today are training in woodwork, metalwork and technical drawing (mostly woodwork, though). The new subject was created with the help of the Finnish government agency FINNIDA. The history and the outcomes of this project are quite interesting and have been considered in this paper. One similarity is that the teaching of something practical is introduced (instead of the academic subjects which can be taught with books alone.) Another is the aspect of Development cooperation: In the 1980s, the Finnish government funded the whole project, from the administration by Finnish officers to teacher training to the supply of tools and workshops for the schools. Today, something similar is happening with computer education: Government institutions, NGOs and companies are donating computers and software for Zambian schools. And the efforts of the United Nations to promote computers in education have been noted before in the introduction. This paper is a form of development cooperation, too: it is written by a foreigner for the Zambian education system.

The FINNIDA project was considered a failure and was terminated in 1990. The main reasons were that management felt that Practical Subjects (or the planning of Practical Subjects by a foreign organisation) were not regarded as necessary by parents, employers, teachers and the Ministry of Education alike. It was also very difficult maintain workshops at the schools. Due to the widespread poverty, many of the tools were stolen, and the schools could not afford repairs. When the Finnish officers and the funds were withdrawn, the teaching of Practical Subjects nearly collapsed. As management of the project had been done entirely by the Finnish officers, there were no allocated resources within the Zambian Ministry of Education.

An evaluation of the project afterwards in 1993 however revealed that, after 15 years of work, the views of many people had changed. Parents now see education in practical skills as helpful. A reason may be that the number of office jobs has not increased over the years, while the population has grown rapidly - nowadays, it is very hard to get a job where tradidional academic subjects are needed, so skills for self-employment have increased value.

There was another basic curriculum review from 1993 to 1996, after which education

in issues of population, environment, drugs, HIV/AIDS prevention, democracy and human rights were included. Only two years later the curriculum underwent change again, from 1998 till 2001. It was adapted to use concepts of Outcomes Based Education (OBE), which was also introduced in South Africa in the 1990s. (OBE originates from the USA and is used in New Zealand as well; there are positive and negative opinions on its effectiveness.) The new curriculum proposes more learning time and continuous assessment (i.e. weekly tests, to help teachers monitoring the pupils and to give pupils a better view on their own progress.) It also concentrates on fewer subjects (with emphasis on literacy and numeracy) and includes local content and life skills education.

The Zambian education system has been subject to the global change from a teacher-centered to a pupil-centered approach. As a result, "there is a wide range of teaching and learning strategies used in Zambia. These include discussions, investigation, experiment, project work, field work, demonstration, inquiry, problem solving, brainstorming, research, drama, role play, theatre, reflection and debate. [...] Teachers are encouraged to use a wide range of teaching techniques that promote active pupil participation and class interaction, in particular methods which encourage learners to reflect, think and do rather than merely reproduce from memory." [UNESCO 1]

High schools in Zambia used to follow syllabi prepared by the Cambridge University in the United Kingdom. In the early 1990s however the Ministry of Education decided to give up this cooperation, and now the high school curriculum is designed in Zambia.

2.2.4 Administration

The Ministry of Education (MoE) bears responsibility for primary and secondary government schools. Some schools are also run by churches, there are private schools (which are expensive) and community schools, which emerged in the second half of the 1990s as a response to the insufficient number of government schools (their numbers rose from 55 schools in 1996 to 373 in 1999.) Community schools are administered through the Zambia Community Schools Secretariat (ZCSS), and learning materials are provided by the MoE.

Higher Education is the responsibility of the Ministry of Science and Technology. However, of the eleven Teacher Training Colleges, four are owned and managed by churches. The Ministry of Community Development and Social Services takes care of non-formal education (e.g. literacy or home economics classes outside schools.) HIV and poplation issues are also taught by NGOs. Pre-primary education is done by local authorities, communities, NGOs and private individuals.

The Zambian school system has been criticised for being too centralized. Procedures to recruit and promote teachers are bureaucratic. The hierarchical structure has led to an unclear chain of command. Furthermore, structures for planning and monitoring the school system were and are deficient. Thus attempts have been made since 1997 to decen-

tralize the system into provincial and district boards, and also into college and secondary school boards. By this way, communities shall have their word in the choice of subjects and the school affairs. The Copperbelt province has been a piloting scheme for the change.

Curriculum Development Process The changes in the education system have affected how curricula are developed. The Curriculum Development Centre (CDC) of the MoE is responsible for the curriculum, but other institutions may get involved. There are now five phases of curriculum development (quoted from [UNESCO 1]):

1. Formulation of aims and objectives
2. Selection of learning experiences (i.e. what students should learn by the curriculum: knowledge, competencies, skills, values, attitudes)
3. Selection of content or subject matter through which certain types of experiences may be offered
4. Organisation and integration of learning experiences and content with respect to the teaching and learning process within school and classroom
5. Evaluation of the effectiveness of all aspects of these steps in achieving the goals

A change of the curriculum, which undergoes these five steps, may be initiated by a number of incidents:

- a change in government
- a change of the teacher education curriculum
- national or international demand for inclusion of cross-cutting issues or disciplines such as family life education, reproductive health, environmental education, human rights etc.

Apart from the specialists for curricula and examination of the Ministry of Education, there are other stakeholders who can contriubte in the process of curriculum change. University and college lecturers, teachers, NGOs, CBOs (community-based organisations) and churches contribute to the development of curricula. During the process of a curriculum review there will be call for a national symposium where the stakeholders will meet and express their views. A set of draft syllabi is then prepared by technical committees at workshops - these committees are part of the Curriculum Development Center (CDC). The draft syllabi are presented at a second symposium, and the stakeholders get a chance again to participate. After another period of development, the final syllabi are approved by the curriculum committees.

Monitoring of the curriculum and curriculum materials is done by the Evaluation and Research Department of the CDC.

Learing Materials Another change in the education system was the liberalisation of the provision of learning materials. It used to be that all materials were developed by the CDC, and then printed by Zambian companies, e.g. the Education Publishing House, Printpak Zambia or the Zambia Printing Company. Nowadays, private companies (like Macmillan for example) produce textbooks, which are then approved by the Ministry of Education. The establishment of a Book Development Council to coordinate efforts is proposed, but not yet realized.

Learning materials are in short supply at most schools. Very few schools have libraries, and even fewer have computers - though computers are being used in teacher education. The workshops that were built in a quarter of the Zambian primary schools by the Finnish development cooperation were not in a good state at many schools when the project was evaluated in 1993. The schools had no funds to afford repairs, and tools were missing due to theft, which could also not be replaced. As the tools were European high-quality products, they were of considerable value for those many people who live in poverty, for either selling or for using them to make an income.

The Zambian government also set up Educational Broadcasting by radio and television, but according to the profile by the UNESCO, it has deteriorated to a great extent. Audio-visual equipment is not available at most schools.

Financing Education The Kaunda administration spent a lot of money on education. However, "from 1975 onwards the Education sector was dominated by a growing shortage of resources. Between 1975 and 1983 there was a 25% reduction in educational allocations, which, after allowing for inflation, represents a reduction of 40%. This hard fact of life has forced changes in educational planning more and more towards self-sufficency, i.e. schools having to fend for themselves." [FINNIDA, p. 13]

In 1986, boarding fees for schools were introduced - which are low, for European standards, but nonetheless unaffordable for some families. In 1985, the government also launched a program called SHAPE: schools should raise funds by selling goods that were produced by students in class or by reparing furniture for the community. Another form of cost-sharing are the Parent-Teacher Associations (PTAs), which charge fees from parents and contribute in many ways to the school system.

The directions of the International Monetary Fund have also had a negative effect on education. A serious drawback of the Structural Adjustment Programmes is that there is not enough money for teacher wages: "Last year [2003] the Fund froze lending to Zambia after a higher budgetary deficit than anticipated, and told the government to reduce its public sector wage bill to no more than 8% of GDP. In order to achieve this, the Ministry

of Finance [...] had to withdraw any new hiring of teachers and health workers. [...] In 2004, the Zambian government will be paying the IMF alone $25 million *more* than it is spending on education. [...]" [GCE, p. 1/2]

As a result, pupils do not get accepted for schools, or classes grow to unmanageable sizes. In some schools, teachers work two shifts a day: one half of the pupils are educated in the morning, the other half in the afternoon.

The salary of teachers in Zambia is low in comparison with other countries, but way higher than the average GDP or $340 a year: After teachers' strikes, the government increased wages by 40%, giving the least paid teachers a monthly income of 405,000 Kwacha, which is about $90[67].

2.2.5 Teacher Education

Teachers for Primary Schools Teachers for primary schools can either obtain a college certificate after two years of education, or a college diploma after three years. An upgrade from certificate to diploma can be obtained through in-service training, after some years of school service. There are 11 colleges for primary school teachers, four of which are maintained by churches. Teachers are educated in all subjects for primary school. About 1,900 teachers for primary schools graduate per year. This number is too small, and as a result, 15% of primary school teachers are untrained.

Teachers for Junior High Schools Junior high school teachers need to obtain a diploma from one of the three institutions: Nkrumah Teacher College, Copperbelt Secondary Teacher College and Luanshya Technical and Vocational Teacher College. There are some other colleges that offer special training, like the Evelyn Hone College in Lusaka that offers education for art and music teachers. The curricula of all colleges except Evelyn Hone are set by the Ministry of Education.

Teachers for Senior High Schools Teachers need to obtain a degree from the University of Zambia to be allowed for senior secondary education - in theory. In practice, there are not enough senior secondary teachers, so there are also diploma teachers in senior classes, especially in English, Mathematics and Science.

New teaching and learning strategies (like for example Outcomes-based Education, education about HIV, or the use of ICTs in class) are introduced to teachers in workshops or in-service training. The capacity for in-service training however is very limited: In 1994, only 1% of serving teachers underwent formal training.

[67] http://www.nswtf.org.au/world/20010626_fortypercent.html

2.2.6 Problems

The problems of the Zambian education system are manyfold and have been mentioned above. They are presented here in a short overview again:

- High attrition rate of teachers: about 10% of the teachers leave the education system per year, because conditions are better in other sectors or in the neighboring countries.
- HIV/AIDS is another reason why there are not enough teachers - many die at a very young age.[68]
- Insufficient number of schools at all levels - 15% of the school age population is not enrolled because of lack of places
- Education is not compulsory, and some parents cannot afford school fees, so some children are not sent to school.
- Girls have a higher drop-out rate than boys, because of early pregnancies or marriages. Also, there are less schools for girls than for boys. This had led to a number of affirmative actions: girls may pass on to secondary education with lower grades than boys; some boys' schools have been opened for girls; and teachers are being sensitized for gender problems.)
- Lack of funds for school repairs
- Shortage of learning materials: starting from textbooks and ending with computers
- Theft and vandalism of school property, especially expensive tools
- Computer education: there is a lack of skilled computer studies teachers, and a lack of resources within the ministry of education to develop plans for the integration of computers in school education.

[68] For more information, refer to "A lesson in dying" by Joshua Benton, The Dallas Morning News, Fall 2003
http://www.journalismfellowships.org/stories/zambia/zambia_lesson.htm

2.3 Current ICT Situation in Zambia

As an industrialized country, Zambia has a long history of using computers. They have been used by the large organisations of the public and the private sector alike (by the city councils, for example, or the mining companies.) The average citizen, however, with an income of $340 per year can afford neither computers nor internet connections. This section gives an overview about the history and the current infrastructure of telecommunication in Zambia, introduces the recently established internet service providers and outlines Zambia's ICT policy, which is in the process of being created.

2.3.1 History

Zambia's telecommunications sector was controlled by a single company, the Posts and Telecommunications Corporation (PTC) until 1994. The company administered the country's telecommunications infrastructure, the telephone and postal services and possessed also the regulatory functions.

The PTC was split up in 1994 by the Telecommunications Act. The telecommunications infrastructure and services were now owned by ZAMTEL[69], the postal services by ZAMPOST and a new regulatory agency was founded: the Communications Authority of Zambia (CAZ)[70], all of which are still state-owned. There are plans to partially privatize ZAMTEL into a joint venture with a strategic partner and to offer ZAMTEL shares to the public. This has however not been done yet.

The Telecommunications Act of 1994 opened the sector for competition in all segments except the Public Switched Telephone Network (PSNT). Other segments like cellular networks or internet service provision are open for private companies.

Today, there is competition between three cellular operators as well as ten Internet Service providers (not all of which are operational yet.) The fixed telephone network has not grown substantially in the past ten years, but the number of cellular subscribers has increased tremendously. Internet is still unaffordable for most private people and small business because fixed telephone lines are too expensive. Internet cafés therefore have a growing population of customers.

2.3.2 Infrastructure

This sections presents some more details about today's capacities and services offered in telephone, mobile phone and internet segments.

Telephone network ZAMTEL is still the only operator for Public Switched Telephone Network (PSNT). Its trunk network consists of 70% digital and 30% analogue switches -

[69] http://www.zamtel.zm/zamtel
[70] http://www.caz.gov.zm

the analogue switches have been in use for more than 15 years and are difficult to maintain, because they are no longer supported by their manufacturers. The network has a capacity in the range of 130,000 lines.

The transmission network that links Zambia's cities and provinces is "predominantly analogue and is mainly based on microwave technology" [MCT, p. 7] There is a broadband digital microwave network linking Lusaka and the Copperbelt, and is commissioned to include Eastern Province and Siavonga. "Medium-sized towns and rural areas are connectied via light microwave links that also enable connections with neighboring countries" [Munsaka, p. 17]

For connecting rural communities that cannot be serviced by wires, ZAMTEL has installed a "Wireless Local Loop" system, but rolling out this system has been difficult because of financial difficulties.

The international gateway to connect Zambia with Europe, America and Asia is formed by three satellite earth stations[71]: Mwembeshi I (built 1974), Mwembeshi II (1987) and Mwembeshi III (2002). Besides telephone connections, also international television is received (from the Intelsat satellite.)

Some figures about the telephone network (from 2000, based on [Munsaka, p. 16]):

Capacity of Local Telephone Network:	135,500
Telephone Lines:	79,600
Telephone Lines in Lusaka:	36,762 (46%)
Waiting List:	9,755
Growth of the network:	0.8% (1997), -0.4% (1998)
	0.2 (1999), 1.6% (2000)
Teledensity:	1%
Teledensity in Lusaka:	2.4%

("Teledensity" is the rate of telephone lines per capita)

Cellular networks Since the Telecommunications Act of 1994, three Cellular service providers started to operate. One is ZAMTEL (whose cellular service is named CELL "Z"). The service was initially based on the Analogue Mobile Phone System (AMPS), but was switched to GSM in 2001.

The second operator is Telecel Zambia[72], "owned 30% locally, [and] a subsidiary of Telecel International Ltd, the U.S.-based cellular telecommunications group which has substantial experience of operating telecommunications businesses in Africa." [UNECA 1, p. 336] (Telecel International is again owned by the Egyptian conglomerate Orascom.) It launched a cellular service based on Code Division Multiple Access (CDMA), but

[71] http://www.zamtel.zm/zamtel/mwembeshi/index.htm
[72] http://www.telecel.co.zm

switched to GSM in 1999. Telecel built a broadband digital microwave network to connect Lusaka and the Copperbelt, where its main operations are.

The third cellular operator is CelTel Zambia[73], which is primarily owned by the UK based MSI Investments. CelTel built a GSM network in 1998 and operates in areas of Lusaka, the Copperbelt and Livingstone, and has also build its own broadband network.

Today, there are about 400,000 cellular subsribers, far more than the 80,000 fixed line subsribers. As of now, cellular services are only available in the urban centers and a number of rural towns.

Internet Service Providers (ISPs) "In 1994, Zambia became the first country in sub-Saharan Africa (outside of South Africa) to have full Internet access." [Munsaka, p. 20] There are 10 licensed Internet Service Providers, five of which are operational. A popular technology in Zambia is VSAT (Very Small Apparature Terminal), to connect subscribers via Satellite - as there is not yet a national fibre optic backbone, nor an extensive telephone network in the rural areas.

The Communication Authority (CAZ) charges a fairly high license fee of $40,000 for new ISPs, which is said to have the effect of discouraging too many ISPs on the Zambian market, only allowing well funded companies that offer quality service. [ZOI] There is however a lot of activity in the Zambian ISP market - even though an internet connection is not affordable for most people, there are many companies that are starting to use the internet, and the young market is growing.

- The first ISP in Zambia was ZAMNET[74], which is fully owned by the University of Zambia and started operating in 1994. It has three VSAT-enabled Points-of-Presence (POPs) in Lusaka, Kitwe and Livingstone. ZAMNET provides dial-up, leased-line and wireless access, and is also into web design, hosting and training services. ZAMNET is the ISP of the University of Zambia, which made UNZA one of the 20 African universities (out of a total of 250) to have internet access for all staff.

- The second ISP in Zambia was ZAMTEL[75]. ZAMTEL startet its internet service provision in 1997 and provides dial-up and leased-line access and operates one POP in Lusaka.

- CopperNET[76] used to be a division of Zambia Consolidated Copper Mines (ZCCM). When ZCCM was privatized, ZCCM Internet services became an independent company as joint venture between a team of former managers of ZCCM and the Cavemont Securities bank. CopperNET has two POPs at Lusaka and Kitwe and offers

[73] http://www.zm.celtel.com/en
[74] http://www.zamnet.zm
[75] http://www.zamtel.zm
[76] http://www.coppernet.zm

dial-up, DSL and wireless access, as well as networking for companies, web design, training and software development.

- Microlink[77] started operations in 2002 and currently has three POPs in Lusaka, Kitwe and Livingstone. Microlink and offers dial-up and wireless access, as well as hosting and training services.

- UUNET Zambia[78] started to operate recently and is a joint venture of UUNET South Africa (part of the U.S. company MCI) and Africa Online, an ISP offering services in a number of African countries.

The Draft ICT-Policy of September 2004 estimates 10 - 15,000 internet subscribers in Zambia, with another 30,000 people using internet cafés. In the big cities, internet access is "affordable" - installation fees vary from $10 to $30, and monthly charges range from $20 (for 40 hours, ZAMNET or 20 hours, ZAMTEL) to $25 (unlimited access, Coppernet), and on top of that, customers pay a low price for using the telephone line. In other places however, internet is still luxury. The prices for telephone connections to the nearest Point of Presence of an ISP, with an average use of 30 hours per month range from $180 to $480. With telephone prices like this, connection via satellite become interesting for remote places.

2.3.3 Use of ICTs in Zambia

Information and Communication Technologies are used in quite diverse ways in Zambia. In many ways, however, the applications of computers and the internet are either not used, or in the stage of introduction. As noted before, the cellular phone services are very popular in Zambia, while there are only few internet users. Access to ICTs exists in the urban areas with increasing coverage and quality, but in remote areas it is either impossible or very expensive to use the full spectrum of ICT services. There is also a lack of qualified staff in all areas of ICT, which has led to high salaries and a culture of job-hopping. [Munsaka] argues that the lack of skilled ICT personnel has discouraged small business from investing in computers.

The following list describes the status quo in Zambia. For the future, the Draft ICT Policy aims at promoting more applications of ICTs in many ways in Zambia (see section 2.3.5 on the ICT Policy.)

- *Computers in Business:* Those business that do have computers use them mainly for accounting, and an accounting software package named *Pastel*[79] is popular, which

[77] http://www.microlink.zm
[78] http://www.uunet.co.zm
[79] http://www.pastel.com/

is Windows based and developed by Softline Pty. in South Africa. Another package for larger companies is Sun Systems[80], developed in the U.K.

- *Government institutions* have been using computers since decades. In the city councils, for example, the main use of computers has been recording tax revenues. Only since recently government institutions are presenting themselves on the internet. At the moment, however, many websites of the Zambian ministries are often not reachable.

- *E-commerce:* As there are not many private internet users, there is also not a big market yet for commercial websites. There is one website called *Broken Hill Media*[81] that has an online shop, selling music and t-shirts.

- *Public information:* There are a number of well-maintained news pages and web directories: The newspapers *The Post*[82], *The Times of Zambia*[83], *Daily Mail*[84] and the webpage *Dispatch*[85] publish news on a daily basis. *The Zambian*[86] and *Zambia Online*[87] offer portals to many Zambian sites.

- *Software development:* There are only a few small companies besides CopperNET that produce software - which, again, is due to lack of skilled computer people.

2.3.4 Computers in Education

ICT is regarded as important for development by governments and NGOs alike. The United Nations' institutions (UNESCO and Worldbank for example) are promoting education with computers, by preparing guides for curriculum development and teaching methods. The World Summit on the Information Society (WSIS)[88], prepared by the United Nations is the leading conference to promote ICT in all countries, and Zambia participated in the WSIS.

The computer age in the Zambian education system is only beginning: "The Zambian Education System especially in the public schools in characterized by low ICT adoption rates such that only a small percentage from the private schools are ICT literate by the time they leave secondary schools. There are over 6,000 public schools out of which very few have ICT subjects as part of the curriculum. In 1998, the Ministry of Education started an

[80] http://www.sunsystems.com
[81] http://www.brokenhill.co.zm
[82] http://www.post.co.zm
[83] http://www.times.co.zm
[84] http://www.daily-mail.co.zm
[85] http://www.dispatch.co.zm
[86] http://www.thezambian.com
[87] http://www.zambia.co.zm
[88] http://www.itu.int/wsis

initative to introduce computer studies in selected secondary schools. The initative needs to be encouraged and scaled up to all schools" [MCT, p. 3]

The efforts to equip Zambian schools with computers are carried out by a number of European nonprofit organisations. The British NGO *Computers for African Schools (CFAS)*[89] has equipped schools in all provinces with computers. The computers were donated by a number of British companies that upgraded their PC inventories and gave the old machines away for free. British Airways then transported some of them, also at no charge, and the rest was carried by ship. CFAS has a Zambian partner organisation, *Computers for Zambian Schools (CFZS)*[90], which is run by the British Council[91] and the Beit Trust in Lusaka. Here, the schools may apply for 10 computers and a printer, and the only conditions are that they pick up the PCs, that they have a dust-free classroom for the computers and that there is at least one person with some computer experience at the school. If there is no-one, CFZS promises to provide training as well.

CFAS and CFZS have donated some 1,500 PCs to Zambia in January 2004, and they have commitments for 500 more. The machines are Pentium 1 Class PCs. Initially they had Linux installed (SuSE or Lycoris), but Microsoft donated licenses for Windows 98 and Office 97, which have since been used. Their list of schools[92] has 44 names, and their map has even more schools listed. In total, there were 340 PCs donated in Copperbelt Province, 331 in Lusaka, 153 in Central Province, 211 in Eastern, 127 in Northern, 251 in Southern, 69 in Western, 75 in North Western and 10 in Luapula Province.

A second organisation has brought some computers to schools in Zambia: *Computer Aid International*[93] is also a British NGO and they have donated 45,000 computers worldwide (however they don't seem to be active in Zambia at the moment.)

Then there is the African NGO *Schoolnet Africa*[94], based in Johannesburg, which operates in many African countries. Their ambitious plan (among others) is to bring one million computers to African schools.

Another organisation that is involved in ICT-utilization for education is the *International Institute for Communication and Development (IICD)*[95], which was established in 1997 by the Netherlands Minister for Development Cooperation and is now funded by the Netherlands, the UK and Switzerland. IICD has organized a "Roundtable on ICTs in Education", which was held in 2003 in Ndola. An outcome of this conference was a paper that analyzed the current state of computer-usage in Zambian education institutions. Following the roundtable, some projects have been initiated : a Management Information System is being designed for the Ministry of Education with the help of IICD, as well as

[89] http://www.cfas.org.uk
[90] http://www.cfzs.org.zm
[91] http://www.britishcouncil.org/zambia
[92] http://www.cfzs.org.zm/list_of_schools.htm
[93] http://www.computer-aid.org
[94] http://www.schoolnetafrica.net
[95] http://www.iicd.org

an ICT policy for the same ministry. The goal of the proposed ICT policy for the Ministry of Education is to be a framework of how ICTs should be used by the ministry for management and for improving the quality of education. The purpose of the "Education Management Information System" (EMIS) is described as follows:

> "Having established an EMIS system the Ministry of Education now is training school mangers in methods of how to make use the technology. The aim is have computers and their use aid managers in making management decisions. Schools, districts and regional offices ought to start to use computers to store useful information and data for future use." [Roundtable, p. 23]

IICD is also running computer projects with "Global Teenager Schools"[96], but not in the scale of the British NGOs. Furthermore, they are planning a project with the Zambian internet service provider Microlink to bring ICTs to schools.

As for higher education, there are some programmes for ICT training in Zambia. Before 1996, "Zambia's highest qualification in computing was a three-year computer studies diploma taught by Evelyn Hone College, with an annual output of 30 - 45 students. In 2000, the University of Zambia rolled out its first graduate degree students in Computer Studies. [...] The Copperbelt university offers a four-year computer degree programme, which was introduced about five years ago [also in 1996]" [Munsaka, p. 23]

Both universities however suffer from lack of staff - when the author visited the Computer Studies Department of UNZA in 2003, the professor from Belgium was about to leave, and only a handful of lecturers remained. The post-graduate diploma course had been suspended because there were no lecturers to teach the curriculum.

For teacher education, there is a course by the School of Education at UNZA, which offers "a four-year program leading to the degree of Bachelor of Arts with Library and Information Studies." [Munsaka, p. 23]

2.3.5 The Draft ICT Policy

The need to promote Information and Communication Technology has been recognized by the Zambian government, and in order to have a better legal framework for ICT infrastructure development and the use of ICTs in business, education, health and other sectors, efforts have been made to create a National ICT Policy.

These efforts were initiated through the United Nations in 1995 by the adoption of the Africa Information Society Initiative (AISI)[97]:

> AISI is a common vision for Africa's quest to bridge the digital divide. It was adopted by the [UN-] ECA Conference of Ministers responsible for

[96] http://www.globalteenager.org
[97] http://www.uneca.org/aisi/

> economic and social planning and development (Addis Abeba, 1996) and subsequently endorsed by various high-level Ministerial and OAU[98] Heads of Summit meetings including the 1997 G-8 Summit. It was revised during the African Development Forum 1999. Several implementation activities have taken place in the following areas:
>
> - Policy awareness
> - Democratising access to the information society
> - Infrastructure development and internet connectivity
> - National Information and Communication Infrastructure (NICI) Plans
> - Development Information
> - Sectoral applications[99]
> - Training and capacity building
>
> By the year 2010, AISI intends to realize a sustainable information society for Africa. [UNECA 2]

The AISI is embedded in the international context with the United Nations, the World Summit on the Information Society and the Millenium Development Goals[100] of the UNDP for Africa. On the level of the African continent it is aligned with the ICT-related projects of the New Partnership for African Development (NEPAD)[101].

Since the adoption of the AISI, there have been efforts in many African countries to establish national ICT policies. In Zambia, a draft NICI policy was developed in 2001:

> In 2000, Zambia, under the leadership of the Ministry of Information and Broadcasting Services, and through support from the [UN-] ECA, engaged two local consultants that developed a draft ICT policy working document for discussion at a consultative meeting that was held in March 2001. The document articulates the need for Zambia to emerge with broad-based information society policy with emphasis on the development of physical infrastructure, promotion of universal access, human resources development, by launching electronic government, the development of ICT sector and creation of jobs, harnessing ICTs by SMEs [Small and Medium Enterprises], particularly the electronic commerce and the promotion of applications in education, environment, livelihood and health.[UNECA 3]

The NICI document assessed Zambia's ICT situation and proposed how the ICT sector should be reformed. While it had a focus on ICT infrastructure, it also addressed the

[98] Organisation of African Unity, which is an attempt to form a union of the African Nations and is based in Addis Abeba, Ethiopia. The OAU was dissolved in 1999 in the creation of the Afrian Union (AU).

[99] i.e. the application of ICT in other sectors, like agriculture, health, business, education, ...

[100] http://www.undp.org/mdg

[101] http://www.nepad.org

problem of lacking ICT professionals in Zambia and proposed teaching of ICTs through the education system. Moreover, it showed a number of applications of ICTs, for example in government, in the health sector and for tourism.

Much of this first attempt was incorporated into a draft National ICT Policy[102], which is still in the process of creation. A first draft was released by the Ministry of Information and Broadcasting in November 2003, and a second draft in September 2004. It has three parts: a background part about the current situation, a part about goals, which is mostly about future applications of ICTs in Zambia, and an part that proposes how government and other stakeholders should proceed with the implementation of the policy.

2.3.6 Vision for the future

For the future, the draft ICT Policy proposes that Zambia should adapt to the international ICT frameworks of NEPAD and the World Summit on the Information society and other programmes. Ambitiously, it notes 13 pillars on which the information society in Zambia should be built:

- *Human Resources:* all Zambian employees should be educated in computer literacy
- *Education:* all schools should use computers, and there should be offerings of distance education for remote areas. Furthermore, the internet should be used to link universities, colleges and libraries with global networks.
- *Public access and local content:* in order to make computers and internet available to many people, there should be telecenters at all post offices and libraries. These may be used for e-commerce, receiving news, consulting in issues like HIV and creating local and cultural content.
- An *ICT industry* should be built up to create local software, to be able to compete internationally and to attract foreign direct investment.
- The *ICT infrastructure* should be extended.
- *E-government:* all ministries should have ICT departments; government agencies and offices should be linked nationwide; By means of ICTs, a decentralisation strategy should be implemented, and the civil society should be incorporated into decision-making; information and consultation should be offered to the public; and the use of proprietary as well as Open Source software is recommended.
- *E-commerce:* ICTs shall be used to link Zambian business with each other, with their customers and with foreign companies.

[102] It is available to the public at http://www.coppernet.zm/ictpolicy

- In *agriculture*, ICTs should be used to collect statistical information for research and nationwide planning and to enhance production. A nationwide weather-warning system is proposed as well.
- *Health:* ICTs should be used for clinic management; to distribute medical skills better, telemedicine is proposed; health information should be offered for the public, and information gathered for research.
- *Tourism:* ICTs should be used to collect more information about Zambia's potential for tourism, so more touristic attractions can be offered. Information about places-to-see, hotels and transport should then be made available online.
- *Youth and gender issues* should receive more public attention through ICTs; communication networks should be offered to disadvantaged groups, and costs should be reduced for them.
- *A legal framework* shall ensure that all the above developments are done in a concerted effort.
- *Issues of security, privacy and consumer protection* need to be considered.

2.4 Interviews

The interviews presented here were conducted by the author in Kitwe during his travel to Zambia in September / October 2004. Starting out with some short talks with customers of internet cafés, people from different areas of the Zambian "IT world" were interviewed: managers of internet cafés, a university lecturer, computer shop owners, the computer manager of the City Council and a manager at an internet service provider. By conducting interviews, some insight into the topic of this paper was gained that would not have been possible by research in books or the internet.

The design of the interviews followed a method of qualitative social research, which is to prepare a guideline for the interview rather than a fixed set of questions. The guidelines gave a meaningful structure that roughly outlined what type of questions should be answered, but left space for additional questions and intuition during the interview. All interviees were firstly asked about their acquaintance with Open Source; there were enquiries about their work and their education, and finally they were asked to share their view about the future of ICT in Zambia.

The interviews were recorded on tape; the transcriptions of three of them are presented here.

2.4.1 Computer Retail Shop: ACL

Interview with Narendra Sachar, Managing Director of AT Computers Ltd., Kitwe
Date: Sept. 16, 2004
Location: AT Computers, Zambia Way, Kitwe

AT Computers offers new computers and accessoires as well as software in a large shop. The interview starts in the main shop, but when I ask if I may use a recorder, Mr Sachar invites me into his office. Some days before, I gave him a list with questions for preparation, and first we walk through these. During the course of the interview, we are interrupted once for an important phone call, and I'm offered coffee while waiting. At the end of the interview, Mr Sachar also shows me the workshop in the same building, in which computers are assembled and repaired.

Christian Pothmann: So you've never heard of the Linux operating system before?

Narenda Sachar: No, I heard... but I don't use them because, mostly the people also don't use it. My customers, you know. So that's why I've never done. Ok, the next one [question on the sheet] is about computer hardware and network hardware. Do you deal with second hand hardware? No. We don't deal with second hand goods. We only deal in brand new ones. Then, installation of operating system and software. We use Microsoft Windows.

CP: What type of customers do you have? Single users or also large networks?

NS: We do set up networks and networking hardware, but mostly we sell single computers.

CP: And which software do you sell?

NS: Only Windows and MS Office.

CP: Do you give support to customers?

NS: There's a warranty of one year on the machines, by the supplier itech, which is based in the United States. We only complete systems. We're authorized dealers for HP, Mecer...

CP: Do you repair machines if customers have a problem?

NS: Yes, we have a workshop.

CP: Who is working there?

NS: We have technicians, apprentices, and even myself. I'm a computer engineer, you know.

CP: Where did you receive your education?

NS: In India, 20 years ago. I went to university and studied electrical engineering. There were no computers in those days. I taught myself in computers. When I came to Zambia, 20 years ago, I bought my first compupter. This business I've had for four years.

CP: Do you do any training or consulting?

NS: Yes, we have apprentices in the workshop. They come from college and stay for six months up to one year.

CP: What type of customers do you have?

NS: Some private, some business, some government - even the ministry of education buys from us, the city council. There's ZESCO, Zamtel...

CP: Do you have a contract with them?

NS: No, they just come and ask for the quotation, and then walk to the next, and choose which one is the best.

[There is a break due to a phone call]

NS: What else?

CP: You said that none of the customers will ask for Linux?

NS: No [laughs] unfortunately not.

CP: But have you dealt with the big internet service providers like CopperNET or Microlink?

NS: They are our customers as well, but they never asked these things before.

CP: Ok. What's your vision for the future of information technology in Zambia?

NS: It's very good, very good, because... four years ago, when I opened this shop, the number of machines I was selling at that time and the number of machines I'm selling *this time* is... too high. It's improving. Nowadays, you know, every child who goes to school will also learn computers in school as well. As soon as he grows a little bit, he needs a computer at home.

CP: But isn't it a bit too expensive for most families to afford a computer?

NS: No, the thing is... Ok, it's expensive, you're right. But only people who can afford it will buy, you know. The others can't buy, because the minimum computer we're selling here is about 900 dollars.

CP: Ok.

NS: And that of course includes VAT. I mean, some people, they buy on lay by system, they keep on depositing money.

CP: Yes.

NS: But still, sales are improving.

CP: So would you say, four years ago, how many more computers do you sell now?

NS: You can say that sales have more than doubled.

CP: And the price of computers are dropping?

NS: Prices... of course what it was four years ago and now, it is much less. Four years ago I know the same computer which I was selling at entry level was 1,300 dollars. Now, I'm selling entry level computer at 900 dollars. And it's more faster and more bigger than before.

CP: I know. If you bought a computer ten years ago, you paid 2,000 dollars, and you got...

NS: That's what I'm saying. Now they are going at a higher configuration and a lower price.

CP: Of these 900 dollars, how much is the price of the software?

NS: Software is just one Windows XP Home Edition, which is, you can say, a hundred, hundred and ten dollars.

CP: So if you sold the machine with Linux...

NS: I don't know the price of Linux.

CP: Well, it's Open Source, which means you can make a copy without charge.

NS: Is it?

CP: Yes.

NS: I know nothing about that.

CP: The Linux companies, the only way they make money is... they give you the installation disks for free, and then they charge for books, or for education. The way it works, it is developed by a community. Most Linux software products, they are free of charge.

NS: Yeah, but the thing is, if I would take that operating system, then what about the other software, about Word, Excel and other things, you know, because nowadays most of the hardware and software as well are made for Windows.

CP: Well, Linux works on the same computers. And there is software which is similar to Word and Excel. It's just, you know, most people, they're used to Windows.

NS: No, what I'm saying is that if I put Linux as operating system on my computer, then the driver which it needs, those are supposed to be compatible with the same operating system. So if I put, let's see, a VGA card and it says "compatible with Windows 98, Windows 95, NT, 2000 and XP", it doesn't say for Linux as well.

CP: Many companies, they don't recognize that there's Linux.

NS: Yeah, that's the thing - tomorrow, if they want some software, it doesn't run with Linux, then what will they do? Somebody brings some software that is written in Microsoft Word. How will they work with Linux?

CP: It's possible...

NS: Yeah, it's possible, but you know, people they... it's very difficult, you know.

CP: To convince them?

NS: Convince them for what... Unless, you know, something is done in the larger scale, and some publicity is done by the company, and you go to people and say "You try this, if it doesn't work after six months, we don't charge you."

CP: I know.

NS: So, you are mostly doing this research about Linux?

CP: I'm doing research on the use of computers in developing countries...

NS: Do you have some software with you, about Linux?

CP: I have a...

NS: Do you have some operating system and other software like Microsoft Word, Excel, which is supposed to be Linux? Maybe we can try putting it on some machine and then maybe we can reduce the price of the machine, you know? So that people, they can buy

in terms of “If you buy this operating system, if you just want to use the basic computer, try this, and you will not have to pay for the operating system, which is almost a hundred dollars in the pay.”

CP: I do have a Linux with me, but... maybe we can make a demonstration.

NS: Yeah, I can make a copy, and then try it. Some people... I can ask people, if you have a copy, and maybe, because you’re saying it’s free, maybe I will put them for a trial phase, you know.

CP: Yes.

NS: And see if people ... like it, you know. But does it work like Windows?

CP: It’s similar in the way that it has a graphical user interface, it has windows, it has buttons, it’s got a browser, which is Mozilla...

NS: The use is same like Windows?

CP: Yes, but it doesn’t look the same, so you have to get used to it. But once you get to the more advanced things like networking, it’s totally different. But if you like, I could show you a tour right now, because the CD is an operating system which you don’t have to install. You put in the CD, it boots, it doesn’t copy any files to the harddrive.

NS: Is it?

CP: Yes.

NS: Let’s see...

[He lets me run the Knoppix CD on the computer in his office; but as the language is German at first, the switch to English requires a bit of configuration; and moreover, Open Office won’t start because the memory of the computer is too small. He says it’s too complicated to install it on computers for customers. He shows me the workshop, and we conclude the inteview.]

2.4.2 Internet Service Provider: CopperNET

Interview with Patrick Mugabeni, Technical Manager at CopperNET Solutions
Date: Sept. 22, 2004
Location: Silicon House, Kitwe, Zambia

The interview takes place in Mr Mugabeni's office, one of many surrounding a large empty space. It is my third attempt (the first time, he was too busy because of a technical problem, the second time (this morning) he was not in yet because he worked on the problem till late at night. He welcomes me, and when I start off with "I would like to use a tape recorder", he says "Well, first you should introduce yourself, so I can see what this is all about", not unfriendly. He is sitting behind a desk that occupies most of the room, behind a laptop, on which he types from time to time when I'm busy taking notes. In the beginning he receives a phone call and indicates that this may happen a lot, but luckily we are not interrupted again during the interview. He seems well educated, had some grey hair, "between 40 and 50 years" would be my guess, and he is quite talkative.

Christian Pothmann: Which equipment is used at Coppernet for networking services, especially operating systems?

Patrick Mugabeni: Coppernet is well known as an ISP, but we're not just an ISP. We deal in software development, we deal in training, to a limited extent, we have field networks, we provide telephone services, and we're also into internet service provision. So, to answer your question on the operating system, it's really a combination at the moment, it's Windows 2000 server, and Linux. But predominantly Linux.

CP: Which distribution?

PM: Well, primarily Red Hat for production, and then several others. Individually we use different ones - I use Debian, sometimes Red Hat, but at the moment, I'm with Debian. In the past, we used SuSE, but I think it was too heavy for our requirements. We are really into Open Source in terms of our operations. But for the clients, they run Windows XP; and NT or 2000.

CP: And the office people in the company, do they use Windows?

PM: Yeah, they use Windows.

CP: And the technical people?

PM: The technical people, most of them run Linux. Sometimes a combination. I have two partitions where I run both Linux and Windows - if I can't find something on Linux.

CP: So do you find it difficult to find staff that is educated in Linux? I mean, I talked to quite a few people and I've never met anyone who is familiar with Linux.

PM: Ok, let me see. I've been in the computer industry for a long time. I think I started in the company for ZCCM in 1995, until 1999. I did school also for 16 years in computing. I've moved through all the operating systems from DOS, 2.1, 3.11, 95, 98[103], you mention any operating system, I've gone through that. But I made a decision in 1999 to move away from Windows. Actually even earlier than that, about 1998, I moved to Macintosh. I ran the Mac until the hardware failed, at some point, and thereafter I shifted over to Linux. I haven't used Windows for a long time. So I prefer that Linux is the way to go. It's been made easy to configure now because it comes pretty much prepackaged. And all you do is just pick up your packages and configure them. The real thing is that to work in an office I don't need things like Encharta, I don't need things like Encyclopedia... I'm happy with Linux spreadsheet, I can use either Star Office or K Office or I can use, ah, the other office suite, separated from Linux. I get to do my job. I can exchange information with the Windows platform without any problem.

CP: Are you responsible for configuring the Linux servers?

PM: I am the head of the department, there are guys who are responsible for configuring Linux. Though I know how to configure Linux, I'm not a guru. But I've got guys who are good at that. And about the telephone network, I've got good guys who do that. So, my section deals with telephony, and with server system, networking...

CP: You say you have people who configure the servers, and they're good at it. Where did you find these people?

PM: The history of this company... We were a department of the Zambian Consolidated Coppermines mining company that was running almost all the mines in Zambia. And we broke away from there after the sale of the mines...

CP: Yeah, I've heard about that...

PM: So basically, most of the staff that we use has been trained by ZCCM, in their respective knowledge. Of course we picked up a couple of other people, who were still comforted by ZCCM but from other units of ZCCM. Their manpower training policy was very good.

CP: They trained their staff abroad?

PM: They trained their staff abroad. I mean, I've been abroad myself, I don't know how many times, doing all sorts of training. Computers, telephone services and the like.

CP: In the U.K.?

PM: In the U.K., in the U.S., in Germany...

CP: Oh, in Germany.

[103] 2.1, 3.11, 95 and 98 are versions of Windows.

PM: Yes.

CP: Do you speak German?

PM: No, it was a very short stay...

CP: So, how many people are employed who know about Linux?

PM: How many people? Oh geez, let me just count, I think about... five or six people have Linux knowledge. Of those, three are very good. They've got very good knowledge of the details.

CP: So you say that you set up networks for companies and the like?

PM: Yeah, we set up networks for companies. Most of these companies come primarily for internet services or VPN[104] services. And we found, in most of these incidents, that those companies initially come at a stage where they don't have any network, and tell us to set up the network for them. In certain incidents, there's also requests for application development, so we do that.

CP: Ah, what type of applications?

PM: There are applications for payrolls, human resource packages, transport management systems, internet management, accounting for mining, export... Oh, I'm too fast for you [as I'm taking notes]. clinic management, accounting, mineral exports. Again, that's coming off the background of ZCCM.

CP: When you say you develop applications, do you use preprogrammed packages?

PM: For the RDBMS [Relational Database Management System], we use Oracle[105]. For record maintenance, we use Crystal Reports[106]. But mostly now, we're using Visual Basic[107] and Microsoft SQL Server for our DBMS.

CP: Have you ever used MySQL?

PM: We've used MySQL, but it is very limited, compared to Oracle. I don't think it's got enough high level queries. It's good, but I don't think it would be the right application for business. Right now we have plenty of systems where you can see the limits MySQL has. For interrogating the database in a lot of areas, it's very powerful. Maybe in the future, it might expand, although... but I don't think it will be as much as Oracle.

CP: Sure, behind Oracle there's a big company. Has any of your customers ever expressed the wish for Linux? Or have you ever set up a Linux machine for a customer?

[104] VPN = Virtual Private Network, a technology that allows employees (or customers) to connect their own computer to a company network.

[105] Oracle provides one of the world's leading databases for business.

[106] Crystal Reports is a management software.

[107] Visual Basic is a programming language by Microsoft, to be used with their products.

PM: We encourage our customers to use Linux. Now, for their main servers, we encourage Linux. But they have a choice to make, to choose Microsoft, maybe 2000 Server, or the other Microsoft servers, but normally we encourage them, because we have knowledge about Linux, and we don't have as much strength in Microsoft server products.

CP: So, when you encourage your customers to use Linux, don't they complain that it's not known to them?

PM: They do, at certain instances they do, but considering the way Linux now has developed, with the interface pretty much like Windows, and there's little they do on those systems themselves ... And like any other thing in life, it's got its own pros and cons. The downside is on its complexity, it's upside is that it's nearly robust. On the other side, Windows is very less complex, but it's very, very fragile.

CP: I talked to other people and they said that many businesses use Pastell for accounting. Do you also install that?

PM: We're using Sun Systems, but we have our own application in financing, called CopperNET Financials, which we have developed. We have a few customers - we have four, it's a new package. It's based on Oracle DBMS, and we're shifting to it as well as CopperNET moves away from Sun.

CP: What's the price of CopperNET Financials?

PM: It depends, again, on what you buy. The basic is, if I'm not mistaken, 4,000 U.S. dollars.

CP: So it's cheaper than Sun?

PM: Cheaper than Sun, by far. Sun is about 6,000, 8,000 *pounds*.

CP: Pastell, I heard, is about 1,500?

PM: Yeah, Pastell is a Windows-based application. If we developed our CopperNET Financials on that, possibly we'd be talking about the same amount of money, for CopperNET Financials on the Windows platform.

CP: Now, I'd like to go into the area of Information Technology in Zambia. Apart from accounting software, clinic management and things like that, what type of software do you think is needed in Zambia?

PM: I think, personally from my experience in the industry, I think the applications that are missing in the country are those that handle human resources.

CP: Ok...

PM: I mean, there's very little on that ground than can tell you a lot about human resources, the skill level of Zambians. I know that the previous government, the very recent government spent a lot, huge amounts of money on training for Zambians, and they did

training, but ... what has happened is that there's *no* way of finding out where this skill is. Therefore we have a lot of pockets that indicate that there is no available people, but they are there. If you want to find people, there's no source of information. I think that's one piece of software that is needed. The other piece of software has, well, more to do with a proper database. Mainly, the country should develop a database for its cultural traditions, culture, music.

CP: As a matter of fact, I talked to a lecturer from CBU, and he said he wanted to start a project like that.

PM: Who was that person?

CP: His name is Mike Mwale. He's in computer science, but in the business department.

PM: I've talked to a number of people, I've always expressed the same thing. And the universities, they are in a better position to do that kind of project than ourselves in business. We're short on time, keeping the business alive and running. The university must go into research, come up with information. The internet... Primarily, the internet was started by universities. I mean, it came from a military base, of course, of the United States government. But universities played a very important role in developing the internet. And at the same time, look at the databases on the internet. I mean, there's surely government involvement, but mostly it's either dot edu or dot org. That's where you find a lot of information. Not in dot com. The dot com, they are there to sell their products. Sell modems, sell cars, or something. So those are the two areas that I think the country needs. And the other thing that's needed - generally speaking about IT - the country needs to build infrastructure. You know, building a database on its own standalone is not sufficient until it's used in a network. And this network should be built. For example, the Copperbelt Energy Corporation has its own fiber network; Zesco has its fiber network, and microwave; Zamtel has got its own network, and there's no concerted effort at the country's service. The kind of network I'm talking about must not necessarily be driven by the policy of the government, but the private sector...

CP: You are talking about a dialogue between the companies in the private sector that are involved in building a nationwide network?

PM: Yes, but the government must play an important role in drumming up the direction. I mean, companies come in there to make money. I want to see a situation where the government *says* this is the infrastructure. Anyone who wants to invest can invest here and there and there, and the plans are readily placed. Not in detail. But policywise, to say for example "We're thinking that towns must be linked up by fiber." So you can discourage investors from using microwave or phone technology in favour of fiber. Or whichever technology you like.

CP: Do you think the government has the knowledge capacity to make such plans?

PM: They... need to. They don't have, but they need to put the necessary legislation in place. So that you can start up the engine. To put up all those policies. Well, the legislation is not there, there is really no basis for starting any kind of plan. If there was a legislation... for example, I want to believe that, at one point, the government must come up with a ministry that drives IT. Not the ministry of commerce or industry or communication, but information technology. Because, what's been happening in the world is, there has been an agricultural revolution, an industrial revolution... This is the information revolution. And always - sorry to say that - Africa has always been behind. When Europe moved from agricultural to industrial, Africa is in the agricultural [era]. When Europe moved from industrial to information, Africa is trying to be industrial. I mean, I think we can leapfrog, jump and start moving straigh to information. Information is the driving force.

CP: Do you know Mr John Munsaka from the University of Zambia?

PM: Yes, I know John.

CP: Because he helped to develop the National IT infrastructure ...

PM: Policy

CP: Yes, policy

PM: Actually the IT policy was done in conjunction with several other stakeholders. And CopperNET was one of them. Besides, we're the ones that are hosting the draft policy. It's on our site, if you want to have a view. John was ... we worked together in ZCCM. Again, that's one of the things that you notice about ZCCM, most of the guys in IT were from ZCCM. And they were trained well.

CP: Now that ZCCM is privatized - are they still doing this kind of training, or is there any other institution?

PM: I doubt it, I doubt it. Maybe the other institution that would be in training is the police, and the others are parastatals. But I'm told that, even those parastatal business - I don't think they have the same importance as ZCCM. ZCCM had, just as anybody, a policy on human resources. They trained people ... from their primary and secondary schools in the U.K. and elsewhere abroad. They sent ... numbers, large numbers of people there, as well as me. I went for training in 78, in 92, 94, 96.

CP: So you would say that the privatization of ZCCM is a loss for Zambia?

PM: For human resource training, yes, it's a loss. But we could not run the mines... the government spent a lot of money to keep the mines running. Basically it was not possible for us to keep them running. So the best we could do is what we did, to privatize them.

CP: The next question I would like to ask is, what is your vision for information technology in Zambia? How is it going to look in the future, especially in education, and what

type of software will be used?

PM: Ok, basically - like I said - eventually the future of information technology is in the educational system. We should start from there, both in primary and secondary school. There must be a plan. If we start from there, the future is in the education sector. Both private and public. In the sense that after we've done that, then we can possibly move on to other areas. You can't talk about the future if you don't talk about education, I've always believed that. Unless what you're asking is what I *expect* will happen.

CP: Yes, more like that.

PM: I think that, what I've just said, there is no... no IT for that.

CP: Do you think government is aware of that?

PM: I think they are. The problem is, the government is driven by, what should I call them, by politicians. The government has politicians, the government has civil servants. The civil servants will possibly know what happens. I doubt that the politicians know.

CP: Do you think that people like you, or John Munsaka are having influence to direct government into this direction?

PM: We do try. I mean, the IT policy, that's one of the products we've just... we actually need to pull on, like emphasizing to our leaders, to take information technology seriously. We do have *slight* influence. But if you look at our newspapers right now, there's *nothing* that talks about information technology. Almost all the newspapers are very poorly designed. They're talking about a particular politician, like for example about John Kerry and George Bush. I mean, this happens in Germany, it happens in the UK, but in Zambia, it's like *every* morning is election day. And there's no time when the politicians talk about development. Very little.

CP: I see. Now, do you think it would be useful for Zambia to introduce Open Source on a broad basis? To be used by private people?

PM: Well, yes, I think it would be necessary. I think at this stage, if we use Open Source we'll be able to improve some of the gaps that we have between the developed nations and ourselves, in information technology. We won't spend a lot of money ... I mean, Linux is free, other than the price of the CDs. Typically, the CDs will cost about 30 dollars for the package, all the packages and then shipping. 30 dollars, compared to the equivalent operating system from Microsoft that will cost about 2,000 U.S. dollars. You talk about twenty organisations and 2,000 U.S. dollars, how much is that? Or a hundred organisations. That's 200,000 U.S. dollars. In Kwacha terms, over ... over 975 million. So really, I mean Open Source has a financial advantage.

CP: Do you think people can be convinced to use Open Source?

PM: Yes. Just make it a policy and encourage it. Make it tax-free, for example. We encourage people that there's no tax on Open Source. Besides, Open Source comes by internet.

CP: Yes, but the Debian Distribution is maybe three, or five CDs, and there's not many people in Zambia who can download that much of data, is there?

PM: Yeah, but there's a lot of Zambians who will make copies, once you've downloaded the CDs. Then you can make as many copies as you like.

CP: If Linux would be used in schools, how about would you see the chances that this is going to happen? 50%, 70%?

PM: In the Zambian environment?

CP: Yes.

PM: If we pushed it, if for example the computer society of Zambia pushed it, and there was a policy by the government, the chances are... 40%. Otherwise, almost zero. Because, we destroyed the educational system ourselves to a point where whatever... It's like really saying to yourself, what's the possibility of growing an apple, and basically we've destroyed the ground where the apple is supposed to grow. Changes are almost zero, you won't grow nothing.

CP: Ok.

PM: We advertized with the government very seriously about Information Technology. You can definitely say that you must invest a lot. I really think that you need to invest in education before you can invest in IT.

CP: Do you think Open Source can be used by the government?

PM: Yes. Tremendously. That's where the big amounts of money are spent on Microsoft products, and any other products that require purchase. Open Source also gives us a possibility eventually to grow in education.

CP: Do you know about software being produced in Zambia?

PM: Other than ourselves, there's a company called [...][108] That's the only company that develops. There are small companies that develop comparably. But very small.

CP: They are based in Kitwe?

PM: These ones are based in Kitwe. [...] are based in Lusaka. There's another company called Palm Computing. But they don't actually do the development of the Palm computer. Those are the ones who have developed some packages. The biggest one is Access Information Systems. We exchange customers with them. We're almost picking up all the customers that used to be Access Information Systems.

[108] the recording is not clear at this position

CP: And they develop with Microsoft?

PM: With Oracle.

CP: Ok, I've covered my questions. Thank you very much for the interview.

2.4.3 City Council Kitwe

Interview with Sedson L. Muyenga, Computer Manager at the Kitwe City Council
Date: Sept. 30, 2004
Location: City Council, Kitwe, Zambia

Mr Muyenga welcomes me in his office in the basement of the City Council. I have given him a sheet of questions some time before, and I bring a letter of authorization from my supervisor that he wished to see before conducting an interview. He seems to have prepared himself for the interview, and we're not interrupted during the course.

Christian Pothmann: At first, I should introduce myself. My name is Christian Pothmann, and I study computer science at the Technical University of Berlin. And the project I'm doing is about the use of computers in Zambia; especially about the use - about the possibilities for use of Linux and Open Source. Have you ever heard of Linux or Open Source?

Sedson Muyenga: Yes; foremost, my name is Sedson. I am the acting computer manager of the City Council. I've heard about Linux operating systems. But I'm not familiar with its use. I'm more familiar with Windows.

CP: Are you aware that there is a competition between Linux and Windows?

SM: Yes, I've heard about that from the news. The time I read about Microsoft being sued in Europe, saying that they are dominating the market. Because, when they sell their software, it's like they sell everything - including Windows Media Player. So other companies can't sell their products. So that's the issue I know about.

CP: So what you heard is that there was a big lawsuit in the United States about Microsoft using their monopoly...?

SM: Yes. They were sued in Europe, and Bill Gates and his company, they lost some money[109]. They paid to some companies. I can't say which companies. But he did pay. I'm sure you know about it.

CP: Yes, I read in the newspaper... But which kind of news, was it on TV...?

SM: Yes, TV, newspaper, internet.

CP: So you read some news on the internet?

SM: Yes, I do read BBC, and I do read CNN, Time Magazine.

CP: Ok, good - so you know more about Linux than most people I've see so far. Because, you know, most people in Zambia, they know only Windows.

[109] In fact, Microsoft was sentenced to pay almost $500 million by the European court - but it will take many years of court revisions until the final decision has been made.

SM: Yeah, in Zambia, in most cases, let me say we just know Windows operating system. If there is somebody using some other operating system, it's only about Unix. But with us here, we use Windows; and that machine there, that is AS 400.

CP: What's that, IBM?

SM: IBM, yes.

CP: Ah. So the operating system is AS 400?

SM: AS 400, yes.

CP: The machine is used for what?

SM: We use it for billing, rentals, daily cash.

CP: Sorry, what's "daily cash"?

SM: Daily cash is income which comes in only a day. It's like vendors' revenue. We charge those people that sell goods in town. We charge them a fee.

CP: Like the people in Chitsokone market[110]?

SM: Yes. Because those people, we can't bill them. They just come, only on a daily basis. They come and go. You can't bill them. You can bill people with fixed salaries. But those, you can't. Just charge them.

CP: So can you describe how this works? Like, some people, they go to the city, and they find those vendors and charge them...

SM: Yes, what happens is, we have got our police section. So, those people will go around in town and charge those people that are vending. Charge them a fee ... I can't say how much now, but I think it's around one thousand kwacha[111]. But I can't really say the exact amout.

CP: And those are recorded in the AS 400?

SM: Yes, recorded. But the money [...] That is like, the amount which was collected in day one up to the amound which was collected on the thirty-first day, in the sum will show how much has come in.

CP: And the results will be transferred to your finances?

SM: That one I can't really give you, but we do have a budget which is submitted to the Government, and the Ministry of Finance. So, I'm sure that the exchanges part and the income part eventually are submitted to the Ministry of Finance. Because, we have a

[110] Chitsokone is the "second class market" in Kitwe, a large place with wooden market stands, where everything from food to clothes to furniture is sold every day. It's the busiest place in town during daytime, and at night it's where the streetkids sleep.

[111] 1000 Kwacha is about $0.20.

ministry to which we report - the Ministry of Local Government and Housing. That one also reports to the Ministry of Finance - financial matters.

CP: Sorry what's that? Ministry of local... I didn't get the name.

SM: Local Government and Housing. Which reports to the ministry of finance on how the government is spending their money. And how much the councils have collected.

CP: Just out of curiosity, those reports, are they done in letters, or electronically, by internet?

SM: Letters to...?

CP: Suppose, at the end of the month you say, you earn this much in cash. This result, is it transferred electronically? Or...

SM: Yeah, it's done both digital and hardcopy. In fact, those I'm talking about are internal reports. Like the reports which come from the computer section, we bring them upstairs to the revenue section.

CP: So, those people are responsible for...

SM: Yeah, it's now them or us would know which companies have paid rates, and those that have not yet paid, they go and call them up.

CP: Apart from collecting of revenues, what other use have computers in the City Council?

SM: When the computers were introduced in the councils, they were mainly meant for revenue collection. And even now, they are mostly used for revenue collection, for rates and rentals. But we have a view that we should do... that we should introduce human resource software. But as of now, we won't be able to do that because of financials. But more and more, the computers are used for typing letters, doing some summaries with Excel.

CP: Do you write a lot of emails to your colleagues?

SM: Yes, we have already internet facilities here. We have a network which has 24 points. This network has been here since about 2002, October 2002. We've got 24 points on the network, but only about 12 have got computers connected to them. So, those 12 computers are able to communicate. The internet connection we have is a dialup connection, which means that we're connected to the internet using the modem. And we're able to do so because we have some software which can allow 12 computers to connect, using a modem. And that is something like Winroute.

CP: So there are 24 computers which will...

SM: No, I'm saying 24 points.

CP: What exactly is a point?

SM: A point is a ... like a socket. So, there are 24 points, which means you are able to connect 24 computers. But some of the points have no computers yet.

CP: Ok. But is there other computers that are not connected to the network?

SM: Yes, there are about five or six, I'm not sure. These were not done so because the computers are situated in offices which have no point.

CP: The operating system used with these computers, which one is that?

SM: Some of them are Windows 2000, like the server here is Windows 2000 Server. We have about five of them using Windows XP. Then, there are a few more that have got Windows 98, and one has got Windows 95.

CP: Ok. The server here - what exactly is the purpose of this server?

SM: The server is meant to enable us to share resources.

CP: Like the internet?

SM: Ok, we share the internet, and share the printer, and we can share folders. I'm saying, there are 12 computers connected to the network. We don't need to have 12 printers. So, somebody who is seated in an office can send his file to this machine.

CP: Can anyone employed at the City Council use some of these computers? Or is it restricted to some offices?

SM: Yeah, the idea is that anyone should have access. We intend that anyone should access the PCs, but that should be done when it is secure. Because there are some people that can access the PCs with the intention of either stealing data, information or maybe with malicious intentions. They can go to the PC and introduce some viruses. So, we allow people to use computers and printers only when it's secure.

CP: So when somebody requests the use of a computer, will somebody who's responsible watch what they are doing?

SM: Yeah. There should be somebody who is there to either assist him do his work or if that person feels that he can do his job on his own, then he can be allowed to sit there on his own. But unfortunately we don't have a book where we can write who sat on the machine.

CP: So you don't have a system for user accounts where each person get their own user account and log on with their own password?

SM: On some of the machines, there are some user accounts, but we don't allow that much.

CP: Can you give a short history of the computerization: When were computers first introduced at the City Council?

SM: It is unfortunate that I don't have come here before eight years ago. So I've never even got to see the beginning. But I checked some documents. I've seen that as far back as 1968 there were computers here. And I know that in the past we've purchased computers like ICM, those big ones. ICM, we have bought one, and we have bought MCR. And now we have AS 400. And we now have Fujitsu server. And we've got several PCs. So, in short I'm saying that the council has had computers at least for the past 30 years.

CP: Ok, that's more than I thought. I didn't have any idea... So can you describe a little more about your responsibilities? The decision which kind of computers are bought, is that up to you?

SM: Oh yes. My job is to ensure that I advise management on which computers we are going to buy. It is my job to recommend. My job is also to supervise that the work that comes... [the phone rings. There is a short break]

SM: Supervise that... to see that the work has been done. Portations have been done. Partations, I mean the counter-checking of the data. Because sometimes they submit data and then somebody mispunches. So we should counter-check that the data which has come is the exact data which is going out. That's my job here.

CP: Hmm. Sorry, but isn't that a lot of work? Because, there's lots of data coming in, and data to be checked?

SM: Yes. Actually it is so much work, especially when we come to the time when we do the bills, in June and July. That's when we are especially busy. But after that, we're busy, but it's not as much busy as in June.

CP: How many people do you have to assist you with this job?

SM: In my section, there are about eleven of us. I'm the manager, there's a systems analyst who has resigned unfortunately. Then after the analyst there's a programmer, and I've got three operators, computer operators. And two data control staff. And five data entry officers.

CP: What exactly is the task of the programmer?

SM: The programmer, his job is to code the instructions for the computer.

CP: What kind of instructions?

SM: Instructions like... the billing that used to be in this format. He'll write the source code to enable the computer to give us the exact format of the bills.

CP: What kind of software is he using, is it Visual Basic?

SM: As of now, we're using dbase[112] and Cobol[113]. We have started with Visual Basic version 6. We want to start using Visual Basic version 6, and then we can use Microsoft

[112] dbase: a database system

[113] Cobol is a programming language that has been used for financial programming for decades. It is old but still commonly used.

Access. But that may take a bit of time. Because, me especially I'm more familiar with dbase 4 and 5. As well as Cobol. But I did Basic. Not the latest one but the Basic of 1991, 92, somewhere like that.

CP: And where did you receive your education?

SM: I did my education at Evelyn Hone College. That was from 1992 to 93 - I mean 94. That means I was at college for three years.

CP: That's a degree in computer studies?

SM: Yes, that's a degree in computer studies.

CP: And, did this education have specific classes on public administration? Or was it just general computer studies?

SM: It had a bit of business organisation. We had somthing to do with busines organisation which was to understand how the business is run. And to do the organisation chart. And about the computer manager, how should he be useful for the entire business. What should be your role, how should we be able to advise management. But it did also have a part on accounting. We did everything to do with computers in terms of hardware internals, a bit of course, I did also systems analysis, design, I did computer architecture, and also I did quantitative analysis, which in short is actually mathematics. And I also did language, like Cobol and dbase 4, at that time.

CP: Did you have any computer education in high school?

SM: No, I just did at college.

CP: But in college, were you thinking about going into the City Council?

SM: No, no. But joining the City Council was the last thing I wanted to do.

CP: [laughing]

SM: Because in Zambia, working for the city council is not something which people like to do. Because we're sort of underpaid. So, everyone first wants to work for some other company. So, after you made the search for a job and you fail, then you can think of joining the council. So, for me actually I joined the coucil, not that I had the intentions, no. It's only that I failed to get a job somewhere else. Once I ... [laughing] But somehow I thank the council. Because, despite that I failed, at least I achieved something.

CP: Ok. Do you also do training for the staff in the City Council?

SM: At the moment, we don't. Bus as you can see behind yourself, there's a board there. Sometime back, some six years ago, whenever we acquired a new system, the suppliers would introduce the system. Like, we bought a server, a new server, and new software, the suppliers asked to come and show us to use the software. But as of now, it has been a long time...

CP: Most of the people who come to work in the City Council, are they required to have some computer skills?

SM: Yeah, those that have come here, usually now are certificate holders, diploma holders or degree holders. Unfortunately as of now, we don't have a degree holder because the last one we had resigned last month. He has found another, bigger job.

CP: Oh, I wasn't talking about the people in this department, but of all the employees in the City Council. Are they computer literate?

SM: No, not everyone. But those that want to to come and sit at the computer, they have. Either they've been taught at school, or they have paid themselves to go to school. Because, there are some schools in town which can offer computer skills. Pay for two weeks or so.

CP: Which company is that?

SM: Actually, there's Digitec, Neo Computers, then there's even this one which is ZIPSIP. And even the Copperbelt University offers short term courses.

CP: So, as far as computers are concerned in public administration, is there a political guideline on how to use computers? I mean, I know that they're being used for accounting, but is there a guideline on how computers should be used?

SM: Now, that one is, unfortunately I've never seen this guideline. But I know that, as of now, government wants to control jobs. ICT policy... There was a workshop in Lusaka where they held - a workshop on ICT. That is information and communication technology. So, I'm sure when the ICT policy has been done, it somehow will accompany to political policies on the councils regarding to the computers. But that hasn't yet been done.

CP: Are the city councils involved in making the policy?

SM: Ah, I've said the policy hasn't yet been done. So we might be invited at the latest meeting.

CP: So. Do you have like a vision for the future, what the City Council would look like with computers in the future?

SM: Yes, the vision which I can give is just from my person. As I'm in charge of the computer section. The vision I have is that in the next ten years, every council shall be connected to the internet. And that we'll share the data. Each one should be able to access the same information from different offices. Of which, as of now, we aren't able to do except a few offices.

CP: But isn't there some information that should be restricted to only some offices?

SM: Yes, in most cases, as I have said, the computers are connceted. Most of them, they don't share their information anyhow, because it's confidential. So, what we decided to

do is to make those folders unsharable. So that somebody cannot access the folders from some other PC. If you have to access it, you should sit at the machine. Or, you should have a password at it.

CP: Do you think the employees are open for more training on computers? Say, there was a change in software, then people would be required to go for two weeks training. Do you think that's possible?

SM: In fact, they're more open to it. The only thing is that the council has got financial difficulties. So they can't send as much as they want. Because, when you send people to as school, like for two weeks, it might cost as much as 200 dollars per person. So, if you were sending, say 30 of them, it might be expensive. The only thing I know is that the council sends some people to school every year. Not necessarily in computers. But they can pick on some people to do management, engineering, accounting, as well as computers. That is done every year.

CP: Ok. The last question would be, is your view on Windows and Microsoft - do you think it's a good way? Or do you think a change might also be good? Like a shift to Linux and Open Source?

SM: A change just can be good. Because that will make us able to compare between the two which is better - between Windows and Open Source. Because as of now, maybe I should take the opportunity, because I don't exactly know what Open Source or Linux is. I just know that it's an operating system. So maybe you can be able to explain Open Source?

CP: Ok. Open Source means that the source code for the software is made public. Which means, everyone can get access to the source code for the software. It's on public internet servers. There's what they call Open Source mediators - big internet sites where people do software projects. So one person codes one part of the software and then uploads this source code to the internet. Then some other people, they can look at the source and further develop it.

SM: But that source code, can it be modified by anybody?

CP: Yes, that's the idea.

SM: But hasn't that affected the operating system? Anyone can go to the internet and change the source?

CP: Ah, it's not like that you can go and change the same source and submit your changes to the same place. But you can take the source, modify it yourself and make your own version of Linux. So, you can modify it and use the modification of your own. And if other people like your modification, they're going to use it. Open Source doesn't mean that anybody can fuss around with the software. There's certain people who have access

to submit the changes. Just, everybody is able to view the source. If you make changes, it doesn't mean you can submit these changes to this version. For example, Linux is an Open Source operating system. It was made by a community of programmers. And usually, they do it in their spare time. They don't get paid to make it.

SM: Is it from Germany or America?

CP: The guy who invented Linux, his name is Linux Thorvalds. That's where the name Linux comes from. His first name Linux and Unix. And he's from, I think he's from Finnland. But nowadays, there's Linux in America, there's a big company called Red Hat, they develop their version of Linux. There's a company in Germany called SuSE, and they've got their own version of Linux. There's a version called Debian which is developed by...

SM: Ok, I know that you can interview me. Now that the interview is over, I can also interview you on...

CP: Of course... Just let me take some notes, ok. [...]

SM: Since I said me, I'm more familiar with Windows, I've never done anything with Linux. Can I know how different Linux is from Windows?

CP: Well, there are two options. I can either show it to you in practice, or I can make some explanations. Because I've got this Linux CD which ... you can run the operating system without installing it on the harddrive. It runs from the CD. So, if you've got a computer...

SM: Yeah, before you can explain, afterwards you can show me.

CP: You know the operating system Unix, right?

SM: Yeah, I've heard of it but...

CP: Ok. Unix is an operating system that was developed by, I think, Berkeley University in America. And they made kind of a standard. They made a standard for an operating system, but left open the implementation. So there's Unix from this company, from that company, they all look the same, just the source code is developed by each individual company. And Linux is also a version of Unix, only it's developed by people in their spare time. So that's like the foundation. And since it's a Unix, it has the same basic commands that every Unix has. And the setup, like the network connections, the user accounts, it's all done in a similar way to any other Unix.

SM: So, my other question is, how familiar and how user friendly is it? Compared to Windows?

CP: It used to be... you see, Linux was developed by computer programmers; and what they wanted was to have a lot of power, but they didn't spend too much time of making it

user friendly. So you can do a lot with Linux, but you have to know what you're doing. But nowadays, Linux is becoming more user friendly.

The tape ends here. We proceed to another office, where I attempt to show the Knoppix CD to Mr Muyenga and some of his colleagues - but unfortunately, we cannot get it to work on the PC that is available.

2.5 Summary and Conclusion

The situation analysis in the previous sections had the purpose of *grounding* the Draft Curriculum which is presented in section 3. A summary is now presented as a number of statements, which have the purpose of

1. *making the analysis useful:*
   by stating the key facts and assumptions in a concise form

2. *making the curriculum more transparent:*
   by showing the basis of the decisions that are made in the draft curriculum.

These statements should not be seen as something absolute. A more extensive research may find more statements or different results, and the future may change them as well. But at least, they should be named here.

2.5.1 Future of computer applications in Zambia

1. *In the near future, computers will probably be used by Zambians who work in "office jobs", but not by people who work as peasant farmers or in the informal sector. This means, the majority of Zambians will not rely on computers in their occupation in the near future.*
   This assumption may need an extensive research to be proven. It is also difficult to make predictions about things like "the use of computers in Zambian jobs". For a school curriculum, it is however necessary to have a view of the future, because all changes in an education system will have visible effects only after ten to fifteen years. And with more than half of Zambia's population working in the agricultural sector (and not on big farms but as small-scale peasant farmers), and many others working as miners or in the informal sector, the majority of the Zambian working population work in areas where very little technology is used, simply because it is not affordable. Most self-employed people do not have the financial resources to buy the technology - even cellphones are affordable only to those with relatively well-paid office jobs. Likewise, computers are not yet affordable for the majority of the population. Since they have been working without computers probably all their lives, they will neither be absolutely necessary. And the mining companies do have the financial power to buy computers, but they would be reserved for those doing "business", not for those working underground.
   Computer may of course be used in telecenters and internet cafés, for private use as well as for business. At the moment, there are not enough telecenters for everyone, and they are not yet affordable for most people either, but - in contrast to owning a computer and paying fees for an internet connection - the use of telecenters and

internet cafés may become affordable for more people soon. The main uses here would be communication and office software. And even for a small-scale farmer, communication and office software can be useful.
Aquiring a computer for the business and using it for accounting, online presence of the company or e-business on the other hand is reserved for larger companies.

2. *Computers are useful in Zambia for any type of organisation above a certain size*
Be it for business, government offices or civil society organisations - any entity that has employees and offices will need computers for a number of tasks:
- office work (letters, spreadsheets and the like)
- personnel management
- accounting
- resource and production planning
- project management
- keeping a history of the past in order to plan better

Additionally, the internet is useful for
- communication
- information gathering
- online presentation and e-business

Some of these applications are already done with computers, especially accounting. Others, especially internet applications, still need to be developed. The main purpose of computers for business is to make the business more competitive by making production more efficient, by attracting customers and by opening new business areas.

3. *Computers are useful for research in Zambia*
Apart from ordinary tasks of university administration, computers can be used in any type of research, from computer science to physics to social sciences. This statement is rather obvious, as computers are used in every university worldwide, and it was noted before that the University of Zambia was the first African university to provide every employee with computer and internet access.

4. *Computers and the internet have applications for the Zambian society*
On a national level, there are some applications that would aid the Zambian society as a whole, and which have not been implemented yet. Their usefulness will depend on how many people in Zambia have access to computers - at the moment, only a small percentage of Zambia's population does, but the number of people will certainly rise.
Applications on the national level are mainly databases that could be used for
- labour market
- health information

- cultural heritage

These databases could be built by government, universities and civil society organisations. If offering of a database service is profitable, it could also be done by private business.

5. *A software industry in Zambia will need many years to develop, and software produced will be mainly for Zambian needs.*
   Again, a number of facts lead to this assumption. First, Zambia is not a high priority target for foreign direct investment (FDI), other than in the mining sector. It is therefore unlikely that a foreign technology company will build computer labs for software production. Second, at the moment (and probably in the near future as well) there will be only a small group of Zambians with experience in software development. The annual output of computer science students of the two universities is well below a hundred, and there is already a shortage in IT staff for Zambia's ordinary business. Third, one has to consider also the question if there would be a marked for software produced in Zambia. Within Zambia, there would certainly be plenty of applications of new software. The African marked is another target, but the competition from South Africa, whose education system and infrastructure is much more developed, is high. And on the worldwide marked, there is an enormous competition from the highly developed nations as well as from the Asian countries like India that have a *huge* IT industry. Thus, there may be of course software products produced in Zambia, but not on a large scale in the near future.

2.5.2 Conclusion for Computers in Education

Following the situation analysis, some general recommendations concerning the use of computers in Zambian schools are made. They are independent of the choice of software (i.e. proprietary or Open Source.)

1. *Zambia's education system will need many years to change from its current state into a state where ICT is used in all schools and all subjects*
   A number of facts lead to this (more or less obvious) assumption. First, the financial constraints will prevent a large scale roll out of ICT hardware to Zambian schools. Apart from the procurement, maintenance of ICTs is also an expensive factor. Even if there were enough computer donations for all Zambian schools, the maintenance of these would require organisation and technicians.
   Secondly, the education of teachers in the application of ICTs will need some time. A syllabus for teacher education still has to be developed, and this can only be done in conjunction with the development of the pupils' syllabi. Then, instructors for teachers have to be trained, before teachers can learn ICTs for the new syllabus. This should be a longer process, even if there were plenty of financial resources.

When the teacher education has been developed and ICTs are used at the teacher training colleges, it will still take some time until the majority of teachers will use ICTs with all their possibilities for education. With the limited capacity of the Zambian education system for in-service training, it will take a long time especially for the teachers who are already in service to adapt to using ICTs for their classes.

2. *Computers should be introduced at first in some Zambian secondary schools. At the current stage, attempts should neither be made to introduce computers in all secondary schools, nor in all primary schools.*
   As funds for education are low and there are only small numbers of trained computer teachers and technicians it is unrealistic to plan for equipping all 3,700 primary and 1,900 secondary schools with computer labs in the near future. Moreover, as ICTs are not likely to be essential for the majority of jobs in Zambia, and the majority of the people will also not be able to afford the use of comptuers, there is no urging need to teach all pupils in computer studies. Since those pupils who are going to work in research or in large corporations are the ones that are going to use computers, it should be primarily them to learn computer studies. For this kind of job, a high school education is certainly necessary, which is why the use of computers is proposed here for secondary rather than for primary schools.
   The introduction of computers to primary schools can be done on a small scale. It does make sense to test computer use and to develop syllabi and teacher education for the future. However, an extensive use of computers in primary schools is not recommended at this time for financial reasons.
   This proposition may seem harsh, especially when considering the call of the United Nations to use ICTs in as many schools as possible. This proposition does however not imply that there will never be computer labs in all of Zambia's schools. It simply takes into account the current financial constraints - which hopefully will change - and the timeframe that is necessary to change the education system. Since Zambia needs investment in many sectors (and most urgently in infrastructure), a large investment to force ICT utilization in all Zambian schools within a few years does not seem justifyable. It is recommended to proceed slowly so that the creation of the curriculum, the development of teacher education and the infusion of ICTs in schools are done in a effective manner.

3. *Computers are useful for all students, regardless of the topic*
   This assumption is based on the findings of Luis Osin and others who have analyzed the benefit of computers for *any* subject in education. Their statement is that computers should not be used only to learn *about* computers but to utilize them to *enhance the quality of education*. Thus, even if a person is not going to be a computer programmer or web designer, they will still benefit from using computers in

school. (See section 3.5 on learning and teaching methods with computers.)

4. *The focus for computer use in high school subjects should be on* how to use ICTs *rather than on* how to develop ICTs.
   In Zambia, there is a greater need for a large number of computer literate employees than for a large number of computer programmers and scientists. This is not to say that there is no need for skilled computer scientists and technicians - however, the quality of education that is necessary to train such IT professionals can only be achieved in colleges and universities, not in high school. It would not hurt to teach some high school students about computer programming (as preparation for college), but the author regards training many pupils "only"[114] to be computer literate to be more effective. A good backgroud in the *use* of computers is also a good preparation for *developing* with computers in higher education. Thus this paper advises to reserve the limited financial resources for training teachers in applications of computers and new working methods rather than in computer programming.

2.5.3 Open Source in Zambia

Open Source is used only by few Zambian business, and almost not at all by anybody else. The fact that it is rarely known and used is a disadvantage of Open Source in itself. On the other hand, computer use is only at the beginning in Zambia, so the chance of changing habits are even better than in other countries that have been using proprietary software extensively for many years.

The general advantages and disadvantages that have been discussed in section 1.2.5 apply in Zambia as well. However, when the characteristics of the Zambian situation are considered, some of them are more important than others. They are highlighted here in short:

Advantages

1. *Cost*
   There are no license fees for Open Source products. If used with a large computer network, a lot of money can be saved. However, license fees are not the only cost of software. Administration of the software and training of personnel are expensive as well, especially in the beginning when new software is introduced. Before making large-scale decisions, a careful calculation of long-term cost should be made.
   Considering donated licenses for proprietary software: while it is true that Microsoft donates licenses for education, it is also true that they urge African gov-

[114] The topic "computer literacy" offers a broad diversity of knowledge and skills to be acquired by pupils, enough for a couple of high school education.

ernments to implement ICT policies in order to fight software piracy, so they can enforce payments for their products.

2. *Stability*
   Open Source products, especially operating systems and infrastructure software are very stable. This applies especially in school environment: a feature of Linux-based systems is that students can't mess with the system (i.e. install software, put files in the wrong place etc.). Secondly, Linux has also been designed for network use. And last, not least there are many more virus, worms and crackers out there to attack Windows-based systems.

3. *Potential to adapt existing software for the Zambian environment, and to create Zambian software*
   This may not be a noticable short-term advantage, as there are almost no capacities to actually develop software in Zambia. In the long run, however, that situation will probably change.
   There are two reasons for this advantage. One is the availability of the source code of software, and the other is the community-based development model of Open Source. With the source code available, it is possible to translate an existing software to a Zambian language. It is also possible to take an existing software and extend it to suit the Zambian environment. For example, a software for the administration of the school system could be taylored to fit exactly the Zambian procedures and regulations. And this kind of work can be done in a joint effort by students and IT professionals with interest in developing their country, as no doubt there will be.

4. *Potential for education*
   The availability of the source code gives students of computer science the chance to see exactly how software is written. There is source code for any type of software, ranging from small tools and games to huge and complex professional systems. Understanding professional source code is a very good preparation for future jobs.

5. *Other African nations, the European Union and Asian nations are considering the advantages of Open Source as well.*
   There are efforts and trials to use Open Source for government agencies and schools in many countries. In higher education, Open Source has been used for a long time - it actually originated there. By using Open Source, Zambia would not choose a solitary path but proceed in an international context.

Disadvantages

1. *Complexity of Linux*
   Compared to Microsoft Windows, Linux' many possiblilities, powerful features and

design for IT professionals are a bit overwhelming for the beginner. This is especially true for system configuration (the steps that are necessary to taylor a computer system to the needs of users.) Efforts are made by different Open Source groups to change that situation, by designing graphical user interfaces and configuration wizards. However, one drawback is that there is no central coordination of these efforts, which means an "overall and consistent easy Linux configuration" is yet to be invented[115].

Complexity means that is more difficult to train system administrators. (On the other hand, well trained system administrators will probably have more power with Linux than with Windows.)

2. *Limited availability of business applications with "industrial strength"*
   Open Source software for large companies that can handle payrolls, resource management and production planning is simply not available yet - at least not in a state where it has proven success. There are Open Source projects to provide Enterprise Resource Planning (ERP) systems, and maybe in the future, companies will start to shift towards these systems. As for now, they will still need to rely on proprietary software. This does not mean however that business software cannot be used in conjunction with Open Source software. There are proprietary systems that do run on Linux, like the Oracle database (the world leading business database) or SAP (the German standard ERP system.)

3. *Limited availability of trained personnel*
   In the Zambian "IT-world", there are some technicians and teachers of private schools that do have knowledge about Open Source software. Compared to the number of technicians and teachers of proprietary software, their number is still desperately small. This means that at the moment there are very few professionals available to build and maintain computer infrastructure with Open Source and to train teachers and other people. It will probably take longer until there are enough technicians available to support an ICT curriculum with Open Source. For teacher educators, however, this disadvantage is not as severe - teaching with computers brings new methods for both teaching and using computers; with a new ICT curriculum, teacher trainers need to learn many new things, no matter if they are used to proprietary or Open Source software.

[115] There are Linux distributions that do provide consistent and user friendly configuration utilites - but these are usually developed by companies for special purpose, like server environments or firewalls, and require license fees.

3 Draft ICT Curriculum

3.1 Introduction

The whole trouble with information and communication technology is that it is still in the process of developing, and that it is applicable to so many different areas. Many schools in almost every country are still discovering the full range of possibilities. The use of computers and software in schools will always be based partially on experience, but will also be exploration of new possibilities. There may be new software for education, and also new ways of using computers in different subjects.

When a curriculum for the use of ICTs in schools is designed, one should have an overview of the range of possibilities that computers offer. There is not just one way of teaching subjects like computer literacy, and there is also not just one subject where computers are used. Likewise, computers may not only be used as teaching objects, but they may be used by teachers to manage their work, by students to type their homework, by the school administration and to enhance the quality of education in general. And finally, there are different approaches of how teaching and learning in class is done, ranging from teacher-centered methods to peer teaching and self teaching, from learning through memorizing to learing by getting involved in projects.

This draft is intended to advise stakeholders in school education with computers in Zambia on how to proceed with the ongoing introduction of computers at schools. Stakeholders include the Ministry of Education, the professional Zambian IT sector, pupils and parents, as well as local and foreign organisations and consultants. These stakeholders are currently in the process of developing an ICT curriculum, and this thesis is an input for that development process.

This concept is not a complete and finished curriculum. It has some parts of a curriculum, like goals, teaching methods and equipment; however, the presentations of methods and equipment give choices rather than delivering a fixed plan. The intention is that different choices should be experimented with before a final curriculum is designed. The way how and when these choices should be made is outlined in an action plan - but the next paragraph shall give a more precise outline:

3.1.1 Guideline Through This Draft

Following the introduction, scope and rationale, the main body of the draft consist of three parts;

- The *scope* defines what is part of the concept and what is not.
- The *rationale* proposes the high-level purpose that should be achieved by an ICT

curriculum.[116]

- An *action plan* recommends a sequence of steps to be taken when the computers are introduced into Zambian schools on a larger scale. It has been designed for a slow process towards an effective use of computers in education, and a sustainable use of investments.
  The action plan proposes the use of certain methods and equipment, which are described in detail in the following two sections.

- *Learning and teaching methods* give an overview about international trends in using computers for education. The list of methods is intended as a toolkit, offering ideas of what can be done.

- Possibilities for computer *hardware and software* finally show a number of ways to equip a school with computers, with varying costs and complexity.

The recommendations and guidelines presented here have been influenced by the World Bank technical note "Computers in Education in Developing Countries", written in 1996 by Luis Osin (action plan, teaching methods, calculating cost); two documents published in 2004 by the UNESCO - an ICT Curriculum and a Planning guide for teacher education (teaching methods); a number of Open Source school projects, like the Skolelinux project (software collection); and my own experience of about ten years of working with computers, four of which including teaching and deploying computers in developing countries (hardware scenarios, operating systems and teaching methods.)

3.1.2 Terminology

- *Computers vs. ICTs*
  In this concept, the words *ICTs* and *computers* are used interchangeably. Generally speaking they are not the same - ICTs refers to computers, networks and telecommunication, so computers are really only a part of ICTs. In a school however, the main application of ICTs (other than using the telephone) are computers and the internet. And since the internet is used with a computer, the term *computer* can be

[116] *About goals:*
In this concept, there are goals on different levels. The *rationale* is about high level goals, i. e. what should be achieved by the curriculum for the education system and for the pupils, especially in the long run.
On a lower level, there are *objectives* that depend on the state of the education system: which point of development it has reached, especially with the utilisation of computers. They also depend on the state of individual schools, because not all schools will develop in the same way or with the same speed. These are discussed in the action plan.
Then on an even lower level, there are goals for each part of the curriculum: there are goals when teaching methods are discussed, goals when syllabi or learning materials are created and when the technical infrastructure is designed. These goals - in the case of the technical infrastructure they are called *requirements* - are given in their respective section in this draft.

used to describe both. This concept uses the term *computers* most of the time, to indicate that it talks about computers and the internet, but not about telephones.

- *Infrastructure, hardware and software*
  In this concept, *infrastructure* refers to buildings, furniture, electrical installations and telecommunications infrastructure. *Hardware* means any type of computer equipment, including networking hardware and cables, computers and additional equipment like printers and video projectors. *Software* can be divided into operating systems and many types of application software, including software for computer administration, for offices and for education.

3.2 Scope

This concept is an input for a discussion towards an ICT curriculum in the Zambian education systm. The scope clarifies what exactly is part of this draft curriculum and what is not:

- Following the recommendation in section 2.5.2, this draft curriculum is designed for secondary schools.[117]
- It outlines the teaching of various applications of computers, as well as the use of computers in schools for any subject.
- The use of computers for school administration has been considered in the presentation of available software (3.6.6), but has otherwise been excluded from this draft.[118]
- The use of computers in education includes using computers in schools (with teacher and pupils being present) as well as distance education (with the pupils using a computer and the internet to learn from a remote teacher.) This draft only considers the first - distance education is regarded as a different topic.

3.3 Rationale

The main purpose of any curriculum is to develop people and their country as a whole in the best possible way. As with any subject, a curriculum for computer education should aim at using computers well. However, considering the cost of computers and teacher education and the available resources, the goal should not be defined as to use computers

[117] Parts of it (like hardware and software, and some of the teaching methods) may apply in primary schools as well, but the special situation of primary schools should be considered in a separate document.

[118] It may be that the same computers are used for teaching as well as for administration (this will particularly the case when there is a central school server.) This implies that the computers must support software for both, which is why software for school administration is listed as well.

in the best way possible, but to suit the situation in the most effective way. In this case of the introduction of computers into the Zambian education system, the rationale is as follows:

1. All pupils (that attend schools with computers) should be educated to be computer literate, as a preparation for office jobs as employees in larger companies or to use them for self-employment and small business.

2. Computers should be used to enhance the quality of education in all subjects. Subjects like science, mathematics or business-related subjects have special applications for computers, but there is also software that can be used to study *any* subject. This will make education in these subjects more effective, and it will also teach pupils in the applications of computers, thus making them computer literate.

3. Computers should be used to develop new teaching methods. Since computers are a tool to do work - either alone or in groups - they offer a number of ways of teaching that are different from traditional methods like memorizing, reading, writing exercises and the like. (Other subjects like drama, sports, industrial arts or home economics do that as well, only that these subjects have *one* focus, while computers may be used for *many* subjects.)

4. Only if computer capacity and trained teachers are available, some pupils at high school level should be prepared for college courses in computer science, computer teaching and computer maintenace.

5. Pupils should be given the option to aid their school through the use of computers, for example by helping the staff with computer-related tasks or by presenting the school in the internet.

6. Computers in schools may also be used by the community surrounding the school.

3.4 Action Plan

The following plan is an example: if the Ministry of Education was going to introduce computers in Zambian public secondary schools, they might consider the steps that are outlined here. The plan is based on the document "Computers in Education in Developing Countries - Why and How" (1996) by Luis Osin, who has had many years of experience in the area of computers in education in Uruguay and Israel. He wrote about his document: "I have tried to avoid the usual pitfall of many transfer-of-technology projects, which is to 'copy' in a developing country a project that was successful in a developed country."

The plan is designed for schools that do not yet have computers; schools that have been given computers before can be integrated in the plan as well (with the only difference that the computer hardware is already there. Teacher education and installation of educational software can still be done in the same fashion like in schools with no computers.)

Defining a national plan for the Ministry of Education follows a *centralized approach* (i.e. the introduction is planned for the education system as a whole), as opposed to having schools choosing their own path with computers. The reason why such a centralized approach is considered to be necessary is that computers are a complex technology that offers many possibilities. In order to be used with satisfaction, they require broad changes, both in schools and in teacher education.

For example, a school where all teachers are supposed to apply computers in their subjects in conjunction with learner-centered teaching methods, all of these teachers would have to be trained in computer literacy and in the new methods. The installation of the computers has to be done, and maintenance has to be organized. The choices of hardware and software are wide, and they should match the teachers' knowledge. All these necessary aspects require planning and expertise - which is not available at most schools. The schools should therefore not be left alone with all the decisions.

Moreover, if each school used a different set of technology and methods, it would be very difficult to prepare teachers for those many different situations, and to organize the technical maintenance. Teacher education, computer procurement, maintenance and the development of teaching and software concepts are most efficient when done centrally.

Please note that the learning and teaching methods in section 3.5 on the other hand propose rather de-centralized and democratic principles. The centralisation in this plan is intended to keep things simple, while on the teaching level, the potential of computers to recognize and promote diversity among pupils should be used.

This action plan first gives a short recollection of the current situation. Then it presents an overview of changes that take place on different levels, and states a number of objectives that should be achieved by the plan. Finally, the whole process is separated into a sequence of tasks.

3.4.1 Current Situation

As a basis for the plan, a short summary of the authors perception of the current state of the Zambian education system is given (which is essentially based on the Situation Analysis):

- A fair percentage of secondary schools, and very few primary schools have been equipped with donated computers. However, most teachers are not yet computer literate, or at least have not been educated in using computers for education.
- Teacher training colleges are equipped with computers. However, there is no national plan yet of how to teach with computers.
- Computers in schools are mainly used to teach the subject "computer literacy", which is done in conjunction with teacher-centered methods.
- The Ministry of Education is in the process of developing an ICT policy as well as an ICT curriculum. Both have not yet been implemented.
- In 2003 a roundtable on ICTs in education took place in Ndola with different stakeholders. For this roundtable workshop, the current situation was analyzed, as far as computer use in education is concerned. (One outcome of this workshop was the initiation of the ICT policy for the Ministry of Education.)

3.4.2 Change on Various Levels

Using computers in schools is not simply done by setting up a computer lab. If they are to be used with all possibilities that they offer, a school needs to change on a number of levels. On each level there are choices, which are independent of the other levels to a certain extent.

1. *Technical change*
   The most obvious change that takes place is that computers and software are installed at the school. Options on this level include a lab-centered approach (i.e. there is one classroom that serves as computer lab for the whole school) or a class-distributed approach (i.e. there are computers in each classroom.) The hardware itself offers many different choices (including extra hardware like video projectors.) There is also a wide spectrum of available software. These technical options are discussed in section 3.6 on hardware and software.
2. *Teaching paradigm*
   Section 3.5 (Learning and Teaching Methods) introduces the change from a teacher-centered towards a learner-centered approach. This change is taking place in education systems worldwide, and is not unique to the utilization of computers (drama for

example is a learner-centered approach by nature.) The learner-centered approach offers a set of methods that can be used with and supported by computers.

3. *From "computer literacy" towards "use of computers in all subjects"*
   Computers may not only be used to teach the use of computers (e.g. computer literacy, computer science, computer maintenance) but also help teaching other subjects. This implies that there is not just one computer teacher at the school but that other teachers apply computers as well. Teaching methods in combination with computers are discussed in section 3.5.3.

3.4.3 Objectives

Computers should be seen by the school as something useful. This implies that teachers now how to use them for education, and that maintenance is organized **before** computers are procured and installed at the school. To quote Luis Osin:

> It's true that installing computers is very attractive from a political standpoint: they can be shown; they are modern; [...] partents are happy; the school principal will declare that his or her school are computerized; but... when buying equipment is the first step, the second step will be to discover that the teachers are not prepared to integrate the computer activities with their current educational practice. Thus the equipment will be under-utilized, a feeling that the investment is useless will start to develop, and from there it is only a small step to generaling that computers do not help in the educational process and are a waste of money that could be put to a better use. [Osin, p. 9]

With donated computers, there is no investment to be lost, but still the feeling may arouse that they are useless.

The following list summarizes what should be kept in mind when planning the introduction of computers to many school.

- *Teacher education*
  In each school where computers are to be introduced, the schools' teachers should have some experience of how to use computers for education *before* the computers are installed. If this proves non-practical (because of limited capacities for in-service training), there should be at least one computer teacher at the school before computers are introduced. This teacher then may be helpful for the other teachers in their computer training.

- *Maintenance*
  Computers are high-tech tools that need maintenance (and the rougher they are

treated, the quicker the will have a problem that will cause them not to work.) Both hardware and software need repairs and updates. If new equipment is procured, a contract for maintenance should be placed. In case they have been donated, it would be wise to seek the donating organisation's help for maintenance. If this is not possible, a service company should be contracted; a service organisation within the Ministry of Education might also be an option.
It is possible to imagine that maintenance is done by teachers. There may even be a special course for students who would then be able to do this job. However: maintaining a computer network is a fairly complex task that needs quite some experience. It would probably be asked too much of the teachers to do this job, if it is not too time-consuming to train them in maintenance in the first place.

- *Administration of the computers*
  Managing user accounts, helping colleagues, ensuring that computers are used in a proper way and other administrative tasks need to be organized. This could be done by a teacher, but this teacher needs to have some hours per week allocated for the task. (Luis Osin estimates eight hours per week to be sufficient.)

- *Number of computers per school*
  In each school, the computer equipment should be sufficient to teach full classes. The author's suggestion would be at least one computer for every pair of students. If there are too few computers, it is hard to have students use them efficiently (which again may lead to the perception that computers are useless.) Thus it is better to equip fewer schools with a sufficient number of computers than *all* schools with an equal distribution of too few computers.

- *Pilot projects*
  A national plan to computerize schools on a large scale needs to be thoroughly tested, for a number of reasons: At first, the decisions made in a national plan are far-reaching. Secondly, teacher education takes a lot of time, so it does not make sense to push the computerization of many schools at an early stage. Thirdly, finances limit the extent of rolling out the plan to many schools. A few schools can do a start, after which their experiences are evaluated and new schools can benefit from that experience.

- *Parents and employers* should learn about the benefits and be involved in decision-making.

- *Long term budget coverage*
  "Without long term budget support for operation, maintenance, upgrading and training, the initial investment will inevitably be wasted." [Osin, p. 9]

- *Management of the ICT curriculum*
  The development of an ICT curriculum, the computerization of schools and all aspects of administration at a later time should be done by the Zambian Ministry of Education. As the example of the introduction of Practical Subjects by the Finnish Development Agency[119] has shown, it is no good to give away all control over finances and management to forgeign organisations. If the decision making is not done by the Ministry of Education from the start, then there is not going to be a structure within the Ministry to support the ICT curriculum. In that case, the ICT curriculum would depend on foreign aid, both in financial and management terms. When this aid is revoked, the ICT curriculum would then probably collapse.
  This is not to say that no help should be sought. It is probably necessary to rely on foreign expertise, but there should be a cooperation with the Zambian ministry, and capacities within the ministry need to be built that do the decision-making and the administration of computer education.

3.4.4 The Plan

The tasks in this plan have been adopted from Luis Osin's document and slightly modified. There are three phases: A. Planning phase, B. Pilot phase and education of teachers and C. Scaling to more schools and teacher training institutions.

Phase A: Planning

- **Task 1: Provide a structure for the decision-making process**
  "In the assumed scenario, where the objective is to *introduce* computers into the educational system, we have to suppose that there are few local experts with personal experience in the area of computers in education. The first recommendation relates to the gathering and development of this local expertise." [Osin, p. 10]
  To achieve this, an Advisory Committee, consisting of local experts in education, computers, computers in education, evaluation, economics, planning etc. should be formed, possibly including foreign expertise. The members of this committee should learn about the use of computers in education in order to have a similar background at discussions and to be able to make long-term decisions about the introduction of computers in schools.

- **Task 2: Prepare a plan**
  The Advisory Committee formed in step 1 can then establish a plan. "The Plan should define stages with short, middle and long-term objectives, with each stage of implementation adjusted according to the experience learned from the previous

[119] see section 2.2.3 on the history of the Zambian school curriculum

stages." [Osin, p. 10] The said plan is basically a more detailed version of the action plan that is presented here; the first stage of that plan thus would be to define pilot projects.

"Having listed what has to be done, it must be clear that the Advisory Committee will have its say regarding to [the plan], but the acutal implementation requires the intervention of executive and administrative bodies. It will be up to the Educational Authority to decide whether to create an organisation that will take care of all the tasks, or whether those tasks will be distributed and assigned to different branches" [Osin, p. 10]

- **Task 3: Define pilot projects**
  Testing technology and learning methods in pilot projects is very important, as it will create a lot of knowledge and experience that can be used to create an ICT curriculum. The task of planning the pilot projects is "the most difficult from a conceptual standpoint" [Osin, p. 10]
  Luis Osin suggests that the first projects should take place in teacher training colleges rather than in schools, because it is difficult to conduct a pilot projects with in-service teachers: "Most in-service teachers have not had any formal education on computer use. In-service training for these teachers includes the difficult task of unlearning acquired teaching habits and learning to use a tool foreign to their culture." [Osin, p. 12] Training in-service teachers should be easier at a later stage when new teachers have been "formed in a environment where the computer is totally integrated. [They] will serve as catalysts in those schools not yet computerized."
  For each pilot project at a teacher college, a neighboring school should be computerized, so the future teachers can practice what they have learned in "real life."
  Osin suggests that a good number of pilots is between five and twenty. Each project has to define the equipment (hardware and software) and the pedagogical approach, as well as a "carefully designed formative evaluation to discover the pitfalls to be avoided in large-scale implementation" [Osin, p. 11]
  The pilot projects should test a broad variety of conditions and solutions: the schools should have different backgrounds (e.g. private and public schools, school in rich areas and schools in poor areas), and different combinations of equipment and teaching methods should be used.

Phase B: Pilot Projects

- **Task 4: Create cadres of instructors for teacher training**
  Instructors are those who train the teachers; Luis Osin suggests that in the beginning there should be one instructor for each pilot project. In later stages, more instructors will be needed as many teachers are going to learn to utilize computers; the best

teachers who have been trainees of the first instructors can then become instructors as well.

At first, these instructors should "develop a common conceptual base", which can be done "with a series of in-depth seminars, offered by local and foreign experts." [Osin, p. 11] Then they will lead the pilot projects, which take place in teacher training colleges.

- **Task 5: Start pilot projects at teacher colleges**
  When plans have been made and instructors are available, it is time to start the pilot projects. This is done by installing computers (if not yet available) and the software that is going to be used. The education of the future teachers should include some basic courses about computers (i.e. computer literacy and computers-in-education), but no in-depth computer programming. Rather than listening to lectures, the future teachers should apply computers: they should use the proposed teaching methods on each other and use computers as a tool for their studies - learning by doing is the only way to fully understand what can be done with computers in education.

- **Task 6: Plan formative and summative evaluations**[120]
  Formative and summative evaluations are tools in educational development and are closely interrelated. "As was already mentioned, the main objective of the *formative* evaluation is to detect the weaknesses in the transformation processes while it is still possible to correct them. [...] The objective of the *summative* evaluation of the pilot projects is to decide which, if any is worth adopting for expansion" [Osin, p. 12] In other words, the formative evaluation is done to help in the process of the pilot projects. Later, the summative evaluation states the outcome of each project. The results of the formative evaluation are a preparation for the summative evaluation: "With this support [of formative evaluations] the summative evaluation studies will not be clouded by minor problems."
  As a basis for decision, the summative evaluation must also include a precise calculation of the cost. (More information on calculating costs is given in 3.6.7)
  Luis Osin advises that summative evaluations are necessary because otherwise the decision which pilot to choose will be arbitrary and lack a scientific basis. They are also needed for political reasons, as they will back the whole project by giving facts about its usefulness.
  Expertise to carry out evaluations should exist either at the Ministry of Education or at the universities.

Phase C: Scale a selected pilot project to other schools

[120] For a brief introduction on formative and summative evaluation, refer to http://www.nwrel.org/evaluation/formative.shtml and http://www.nwrel.org/evaluation/summative.shtml, respectively

- **Task 7: Attract community support**
  The community plays an important role in a number of ways:
  Firstly, "parents should be incorporated into the decision-making process. This will encourage them to feel responsible for the project success and to cooperate with project implementers and planners." [Osin, p. 13]
  Then it may be possible to ask for financial support for equipment.
  The school's computers may also be used for the community, either for learning to use them or for working with them. The more the machines are used, the more effective the investment. This may also be a good way of offering computer services to people where there are no other public possibilities.

- **Task 8: Request for tenders**
  "Once the Advisory Committee has selected a set of pilot projects, organisations or companies external to the [Ministry of Education] will need to be contracted to provide equipment and services. This requires defining a request for tenders from regional and foreign companies." [Osin, p. 13]
  In order to scale a concept to many schools, equipment has to be procured and installations done; long-term maintenance has to be arranged, and perhaps training has to be done by external companies. These companies should not be appointed when the pilot projects start - instead, there should be a chance for competition after one project has been chosen as the best solution.
  "Particular emphasis should be placed on the reliability of the equipment (infrastructure, hardware and software), including the response time allowed for repairs. [...] The most delicate aspect is the assignment of weights to different factors, because the proposals may differ in equipment, cost, conditions for payment, experience and prestige of the company, level of the personnel assigned for implementation and training, and other factors that will be discovered once the tenders are open." [Osin, p. 13] zu viel?

3.5 Learning and Teaching Methods

The change that comes with computers can be more than a mere technical change, more than the introduction of a new subject "computer studies". Computers in education fit well with new teaching methods - and these teaching methods can not only be used in computer-related subjects but in every subject in school. In fact, the UNESCO document "ICTs in Teacher Education - A Planning Guide", published in 2004, even calls for a *paradigm shift*, a replacement of old education theories by new ones: "ICTs provide an array of powerful tools that may help in transforming the present isolated, teacher-centered and text-bound classrooms into rich, student-focused, interactive knowledge environments" [UNESCO 3, p. 16]

The key phrase of this paradigm shift is "moving from a teacher-centered to a learner-centered approach" (and in short it will be explained what is implied by this phrase.) This paradigm shift is not just proposed by "developed countries" to help "developing countries" but it is a worldwide change in education that is taking place. The process of this change has also not started recently, but many years ago. Its methods have been introduced in Zambia some time ago. It is only now that computers provide additional tools to help with the new methods.

3.5.1 Traditional, Teacher-centered Approach

Luis Osin wrote in 1996 that "present educational systems, inherited from a European conception that was created during the Industrial Revolution, group children according to age, in classes which are supposed to be relatively homogenous from a cognitive development standpoint." [Osin, p. 2] In the teacher-centered approach, there are standardized instructions for all pupils of a class. The teacher is always an expert who gives her or his knowledge to the pupils. Research and experience has proven that the teacher-centered approach is based on misconceptions of human learning. A list of these misconception that has been adopted from [UNESCO 3] is presented here:

- *Learning is hard and tedious*
  Teachers and pupils alike view learning as difficult and tedious, which causes pupils to dislike schools, and teachers to enforce discipline to make pupils learn.

- *All pupils of a class learn with the same speed*
  "Experimental measurements in real classes show that this conception is absolutely false." [Osin, p. 2] Osin cites statistics from a school in "an excellent school district" in California, in which only 21% of the pupils in a class are at the level of education which they are supposed to be at. All others are either ahead or behind, with up to four years difference to their peers (in a seventh grade class for example, there are some pupils who should be in third grade, while there are others capable

of attending eleventh grade.) There are great differences in the speed of learning: a fast learner may use only one fifth of the time that is needed by a slow learner for a given subject, which means the fast learner can learn in two months where a slow learner needs almost a year.

- *Learning is based on a deficit model of pupils*
  Curriculums are designed to discover the weaknesses of pupils (for example by assessment) and to "cure" that weakness - in the worst case by having them repeat a class or sending them to special schools. "Bruer, in his book 'Schools for Thought', notes that research overwhelmingly concentrates on the weaknesses of poor children. Very little research has been done on their strengths. In addition, the weaknesses identified are often deficiencies in terms of the traditional organisation and content of schooling. Very little thought has been given to the idea of changing schooling to accommodate new kinds of students; all the effort has gone to changing the students so that they will fit into the schools" [UNESCO 3, p. 17]

- *Learning is transfer of information*
  Pupils learn by reproducing knowledge instead of producing their own knowledge. Luis Osin notes that "the emphasis in frontal presentation, or typical classroom teaching, with students listening to what the teacher tells, is not conductive to real learning. Each student must build his or her own models of knowledge. Learning theorists agree that we learn by doing and that schools should devote much more of students' time to project activities related to real life." [Osin, p. 3]

- *Learning is a solitary process*
  "A study of schools in the United States noted that most students spend long hours working alone at their desks completing worksheets or repetitive tasks. A London Times survey of English school children indicated that students almost unanimously rejected this daily ordeal of dull and ritualistically solitary classroom activity and called for a broader and more exciting curriculum." [UNESCO 3, p. 18]

- *Learning is facilitated by breaking content into small isolated units*
  Which means, pupils do not see the purpose of what they are doing.

- *Learning is a linear process*
  The conception that learning is done in a clearly defined sequence of steps, with every problem having only one solution. Reality usually differs from this conception.

3.5.2 Learner-centered Approach

In a learner-centered approach, the curriculum is based on theories of how human beings learn in the best way. It does not mean that there should be no teacher - no matter what we

learn, a wiser or more educated person can guide us through the learning process faster and help us avoid dead ends and wrong turns. In the learner-centered approach the teacher should find methods that are most appropriate to learn a subject, try to regard the students' individual needs and strengths, and be a learner him/herself. A teacher may have more experience, but much can be learnt from different viewpoints and young people's ideas.

The UNESCO guide summarizes results from thirty years of research on human learning that should be considered in the learner-centered approach. They have been listed and extended here. (Some require more explanation than others, but that is not meant to imply that the short ones are less important.)

- *Learning is a natural process*
  "The natural state of the brain is to learn." [UNESCO 3, p. 19] When there is something interesting to discover, pupils will learn just out of curiosity. How to arouse students' curiosity? If the following items are considered in a school (choices, self-dependent working and producing, collaboration etc.), the school environment should be more interesting for them.

- *Pupils learn in a different way*
  There are fast pupils and slow pupils; some are creative in an artistic way, others in a formal, mathematic way, and yet others are good at organizing. Some people have no problems reading texts but do not understand graphical material, while others are just the other way round. To meet the different nature of pupils, conditions should be created that provide enough interesting possibilities for all of them.
  Choice and diversity has been considered in traditional curricula by giving pupils a choice in subjects - some prefer maths, others sports, and yet others arts or music. However, in most classes the teacher is the central person and all pupils are treated in the same way. Giving pupils choices can be extended in a way that in each class there is a diverse course: not all pupils do the same, and each pupil should be able to participate in a way that suits them. They will enjoy the process more, and the diversity is also more interesting: "schools increasingly recognize diversity as a resource rather than a problem in the classroom" [UNESCO 3, p. 21]

- *Learning is based on a strength model of student abilities, interest and culture.*
  In a traditional classroom, the good pupils are praised and the weak ones left to trail behind. In a diverse environment on the other hand, pupils can discover their strengths and improve their skills in these areas. The fast ones should not get bored by waiting for the others, while the slower pupils should not be discouraged by reproaching them with their "weakness" and by scaring them with failing grades.

- *Learning is a social process*
  When working in collaboration with peers, teachers and parents, students will both

learn more and enjoy learning better. Teachers, too can collaborate with their colleagues, to get a broader view and to keep their knowledge up to date.

- *Learning is an active, not a passive process*
  Complementary to *Learning is transfer of information:* Instead of reproducing knowledge, human beings acquire knowledge by actively involving themselves in projects, solving problems, by writing, by doing scientific research themselves, by getting engaged in discussions, participating in performances, creating artwork or useful physical objects etc. This also means that human beings learn by making mistakes. In every project, mistakes will be made, and they should be seen as something necessary rather than something to avoid or punish.

- *Learning may be either linear or non-linear*
  Everyone has different experiences and knowledge. When a new piece of information is received, it may fit in with what is already there - or it may not. It may however fit in at a later time, when an experience from a completely different topic is gained. This is what is probably meant by "non-linear learning". Some topics, like mathematics, are rather self-inclusive and based on a logical structure, so learning mathematics in a sequence of clearly defined steps may be the best method. But even in mathematics there are different viewpoints, and the first step may find better understanding after the fifth step has been reached.
  It is of course easier for teachers to build a linear structure in their mind of the topic they are going to teach, and to try to pass that logical structure to their pupils. They should however keep in mind that the logical structure may not reach the students, and that they will learn the topic instead in a completely different sequence.

- *Learning is integrative and contextualized*
  This is complementary to *Learning is facilitated by breaking content into small isolated units.* "Pribram's holistic brain theory suggests that information presented globally is more easily assimilated than information presented only in a sequence of information elements." [UNESCO 3, p. 20] It is of course better for students to see the reasons and the context of today's class than to just make them learn something and telling them "you need this for later."
  In order to understand an information, it is necessary to make a connection with other pieces of information. "Information can be given, the connection can even be stated. But even if the information is repeated, it cannot be assumed that it is really known. The learners must discover it for themselves. That is not to say that learners must discover everything unaided. The teacher's role is to help them in several ways to make connections and to integrate knowledge." [121]

[121] From personal experience, the auther can comment that sometimes, especially with complex informa-

- *Learning is assessed through task completion, products and real problem solving of both individual and group efforts.*
  "Rather than simply evaluating students through paper and pencil tests, assessments are made using portfolios of actual performances" [Osin, p. 21] And since the learner centered approach encourages that pupils work in groups, these groups may be assessed as a whole. Individuals may be assessed by the way they participate in the group.

3.5.3 Methods in Combination with Computers

Computers and the internet can very well be used in conjunction with the learner-centered approach; they even offer possibilities that were not available before. The methods in the following list are intended to make the best use of computers. Some of them have been adopted from Luis Osin's document, while others are based on the authors own experience with teaching and computers.

- **Computers can be used to support individual interests and speed of learning**
  Computers as an educational tool "provide, for the first time in history [...] individualized interactivity. Computers can not only present information [...] but also can receive information from the user, and can adapt the presentation to the user needs, preferences or requests." [Osin, p. 3] Well-designed software offers individual choices to each user, as well as individual speed of learning.
  Furthermore computers may be used to *create* things (for example a website, a program or a graphical presentation), so each pupil can form their creation according to their individual skill and speed.
  Using computers for individual learning requires that computers are available for each pupil in class (or at least for pairs of students), either during class time or at a time where the lab is open for any pupil of the school. It also requries pupils to know how to use the computer, and teachers to trust them working on their own, possibly without supervision.

- **Pupils' assignments should be designed to resemble complete and meaningful tasks that require many methods instead of exercises to teach one method.**
  Simple exercises are useful to get pupils started, for example to learn how to type or to train the basic use of a certain software. After that short period of introction however, assignments should be given that include more than one method and more than one kind of software. In real life, most tasks consist of a combination of methods and require knowledge from different areas.
  An example is the creation of a database: it involves doing research on the topic for

tion, there is no other way than to teach small pieces bit by bit, and hoping that eventually the students will understand. The only thing that helps here is patience, on both sides of the teacher and the students.

which the database is created. Research is followed by a high-level design (done on paper), after which the database is created with the database software. To interact with the database, a user interface should be created (for example with a programming language), and then the new system must be tested and filled with information.
The technique to create assignments based on complete "real life" tasks has proven to be successful, even for pupils with a learning disability that were before considered unable to design a database. Starting from simplified (but still complete) tasks, they were able to learn the whole process with slowly increasing complexity.
Apart from being a good preparation for the future, it is probably also more fun to finish a complete task instead of practising exercises whose general purpose cannot be seen by the pupils.
A very brief guideline of how to properly set up assignments based on real-life tasks (based on [Rieder]):
1. research on real-life tasks (e.g. by watching the task being done in a company)
2. analyze the task and prepare a list of key steps done in the process
3. create exercises based on the analysis, starting with simplified tasks and increasing the complexity with each following exercise
4. prepare a guidebook for students that they can use for reference during their exercises

- **Working in pairs** is a good method for certain kinds of tasks that are done with a computer. Computers have been criticised for making people work in loneliness, to an extent that can even produce psychological damage. Be that as it may, for many people it is more fun to work with others (while there are others that prefer to work alone.) This method also trains teamwork and learning from one another.
  Working in pairs can be done in computer programming (it is actually a technique that is used in the software development model called "Extreme Programming"[122]), it may be used in any kind of design, internet research and even in creative writing, if the writers are a good match.

- **Projects are a natural application of computers.**
  A project usually consists of a number of phases, including planning, production, presentation, monitoring and troubleshooting. They require teamwork and thus communication and coordination, and skills in a number of areas: technical, social, management and marketing. Projects that use computers can be done not only with a computer background, but also in context with any other subject. A history research assignment can be done in a project just like wooden furniture, a school garden or a business project.

[122] For an introduction to Extreme Programming, refer to http://en.wikipedia.org/wiki/Extreme_programming

The benefit of using projects as a learning method is that pupils learn together, that they have to use many skills and in the end they produce something which gives them a feeling of achievement and success.
The applications of computers in a project include using project planning and management software, group communication, creating presentations, documentation of the project and guides for users of the product. Computers can also be used to create the product itself: written or graphical material, computer programs etc.
The requirements for equipment and general situation of the school depend on the project. It may for example be initiated by the teacher of industrial arts, which means he or she would have to know how to use computers for a project, and teacher and students would need access to the computer lab. There need to be enough computers with the necessary software installed. If they are to be used for a presentation of the project, a video projector is needed, and if groupware[123] were to be used, the computers would have to be networked. However, even a few computers with only office software installed can support project tasks like planning, accounting or writing documentation, and they may be used to create the product, for example in a programming or a web design project.

- **Computer and internet-based research**
  A method that can be used for projects, self teaching and research assignments
  The world wide web[124] is a huge source of information, a gateway to the world, so to speak. It also requires a lot of guidance for the unexperienced, if they shall not waste their time or even take damage from seeing material which they are not supposed to see (i.e. pornographic or criminal material.) Pupils who are to use the world wide web on their own need to have *media compentency*: they need the ability to determine the quality of an article, and to verify its truth. They also need to know how to use search engines. Giving them addresses of portals can also be a great help to make searching easier.
  On the technical side, an internet connection is required. There are however some e-learning products that can act as substitute, and work without the internet: they provide a database with information that can be used for research. In a way, this technique is more appropriate in schools: pupils can spend more time on reading material than on searching.

- **Peer teaching**
  In a learner-centered approach, pupils may also be teachers - for each other, or even for their teachers. Giving pupils the possibility to teach others has a twofold benefit:

[123] A short introduction to groupware is given in section 3.6.6 about school software.
[124] "World wide web" and "internet" are often used synonymously. Correctly speaking, researching web sites is done in the world wide web, and it uses the internet (which can also be used for other things)

by teaching a subject, they will gain much more insight into the topic (because they must be able to explain it to others.) They also learn how to teach, which is a social skill. It is certainly true that not everyone has an affinity for teaching. However, the ability and affinity for teaching can be encouraged and developed in pupils.
This method helps when there is great difference in speed of learning: the fast learners can use their strength to explain their knowledge to others. And even for the teacher it will not always be possible to be "on top", especially in the fast-changing world of technology, so they too can benefit from their pupils' ideas.
Peer teaching is a very good technique to be used at teacher training colleges, because the future teachers need practice in teaching.

- **Simulations and exploration**
  "There are topics of study that deal with real systems whose complexity makes them hard to comprehend" (for example business organisations, eco-systems, economies, social structures, diseases...) "When we want out students to learn how to cope with such systems, the best pedagogical approach is not to provide a set of rules that describe the behavior of the system, but rather to let them explore the behavior, make decisions and predict their consequences or, in short, learn according to their own experience with the system. This is easier said than done when the real system is a hydroelectric power station or the economy of a nation [...] Fortunately, for many real systems a computer model has been developed" [Osin, p. 4]

- **Using software for pedagogical administration**
  It is good for teachers to know something about their students. To know their strengths and weaknesses, or to know what they have already learned gives them a much better basis for individual teaching. It is easy for students to get bored when someone explains something they know already. On the other hand the teacher may to ask too much of pupils when they have missed something. In outcomes-based education, the frequent tests are used in order to give both pupils and teachers a better view of the pupils' knowledge.
  With computers, "teachers can access a student database, where information about each student's knowledge map is stored [...] For the first time the teacher has the tools to make sophisticated and complex pedagogical decisions." [Osin, p. 5] By such a database, the teacher may also know what students have learned in other subjects.
  However, the author feels that a word of caution is appropriate here: for one, pupils may feel controlled too much by having their information available for all teachers of the school. And the power of such a system should not be over-estimated: having more knowledge about a pupil does not mean that they will learn or work more. It is not a tool to motivate them, only a help for the teacher when designing their class.

Apart from that, such individualized teaching requires extra work by the teachers (and possibly by pupils if they are allowed to enter their experiences and wishes themselves.)

- **Communication networks**
  The networking of computers, especially over the internet gives a lot of possibilities for discussions, bulletin boards, news systems and the like. Communication networks may be used in projects (for example if a project was done in collaboration with other schools), they may be used for discussions about the school itself, and they may be used by teachers to communicate with other teachers, for example to keep their knowledge up to date.

3.6 Hardware and Software

A concept for computer hardware and software can only be given *as a whole*, not as three separate concepts, one for hardware, one for the operating system and one for the application software. The reason is that each of these three affects the other two: A piece of hardware for example may only work with a certain operating system. A certain software application on the other hand may have specific hardware requirements, and in many cases it will run either with Windows or with Linux, but not both. And the requirements of stablility or easiness-of-use may suggest an operating system, which may exclude certain type of hardware and which will limit the choice of software.

This section is not a one-way plan - it rather gives a variety of choices, out of which different hardware-and-software concepts may be built. The hardware scenarios and the educational software should be tested in various combinations in different pilot schools, as described in the Action plan (section 3.4.) Only after teachers, pupils, parents, technicians and administration involved in the pilot projects have given their opinion, a final concept should be formulated.

As a guideline: the first part of this section recollects the conditions of Zambian schools, as far as computers are concerned, and lists the requirements that need to be fulfilled by the hardware and software systems. Some of these requirements apply to any computer system, and some arouse from the special situation at schools. For completeness, the requirements for the infrastructure have been stated as well.

The main part is divided into three components. The first two present a number of different hardware and operating system scenarios for schools, and the third a list of Open Source educational software. The dependencies between these three components have been stated where applicable. The software has been chosen with regard to the teaching and learning methods proposed in section 3.5.

The cost of the concept is an important factor, of course, too. The cost of these scenarios is discussed in the section about administration (see 3.6.7)

3.6.1 Conditions in Zambian Schools

1. The education system in Zambia at the moment has extreme financial difficulties, allowing only small investments.

2. There are few, if any trained computer technicians in the Zambian education system, and there are few, if any teachers who are capable of doing computer maintenance. This is especially valid for Linux.

3. The cost of internet connections at the moment is not affordable for schools, especially in rural areas. There may be funds for selected schools, especially through

efforts by development organisations, that can support an internet connection, but for most schools, it will take many years until they can be connected.

4. According to a short interview with the District Education Board Secretary of Kitwe, about 85% of Zambia's schools have electricity.

5. There are already about 2,000 Pentium I class PCs using Windows 98 and Microsoft Office 97 in Zambian schools.

3.6.2 Infrastructure Requirements

The term *infrastructure* in this concept refers to schools rooms and electrical installations.

1. The schools must have electricity. It is possible (but expensive) to run a computer lab with a dedicated electricity source, like a generator or solar panels. The cost of procurement for these electricity sources is however quite much, and since there are many schools that do have electricity, it does not seem to make sense to use the scarce financial resources for a generator or solar panels.

2. The schools' computer systems must be well protected against theft. This may be a tough requirement to meet, as even grilled windows can be broken if the classroom contains very valuable items. The danger of theft means that a hardware scenario that includes an expensive server may make less sense than a scenario with only cheap workstation computers.
   Yet even if the cost of the machines is relatively cheap, they should still be well-protected from theft, with each individual part being fixed to the table, the windows having grills and the door having a lock.

3. The schools' computers need to be protected against dust. Dust causes
   - monitors to malfunction
   - moving parts like fans and cdroms to break
   - electric contacts between computer parts to lose connection
   - floppy disks break after a short period

4. The schools' computers need to be protected against power black-outs. Power black-outs have three causes:
   - loss of data
   - a quick wear-out of the hardware
   - possible instability of the operating system

3.6.3 Computer System Requirements

By “computer system” is meant the computer hardware (and possibly an internet connection), the operating system on the computers and the educational software which is used.

1. The computer systems used at schools should have a **high degree of similarity**. Maintenance will be cheaper: a technician will quickly solve problems - whereas he would have to find his way into a new situation every time if many schools used a different system. Teacher education would also be more sustainable, if they will find similar systems and similar software in most schools.

2. The computer systems at schools should have a **high degree of stability**. Maintenance will be cheaper when there are fewer problems. Also, frustration among teachers and students will be less. This means, the systems need to be resistant against damage by students and teachers, as well as against external attacks, and against errors in the software itself.
   Damage by students and teachers could be damage to hardware, caused by moving around computers, printers etc., as well as damage to software, caused by uncontrolled installation of software or tampering with important system files or data of users.
   External damage means damage by virus and worm software, or by crackers who hack into the system via internet. The risk of virus increases when the students are allowed to install software. The risk of worms and crackers is only present when there is a connection to the internet. The risk of crackers is fairly small, while the risk of virus and worms is high at the moment for Microsoft Windows, and not very high for Linux.
   Another cause of instability is within the installed software itself. There may be system crashes (which occur by far more with older versions of Windows than with Linux) and unexpected behavior of software (which occurs in many programs, both Open Source and proprietary.)

3. In case a software system becomes damaged and unusable, it should be **easy to restore** it back to a usable standard system.

4. The computer system needs to be **safe**. There should be no risk of injury by electric shock, for example. Neither should there be a risk of exposing students to criminal, racist or pornographic material, nor to addictive games.

5. It should be possible to use the computer systems at schools after a **short period of introduction**. They should not be overly complex, which would cause frustration and more expenses in teacher education.

6. The computer systems should give a good **preparation for future life** of students. This does not mean that they should learn exactly the same software that they will use in their future jobs. As Peter Bingel, a German computer studies teacher put it: "If you learn how to drive, you learn how to drive a car. You don't learn how to drive a Mercedes or a VW." [Bingel] But it is also true that if you get used to a certain software, for example Microsoft Office, you will have some difficulties to adapt to a new software, for example Open Office. The curriculum therefore needs to find a compromise between what is useful and affordable for a school, and what will be used in "real life". It should also keep in mind that pupils may not be working with the same software that they learn in school. It should enable pupils to adapt to *new* software, instead of teaching them every detail of a *special* software.

7. The software used in the system should **not require expensive hardware**.

8. In first phase (when computers are introduced in schools), the educational software should not require an internet connection - simply because there will be very few schools with an internet connection. For later phases, the integration of internet applications should be planned: When there are some public schools that do have an internet connection, internet applications can be tested and the curriculum can be extended to use the internet.

9. Likewise, updates of the software should be possible without an internet connection.

3.6.4 Hardware Scenarios

1. **Single computers without a network**

   (a) *Description*
   The most simple form of a computer system. Exchange of data between the PCs is difficult (especially in schools where floppy disks are liable to break.) Using a printer thus becomes a problem because data cannot easily be transferred to the PC that is connected to the printer. None of the services offered by networks can be used either. This means that if an internet connection is available, it can only be used on one computer.

   (b) *Hardware requirements*
   All PCs can be used as long as they can support the operating system and the software to be used.

   (c) *Technical knowledge required*
   The knowledge of technicians only has to include repairing PCs, installing the operating system and software, and restoring a broken system.

(d) *Recommendation*

In a school that has never used computers before, this scenario may be a first choice. No user management with passwords for everyone needs to be done, which means pupils and teachers can use the PCs with little administrative overhead. Also, this type of scenario is the easiest to set up with a few donated old PCs. After some time, however this scenario will reveal its shortcomings: computers may become messed up because many people work on it, and there is no designated place for each user to store their personal files and profiles[125]. People will save their files in any place they like - on floppy diskettes, on the harddrive of the computer in the classroom which they are using. This means disorder, and when many people have been using the computers for some time, it will be impossible to remember in which place last week's homework is saved. Other network services like a shared printer or an internet connection cannot be used either.

2. **Peer-to-peer network**

(a) *Description*

Essentially the same as the above, only that it is possible use a number of network features: copy data from one PC to another, share a printer among all PCs, send messages from one PC to another, use special e-learning software, and distribute an internet connection to all computers.

(b) *Hardware requirements*

Like in the first scenario, all PCs can be used if they can support the software. Each one needs a network card however. Additionally, network cables and a hub to connect all the cables are needed.

(c) *Technical knowledge required*

Technicians need to know everything from the first scenario; additionally, they need to have basic networking knowledge: how to connect the cables, how to configure the computers and how to share files and printers.

(d) *Recommendation*

Same as for the first scenario - the only difference really is that it costs a little more and requires a bit more knowledge on the technician's and the teacher's side, and offers more services. If there is an internet connection at the school and it is to be used by students, there has to be a network.

3. **Network with a server and fat clients**

[125] A profile is a set of configurations that someone can make when they work frequently with a computer; the computer can then remember "what the user likes."

(a) *Description*

A "fat client" is an ordinary PC like in the above scenarios: it has an operating system and all necessary software installed. A "server" is a computer that offers special *services*:

i. *User management:* The server maintains a database that keeps a username and a password for each student and teacher. Each user can then use any of the client computers, but only with a password. Users will have their own profile, by which they can work with their personal settings on any of the client computers.

ii. *File server:* All data that is created by students and teachers is stored on the server, rather than on the computer in the classroom which they are using. This means, they can create a file on one computer, and the next day they can work with the same file on another computer without noting the difference - the file was on the server all the time.

iii. *Web server:* For an Internet Service Provider, a web server is used to host web sites of many people. In a school, a web server can be used for a number of other things: it is needed for "groupware", for "wikis" and for teaching of web design (and possibly database programming.) "Groupware" and "Wikis" are special software that can be used for project management (see next section on educational software.)

If there is a school web site, it still needs to be hosted on the web server of an ISP.

(b) *Hardware requirements*

Servers in general are more important than the other computers; if they break, all of the network may become unusable, all files of teachers and students may be lost etc. A server thus needs to be well protected from damage (no dust, no access by pupils, and if one part breaks, the server should ideally still keep working), and if there is a problem, the technician should be able to install a spare part. A file server needs to have two large harddrives and a security system that prevents loss of data if one of the harddrives breaks. For a school, a file server does not need any special hardware besides that. (Only in large networks, file servers need to have "real server hardware" like fast, multiple processor and a lot of memory.)

A server for user management can be any ordinary computer for a small network. The same applies to a web server.

Please note that more than one service can run on a single computer. It is possible to install all services - file services, user management and web server - on a single computer. In that case, the server computer may need a faster

processor and more memory.

If a server is used, all client computers need to be connected to a network (there may still be some computers which are not connected, but these won't use the services provided by the server). Like in the second scenario, each computer needs a network card and a cable, and there has to be a hub.

(c) *Technical knowledge required*

If the network is well set up and the server runs stable and is protected from damage, the knowledge required by the *computer teacher* is not much more than in a peer-to-peer network. In a way he or she may be less stressed: with a peer-to-peer network, a teacher has to cope with a chaotic system. With a proper network with file server and user management, computer teachers do not need to know exacly how the operating system of the server works. They just use the system, and user and file services are not very complicated to use. They need to manage the distribution of passwords to the students and the other teachers, and to show them how to use passwords and the file services.

The *technicians* on the other hand need a lot more knowledge than in the first two scenarios: they need to know about networking and the services. If many schools use different systems, they need to know even more, and they need a lot of experience because they will have to deal with problems in unfamiliar situations. If all schools use similar systems, the training of technicians will be much easier. And if the system is well designed, there will be fewer problems than in the first two scenarios, because there is less potential that the computers get messed up.

(d) *Recommendation*

A network with user management and file services is certainly a much better option for a school. It is more expensive and requires a well working system of technical support. For many schools, it will therefore not be an option at this early stage. In the long run however, schools should use proper network, and teachers and technicians should be trained to use and administer it.

4. **Network with application server and thin clients**

(a) *Description*

This is an alternative to the third scenario, network with fat clients.

A "thin client" is a computer that has only a basic operating system. It is connected to an "application server", and all software that is used is installed on that server. The thin client does not do anything besides transferring keyboard and mouse signals to the server, and showing the result on a screen. Besides the application server, a file server and user management are needed (as described in the previous scenario.)

(b) *Hardware requirements*

i. A *thin client* only needs a network card, keyboard and mouse, a small amount of memory and a display. There are thin clients that do not even have harddrives. Thin clients are usually cheaper than fat clients (although fat clients can be used as thin clients as well.) This scenario has the advantage that old computers can be used as thin clients, to access the most modern software on an application server. There are also very cheap computers in development in the U.S. that offer computers for $100 (see section 3.6.7 on calculating the costs.) These computers have limited hardware, but would be ideal as thin clients.

ii. An *application server* needs to be a "real server"; it needs fast, multiple processors and a lot of memory. Typically, application servers use designated server computers, which cost between $3,000 and $5,000.

(c) *Technical knowledge required*
Teachers need to have about the same knowledge as in the third scenario. Technicians need additional knowledge about the thin client concept and the application server software.

(d) *Recommendation*
The thin client concept has the advantage that all important software and configurations are installed on a single machine (the application server), while the thin clients only have a very basic and simple operating system. By this technique, it is much less work to do maintenance of the operating system and the software - only one machine has to be taken care of, instead of every single machine.
This scenario should be tested as an alternative to a network with fat clients. It should be tested which alternative is cheaper and which one is working better in the school environment.

3.6.5 Operating System Scenarios

Each of the hardware scenarios described in the previous section can support a number of different operating system scenarios. These are in essence combinations of different versions of Linux and Windows. The following scenarios assume that at least a modern Office package (including a text processor, spreadsheet and presentation software) can be supported by the hardware.

1. **Linux on single machines**
works with the hardware scenarios "single computers" or "peer-to-peer network"
All Linux distributions can be installed with varying power and complexity: it is

possible to install a Linux with limited features on an old PC, while it is also possible to install it with full features on a new model (at least 256 MB or RAM and at least 5 GB of harddisk are required then.)

The choice of educational and administrative software is limited to those packages that run on Linux. There is a wide choice of Linux distributions. Some popular ones are:

Debian Linux as a very stable operating system and widely used standard in higher education. Its installation and administration requires a fair amount of knowledge.

Skolelinux (a Debian variant) as an operating system that has been developed escpecially for school use in Norway; the software packages that are shipped with this distribution have been chosen for education.

SuSE and *Red Hat* Linux as the most commercially used Linux distributions. Their installation and administration has been made easier, especially for non-technical people.

Puppy Linux and *"Damn Small Linux"* are distributions that have been taylored to use minimum hardware resources.

2. **Windows on single machines**

   works with the hardware scenarios "single computers" or "peer-to-peer-network"

   There are a number of versions of Windows; the most stable for older hardware is Windows NT, the cheapest on probably Windows 98, and the most modern one is Windows XP, but it requires at least 128 MB of RAM, so at least a Pentium II class machine is required.

   The choice of educational and administrative software is limited to packages for Windows. There are however many Open Source packages that have been ported to Windows (like for example Open Office.)

3. **Linux on fat clients, Linux on server**

   works with the hardware scenario "network with server and fat clients"

   The only difference to the first scenario is that Linux is also installed on the Server. Most Linux distributions include software for file services and user management, so they can be installed on the server. There are however great differences in the configuration software[126]. While in Debian Linux all configurations have to be done "by hand" in a confusing mass of configuration files, the SuSE Linux Enterprise Server package includes a complete graphical user interface to do most configuration in an easy manner. There are also great differences in cost: the Debian distribution has zero cost for license, the SuSE server costs a few hundred dollars. Between

[126] Configuration of a computer system is a necessary and complex task: the computers in the network are to be connected to each other, a user database is created, system backups are scheduled, the internet connection is set up, and many more configurations need to be done. Configuration software makes this process easier.

the basic Debian and the advanced SuSE Server, there are many distributions in between that offer configuration software of varying quality. Skolelinux has been designed especially to act as server in a school environment (and is free of charge.)

4. **Windows on fat clients, windows on server**
   works with the hardware scenario "network with server and fat clients"
   The only difference to scenario no. 2 is that Windows is installed on the server. The options include the packages "Windows NT Server", "Windows 2000 Server" and "Windows 2003 Server". They all offer file services and user management. The easiest to configure is Windows 2003 Server, and it will run on any new computer.

5. **Windows on fat clients, Linux on server**
   works with the hardware scenario "network with server and fat clients"
   Apart from the Microsoft server products, the Linux distributions can be used on the server, with Windows on the clients. With the software package "Samba", Linux can offer file services and user management for Windows clients. The configuration of the server is more complex than in scenarios 3 and 4 and requires more experienced technicians.

6. **Linux on thin clients, Linux on application server**
   works with "network with thin clients and application server"
   In this scenario, a very small and basic version of Linux is installed on the thin clients. The only duty it must perform is to display on the monitor what the server is sending. All other software packages run on the server.
   On the server, the same Linux distributions can be used as in scenario 3: The server has to run the file services, the user management. Additionally, all the educational software must be installed on the server, which means that only Linux-based software may be used.

7. **Windows on thin clients, Windows on application server**
   works with "Network with Thin Clients and Application Server"
   In this scenario, a basic Windows with a package called "Remote Desktop" and no other software is installed on the thin clients. Similar to scenario 6 it must only display what is sent by the server.
   On the server, a package like Windows 2003 Server is installed. In addition to file services and user management, the Windows server needs to be licensed for "Terminal Services" - this is a license that allows a client computer to run software on the server. The licences for Terminal Services have to be procured extra.

8. **Linux on thin clients, Windows on application server**
   works with "Network with Thin Clients and Application Server"

Like in scenario 6, a very small and basic version of Linux is installed on the thin clients.

On the server, a package like Windows 2003 Server is installed. This means, the Linux clients are used to display Windows-based software. Like in scenario 7, the licences for the Windows Terminal Services need to be bought extra.

The software package that allows Linux to display the Windows Terminal Services is called “rdesktop”.

9. **Linux on Thin Clients, two Application Servers (one Linux, one Windows)**
   works with “Network with Thin Clients and Application Server”
   This is a combination of scenario 6 and 8. The Linux thin clients are used to display both the software that runs on a Linux- and a Windows server. Instead of one application server, two server computers are needed. With this scenario, it is even possible to access software on the Linux server and the Windows server at the same time.

   The main advantage of this scenario is that both Windows and Linux-based software can be used for education.

   The drawbacks are quite serious, however. Two expensive server computers have to be bought instead of one, as well as the full license fee for the Windows server software. The installation and maintenance of the system is much more complex than in any other scenario. And finally, the education process is more complex, as both teachers and pupils need to learn about both systems.

3.6.6 School Software

Software has been used in education in many countries for many years, but in many other cases schools are only beginning to explore the possibilities. This is not only true for developing countries. Some ten years ago, when the author was still in high school in Germany, computers were only used by a few students to learn computer programming, there was no internet connection and the term “Open Source” was not even born yet. Computers were only used by the secretaries and to create the school timetable for all teachers and all classes, a very complex task.

Today, more and more schools become equipped with computer labs, and more teachers of different subjects become computer literate. There are many mature software packages, as well as new projects, especially in the Open Source world. The Application Index for educational software[127] of the Simple End User Linux project (SEUL)[128] lists a few *hundred* software packages that can be used in a school. Some of them are mature and fully functional, while others are just small tools and games, or new ideas that are begin-

[127] http://richtech.ca/seul
[128] http://www.seul.org

ning to be implemented. Educational software is an ongoing development that still has a lot of potential for new inventions.

Software to be used in schools can be separated into

- *class software:* software to be used by students in class (sometimes referred to as "edutainment software", which highlights that computers should make education more interesting, but hides the professional aspect of using software in school.) The class software can then be separated further into subject areas, e. g. Languages or Mathematics.
- *teachers' software:* planning and keeping track of lessons, gradebooks and the like.
- *school network:* message and discussion boards for communication within the school. Software for the school network may be used by administration, teachers and students in class.
- *administrative software:* creating school schedules, keeping student records, and software that is used in any organisation like ordinary office software, or software for payrolls and accounting.
- *computer system administration:* there are packages designed especially for the needs of schools, for example ease of use, handling large numbers of users or separating teachers' and students' access privileges.
- *distance teaching:* software for giving lessons through computers (this kind of software won't be discussed within this paper, as the concept is only about using computers within a school, not to transfer teaching via internet to remote schools.)

This paper can only supply an introduction into the long list of available software for education. On the next few pages, an example for a school's software collection is given. The following list of software shows that it is possible to equip a fully functional computer lab with Open Source Software.

Software in class The software presented here is all client-based. Client-based software runs on single machines and does not need a server. It is therefore usable in any hardware scenario, provided that the client computers are strong enough to run the software.

- *Typing trainer*
  - **KTouch**[129]**:** training program for typing with 10 fingers
    KTouch is part of the KDE Edutainment Project, and is included in Skolelinux.

[129] http://ktouch.sourceforge.net

It includes training lectures for keyboard layouts for a number of languages, adapts itself to the speed of the learner and shows statistics on speed of typing and error rate.

- *Office software*
  "Office software" is a term that has become synonymous with a number of applications. There are three components that are usually part of an office "suite": word processor (used to type and format letters and other text-based documents), spreadsheet (used for tables, calculations and diagrams) and presentation software (used to create slides.) Other packages like drawing programs, database frontends[130], website editor or project management software are included in some office suites as well. In this document however, those packages are listed separately.

  - **Open Office**[131]**:** software suite with three main components: word processor ("OpenWriter"), spreadsheet ("OpenCalc") and presentation software ("OpenImpress")
    Shipped with most Linux distributions; available both on Linux and Windows. All three components have been desribed as "viable and stable" in [QinetiQ], which means they provide almost the same functionality as Microsoft Office, and all functionality is well implemented, i.e. the software does not crash. The components are described as "interoperable" with Microsoft as well, which means a document that has been created with Microsoft Office can be read and processed by Open Office. The only drawback is that Open Office needs a lot of memory, at least 256 MB to work well. It may be used in hardware scenarios that either have at least Pentium II class PCs, or in the thin-client scenario.
  - **Abiword**[132] **/ Gnumeric**[133]**:** As an alternative to Open Office, Abiword may be used for word processing and Gnumeric for spreadsheet. Both are available on Linux and Windows.
    Both programs are described as fairly stable and mature in [QinetiQ]. Abiword offers limited features in comparison to Open Office, but these may be enough in a school environment, especially for beginners in computer literacy. It is also faster than Open Office Writer. Gnumeric is desribed to implement "about 95% of the [Microsoft Office] Excel functions", but does not support all formatting features. Abiword and Gnumeric thus are not as powerful as Open Office or Microsoft products, but require much less computer power.

[130] A "database frontend" can be used to create graphical user interfaces (GUIs) for databases. A GUI makes it easier to work with the database: to enter new data, to create reports and the like.
[131] http://www.openoffice.org
[132] http://www.abisource.com
[133] http://www.gnome.org/projects/gnumeric

- *Digital image and photo processing*
  Image processing is useful in any area that uses digital photos and images: the personal photo collection, the creation of articles, books or newspapers, and in web design.

  - **GIMP**[134] ("Gnu Image Processing"): digital image and photo editor. Shipped with most Linux distributions; available both on Linux and Windows.
    GIMP is used for enhancing digital photos (removing scratches, adjusting brightness or correcting the perspective.) It may also be used for drawing, merging and combining images and many other ways of creating digital images. GIMP is mature and provides many of the features that professional software like Adobe Photoshop offers. It does not have all the features, yet the style of working with the software is the same.

- *Web design*
  The creation of web pages which use text, graphics (and possibly sound, animation or movies) to be shown on the World Wide Web is called "web design". Aside from presenting information, a web page should appeal to the viewer by "looking nice" - the better the graphical design and the logical structure of the page, the more professional its reception.
  Simple web design is about creating *static* web pages that don't show changing information. A markup language called HTML is needed for these. Complex web design is about *dynamic* web pages. Dynamic web pages need a database and a script in a programming language, like Perl or PHP. The skills necessary to code dynamic web pages however are beyond the scope of school education.

  - **NVU**[135]**:** Editor for web pages
    NVU is based on the Composer program that was part of the popular Netscape browser. It is available both for Linux and Windows.
    NVU provides a "What you see is what you get" interface, which means the creator of the web page does not need worry about the coding of the page in HTML[136]. This makes it easier to use than programs which focus on the HTML code, like for example Quanta. It aims at providing the same functionality as popular commercial software (e.g. Macromedia Dreamweaver or Microsoft Frontpage.)

- *Project Management*

[134] http://www.gimp.org
[135] http://www.nvu.com
[136] The Hypertext Markup Language (HTML) is the language that is used to code web pages.

- **Imendio Planner**[137]**:** Software for planning, scheduling and tracking projects. Imedio is part of the GNOME project and is formerly known as MrProject. Apart from the stable Linux version, a Windows version is in development.
  Planner uses Gantt charts[138], which are used in other project planning software as well. Planner can be used to define tasks and resources necessary to complete the task, and thus to help planning "who should be working on which task at what time".

- *Accounting*

  - **GnuCash**[139]**:** Personal accounting software (based on double-entry bookkeeping); available only on Linux
    GnuCash is easy to use, yet can manage personal and small business finances professionally. Next to the accounting functions, it includes functions for customer and vendor tracking, invoicing and bill payment, and tax and billing terms.
    In the business world, and especially in Zambia, Open Source financial programs are not yet used by the majority of companies. Most companies today are still used to Windows-based financial software. The basics of accounting however apply no matter which software is used, and GnuCash will work just like any other accounting software.
    Above a certain size, companies need larger enterprise resource planning (ERP)[140] systems than can handle payrolls and tax calculations, and that are configured by experts to match exactly the companies structure. Such professional systems however are way too advanced for school use.[141]

- *Programming / Computer Science*

  - **Free Pascal**[142]**:** Pascal compiler[143] with text-based Integrated Development Environment (IDE)[144]

[137] http://developer.imendio.com/wiki/Planner

[138] "A Gantt chart is a popular type of bar chart, showing the interrelationships of how projects, schedules, and other time-related systems progress over time." [Wikipedia]

[139] http://www.gnucash.org

[140] There are professional programs that run on Linux, like SAP R3, but these are proprietary and very expensive.
There are also some Open Source projects to develop ERP systems, like Compiere or GNU Enterprise, which are still in development and which have not yet gained a broad reputation.

[141] There is a good introduction into Open Source options for financial software:
http://freshmeat.net/articles/view/269/

[142] http://www.freepascal.org

[143] A compiler is software that translates source code (written by people) into computer programs.

[144] An IDE usually includes a special editor for writing source code, menus to help configuring the compilation process, and documentation of the programming language.

Available both on Linux and Windows.
Pascal is a fully functional procedure-oriented programming language. While there are libraries to develop any type of software, the design of the language is more simple than for example C or Java. The combination of full features and easiness of use make it a very good choice for teaching programming at school.
There are many proprietary compilers for the Pascal programming language. The Free Pascal IDE's design is similar to the DOS-based Turbo Pascal from Borland.

- *Science and Mathematics*

  - **KMatPlot**[145]**:** Program to display mathematical functions in 2D and 3D
    KMatPlot is a tool similar to Gnuplot[146], only that KMatPlot includes a Graphical User Interface (GUI)[147]. KMatPlot is part of Skolelinux.
    Description of Gnuplot on the Skolelinux webpage: Program for mathematical calculations and plotting of graphs. Advanced functions, programable, based on matrices. Basically simple, but can be expanded with new function. Resembles matlab[148] in many ways, but not as advanced.
  - **Kalzium**[149]**:** A Periodic Table
    Kalzium is part of the KDE Edutainment Project, and is included in Skolelinux. It shows the table of all chemical elements and gives a scientific description of each, some even with a photo.
  - **JChemPaint**[150]**:** Drawing of chemical formulas
    Java-based program to edit and display graphical chemical formulas.

- *Internet Tools*

  - **Firefox and Thunderbird**[151]**:** Browser and email client
    Firefox and Thunderbird have developed from the once popular Netscape browser. They're available on both Linux and Windows.
    Both Firefox and Thunderbird are stable, fully featured and fast and have won a number of awards from computer magazines.

[145] http://kmatplot.sourceforge.net
[146] http://www.gnuplot.info
[147] A Graphical User Interface is essentially a set of windows and menus that are piloted with a mouse. A GUI makes a software easier to use than controlling it simply with text commands. Today, most programs above a certain complexity have a GUI.
[148] Matlab is a widely used commercial mathematics software.
[149] http://edu.kde.org/kalzium
[150] http://almost.cubic.uni-koeln.de/cdk/jcp
[151] http://www.mozilla.org

- *Selfteaching*
  When there is no teacher around and the lab is open for students, computers may be used for practising.

  - **Pauker**[152]**:** Memory cards to practise vocabulary etc. As a Java-based program[153], it will run on Linux and Windows.
    "Pauker is a generic flashcard program written in Java. It uses a combination of ultra-shortterm, shortterm, and longterm memory. You can use it to learn all the things you never want to forget, like vocabulary, capitals, important dates, etc"[154]

Teachers' Software A teacher can use the same software that has been described in the first paragraph: he or she may use office software to prepare exercise sheets, to write letters or to keep track of student grades. The internet can be used to do research or to exchange opinions with colleagues, and project management software to plan projects with students. He or she may also use the software described in the third paragraph (about server-based software): a school network with groupware and content management is intended for the purpose of discussions and computer-based presentation of course material.

There are however a few software packages designed especially for teachers, of which one is presented here:

- *Student Information / Gradebook*

  - **OpenGrade**[155]**:**
    OpenGrade is software for teachers to keep track of grades. It can put the students' grade reports on a web server and allow the students password-protected access to them.

School network software (server-based) Server-based (or "web-based") software has *a lot* of potential for a school. There are many different applications: some may be used by a class for a project, others by teachers or administration, or even the entire school, including the parents. However, communication and discussion software or school information systems require that people in the school have some acquaintance with the system. It may sound easy: just give everyone an introduction to the software, and then everyone is going to use it. In reality, introducing a software to be used by everyone in school may

[152] http://pauker.sourceforge.net
[153] Java is a programming language designed for "platform independence", i.e. Java-programs run on any operating system that has the "Java runtime environment" installed.
[154] description taken from http://freshmeat.net/projects/pauker
[155] http://www.lightandmatter.com/ogr/ogr.html

take much longer. Using a software is a habit, and people do not like to learn new habits if they do not a purpose, and especially if it requires training. Introducing a groupware or a content management system in a school thus may take years of experimenting with software and working with people.

Server-based software, as the name suggests, runs on a server and can be accessed by all computers on the network. Usually the server computer needs to have a webserver and a database installed. The webserver is used for interaction with the client machines (hence the name web-based), while the database stores the data that is used and created with the software. (This theoretical explanation should be more understandable with the examples below.)

Most server-based Open Source packages use a combination of Apache for the webserver, MySQL or PostgreSQL for the database, and PHP or Perl as scripting language[156], all of which run on the operating system Linux. The combination of Linux, Apache, MySQL and PHP (or Perl) is referred to as "LAMP".

The installation of server-based software is usually fairly complex (though it can be made easier with expensive configuration tools.) Installation and maintenance will be beyond most teachers' capabilities, which means it has to be done either by an external company or a service organisation within the MoE. Since it takes time to train teachers in the use of server-based software, it is suggested that many schools use the same software system, or at least very similar ones.

- *Groupware / Content Management*
  "Groupware" is a software that is used to coordinate the work of a team. Typical funtions are mail systems for communication, calendars to handle events and tasks, resource management (e.g. school rooms, copy machines, printers, video projectors, maps...) and bulletin boards for discussions.
  "Content Management Systems" (CMS) are used by organisations or communities in which members may publish information in a uniform way. A CMS may for example be used to publish course material - the process of publishing the material, and the methods of browsing the material would be the same for all courses, while each course would have its own content.
  There are many groupware and CMS packages available, and most combine both groupware and CMS functions. The website OpensourceCMS[157] has a long list of packages, each with various options.

  - **eGroupWare**[158]**:** Groupware and CMS

[156] A scripting language is basically the same as a programming language - the technical difference is that a scripting language uses an interpreter, while a programming language uses a compiler. A program in a scripting language needs the interpreter to be installed on the machine when it runs, while a compiled program does not need the compiler to run.
[157] http://www.opensourcecms.com
[158] http://www.egroupware.org

eGroupWare requires the webserver Apache, for database either MySQL or PostgreSQL, the scripting language PHP, and optionally an email server.
"eGroupWare is a web-based groupware suite. It contains many modules, including Calendar (personal calendar and group scheduling, notifications and alarms), Mail (Email (IMAP and POP3) or FeLaMiMail (IMAP only)), InfoLog (todos, notes, and phone calls linked to contacts (CRM)), Contacts (an addressbook to store and share contact information), and SiteMgr or JiNN (content management)."[159]

- *E-learning*
  Some groupware/cms-systems are dedicated for education. These packages are called "e-learning"-packages and are used to manage courses and present course material over the network. By this technique, students may read the material at a computer. This technique bears chances and risks. Students can do reading at their own speed, which is an advantage to both faster and slower learning students. It requires some responsibility also - for the students to actually do the work, and for the teacher not to use the computer as a substitute for his work.
  E-learning is also a means of distance education (but that is beyond the scope of this paper.)

  - **Claroline**[160]**:** E-learning
    Claroline needs Apache, MySQL and PHP
    "Claroline (ClassRoom online) is a collaborative learning environment that allows teachers or educational institutions to create and administer courses through the Web. The system provides group management, forums, document repositories, a calendar, chat, assignment areas, links, and user profile administration in a single, highly integrated package. It has been translated into 28 languages."[161]
    Another software called Dokeos[162] has descended from Claroline.

- *Wiki*[163]
  A "wiki" is a web page that can be changed by anyone in a very simple way. All that is needed by its users is a web browser and some simple knowledge about how to write inside a wiki. (On the server side, it does need special software.) A wiki enables groups to work together on a documentation, and is a very handy tool for projects. A wiki may also be used for any other kind of collaborative

[159] description taken from http://freshmeat.net/projects/egroupware/
[160] http://www.claroline.net
[161] description taken from http://freshmeat.net/projects/claroline
[162] http://www.dokeos.com
[163] The name was based on the Hawaiian term wiki wiki, meaning "quick" or "informal." [Wikipedia]

writing - translations, dictionaries, encyclopedias, group diaries, to name just a few examples.

- **MediaWiki**[164]**:**
  MediaWiki is the engine on which Wikipedia is built. It requires Apache, MySQL and PHP.
  Compared to other wiki engines, Mediawiki is easy to install and does not provide all functions that other packages offer, but it is definitely sufficient for a school (other packages have complex user and permission management, which also require more time for administration.)

Administrative Software Just as the teachers, the school secretaries may use the software described in the first paragraph (about software in class) for writing, accounting, communication and to receive information. Aside from these possiblilities, there are some software packages designed for tasks of school administration: keeping records of students and employees, printing report cards or managing resources. These packages - except for G-Tablix - are server-based, which means they will only work if there is a network with a server (please refer to the previous paragraph for an introduction on server-based software.)

- **Centre**[165]**:** school administration package
  web-based, needs Apache, MySQL and PHP
  Centre is a web-based student information system for public and private schools. Its features include scheduling, a grade book, attendance, eligibility, transcripts, and more. Student and employee information screens are critical components.

- **Open Administration for Schools (OAfS)**[166]**:** school administration package
  "Open Admin does demographics, attendance, discipline, report cards, and has an online gradebook and parent viewing function. It is designed for elementary, K-12[167], and small high schools. It also includes special education and division-wide central office modules (all schools run on the same server with different virtual sites; two sites per school, one for teachers, and one for the office). Parent functions are by separate parent/school site."[168]

- **OpenSIS**[169]**:** school district administration package
  "OpenSIS manages student information for public and private school districts. It

[164] http://www.mediawiki.org
[165] http://www.miller-group.net
[166] http://richtech.ca/openadmin
[167] K-12 means "Kindergarten through 12th grade" and is an expression for school education in the United States.
[168] description taken from http://freshmeat.net/projects/openadmin
[169] http://www.opensis.org

manages information at the district level and not classroom-level, like many software packages. OpenSIS has the ability to keep track of student attendance, assignments, grades, schedules, health information, student discipline, and more. Teachers can manage their grades, attendance, and communications with other staff. School district staff can produce reports on attendance, ethnicities, grades, and more."[170]

- **G-Tablix**[171]**:** school timetable
  Graphical user interface for Tablix, written in GTK2/Perl[172].
  It helps user to prepare a timetable for high school, using Tablix as a backend. It features extensive documentation, a nice user interface, and several helper features for efficient timetabling.

- **OpenBiblio**[173]**:** library software
  An easy to use automated library system containing OPAC[174], circulation, cataloging, and library administration functionality.

Software for Computer System Administration The software used for the administration depends on the hardware scenario and the operating system used, as well as on the computer policy of the school. Tools for system administration are available in large numbers, and all Linux distributions include some of them. Rather than listing existing software packages, the most important tasks are given to show what configurations should be done by computer system administration.

- Adding and removing users (with passwords) to the computer network; This involves creating "home folders" for the users, in which they may store their personal data; it may also involve creating email addresses for users, giving permission to use the wiki or other services.

- Creating a space on the web server for each user; if the school computer policy allows students and teachers to create their own personal web page, each should be given a space to do so. (This implies some hours per week of administration by a supervisor who should ensure that these web pages do not display offensive material.)

[170] description taken from http://richtech.ca/cgi-bin/seul/seulvw.pl?category=Administrative
[171] http://gtablix.homelinux.org/wordpress
[172] GTK is a software library that is the basis of many other software packages; it is installed with most Linux distributions.
[173] http://obiblio.sourceforge.net
[174] Online Public Access Catalog (OPAC) is a system by which people may browse a library catalogue and reserve books. All this may be done either on computers in the library, or through the internet.

- System backups to save people's personal data and the system configuration in case the server gets damaged. A backup should be done on a regular basis, for example once a night. If the harddrive of the server breaks, the data will still be on a backup drive and can be restored after the broken harddisk has been replaced.

3.6.7 Calculating Cost

Calculating the cost of a large-scale rollout of computers to schools is no easy task: there are many costs to consider, and prices depend on factors like transport, the number of items purchased or the conditions of service contracts. If the Ministry of Education intends to train its own technicians for maintenance, their education and their salaries will be more expensive *per school* in the beginning: when the education of technicians still has to be developed from scratch, some investment has to be made; and when there are only few schools to be serviced, the work of technicians is less efficient than in a case where they service many schools. The cost of software finally depends on the availability of donations, if proprietary software is used.

Luis Osin describes how to analyze costs in the document "Computers in Education in Developing Countries: Why and How":

"Accurate cost must be determined by analyzing the appropriate components in the Cartesian product shown in [the table below].

Infrastructure		Purchase
Hardware		Development
Software	X	Production
Courseware		Operation
Personnel		Maintenance
		Administration

[Osin, p. 6]

The diagram can be read as "For infrastrucutre, there are costs of purchase, operation, maintenance and administration. For courseware, there are costs of purchase or development, of operation, maintenance and administration. For personnel ..."

In Osin's document, *infrastructure* is used slighly different, as it includes computer networking; *hardware* means all computer parts; *software* describes the operating system and administrative software, whereas *courseware* means software used for education; *personnel* means teachers that use the computer lab, and people responsible for maintenance.

Luis Osin then goes on to list costs, separated into *Initial Investment Costs* and *Recurrent Costs* and calculates the total annual cost for a school. He concludes from this annual cost that it makes sense even in developing countries to introduce computers in schools because the cost per student using the computer system is very low compared to the gains

in better learning. His figures are from 1998, so his computer system model and its cost are out of date. His way of calculating however is general and useful today.

Procurement Cost of Hardware The cost of hardware depends on the scenario and on the type of computers that are used in the scenario. The following figures are rough approximations, and they will be valid only for a short period because computer hardware cost decreases *by half* about every 18 months (or rather, after 18 months you'll get hardware with twice the power at the same price.)

There are some projects to develop special computers dedicated for education in developing countries. These projects aim at producing extremely cheap (but still useful) computers. Their strategy is partially based on using cheap hardware and partially on selling very large numbers of the same computer. One of these projects is *Solar Lite*[175], initiated by the U.S.-based company SolarPC. They offer a desktop PC that includes "everything but a monitor" at a price of $100, not including tax and shipment. According to the online magzine LinuxPR, the default operating system is the Linux distribution "Damn small Linux", and the minimum order is 100,000 PCs. The Solar Lite website has announced the PCs to be ready for shipment by January 2006.

The other project for cheap computers is called "The $100 Laptop Project (HDLP)"[176] and is initiated by the MIT Media Lab in the U.S. The laptop which is announced is still in the design process. It is supposed to use a new monitor technology that shall keep the monitor price below $12. So far, the project has published a hardware specification of a 500 MHz processor and a 1 GB harddrive, and a Linux distribution as the operating system. This kind of hardware would allow only a limited set of software. What makes this option interesting is that it includes every component of a computer: monitor, keyboard and mouse do not have to be bought separately.

The advantage of these cheap computers are obvious: since the education system in Zambia has barely enough funds for teachers' salaries and very little funds for any investments, they offer a cheap alternative. They do have a drawback, however. If they are chosen, they would have to be bought in large numbers, so their procurement would cost a large sum of money in a single transaction. If these computers prove to be well-working with the curriculum and have a long durability, the annual amortisation may actually be quite low - in five years, only $20 per computer per year would be spent. If they prove to be insufficient for the curriculum or to have only a short durability, a lot of money would be wasted. Thus extensive testing has to be made before a decision to buy thousands of cheap computers is made.

The full cost of the four scenarios in section 3.6.4 are calculated as follows - under the assumption that 20 computers per school are used.

[175] http://www.solarlite.org
[176] http://laptop.media.mit.edu

1. *Single computers, no network*
   If computers are donated, the procurement cost is limited to the cost of transport.
   If they are bought, cost could vary between $100 (for computers developed especially for education in developing countries) and $1000 (for a standard PC from a Zambian shop) per machine.
   In the worst case, this scenario would thus have an initial investment cost of $20,000.

2. *Peer-to-peer network*
   This scenario has an additional cost for the network that has to be installed; this means costs for 20 network cards ($10 each), 20 network cables (15 meters, $10 - $20 each), a hub ($100) and installation costs. The cost for the network thus add up to $700 plus installation cost of approximately one day's work, which largely depend on the availability of technicians.

3. *Network with Server and fat clients*
   This scenario costs the same as a peer-to-peer network with the additional cost of the server; As todays standard PCs are powerful enough to handle file services, user management and web server for a schools, the cost of this machine can roughly be calculated as $1,500 to $2,000 in Zambian computer prices (around $1,000 for the highly developed countries.)

4. *Network with application server and thin clients*
   This scenario costs the same as a peer-to-peer network with the additional cost of an application server. This server should not be a standard PC but a server computer, which roughly calculated costs between $3,000 and $5,000, not including shipment.

Cost of Software Software costs usually include license fees (which may or may not include upgrades) and installation / configuration / troubleshooting support. License fees are usually calculated *per computer*, which means that in a school with 20 computers, a 20 licenses of a particular software product must be bought.

For most Open Source software there is no license fee. Company support for installation and using the software, as well as training are not free of course.

Example of Calculating the Complete Annualized Cost To give an example of calculating the complete cost (using the model of Luis Osin), two scenarios including infrastructure, hardware, software and maintenance are presented. Exact figures (except for the computer hardware) cannot be given at this point, as the author is not familiar with specific costs in Zambia: cost of installing a computer classroom, or training teachers should be calculated when concrete projects are defined.

1. *Network with donated computers as thin clients and an application server, running Linux*

   (a) Initial Investment

   Infrastructure: furniture and electrical installation (if not present yet), air conditioning (if necessary), protection from theft

   Computer Hardware: $5,000 for the server; $1,000 for network equipment; cost of transport and installation of the system

   Software: As Open Source Software is used, the procurement cost is zero. The installation however requires some work by a technician (the amount of work decreases when the same system is installed frequently.)

   Teacher Training: Luis Osin estimates 60 hours of instructor time necessary to train the teachers to use the computer system

   (b) Recurrent Cost

   Maintenance: Replacement of broken hardware, fixing broken parts of the infrastructure; with donated thin clients, the only way of providing spare parts is to take them from other unused computers (it will not be possible to buy them from a shop.) The spare parts for the server on the other hand are more expensive. And since it is essential that the server works, maintenance should be done quickly.

   Upgrading software: when free software is used, the procurement cost for upgrades is zero. Without an internet connection however, a way of distributing upgrades to the schools has to be found.

   Teacher training: Luis Osin extimates 60 hours necessary per year to educate new teachers in a school, to introduce new software, educational material, and to discuss problems

   Personnel: Instead of budgeting a full-time person in charge of the computer lab, Luis Osin estimates that one teacher with the necessary qualification could take care of the lab, using 8 hours per week (and extra payment for these 8 hours is calculated.)

   (c) *Annualized cost:*

   The initial investment cost are divided by the lifetime of the investment. If for instance 10 years are calculated for infrastructure, the annualized cost is “infrastructure cost / 10”. And if five years are calculated for the computer hardware, the annualized cost is “hardware cost / 5” - in this case approximately $1,500 - $2,000 for computer hardware per annum. If more years are calculated, the annualized cost naturally decreases.

   The recurrent cost are already calculated per annum, and are added to the annualized initial investment cost.

2. *Network with $100 computers as fat clients (using Microsoft software) and a file server (using Linux)*

   (a) Initial Investment
   Infrastrucutre: same as in 1.
   Hardware: $2,000 for 20 clients; the server hardware is cheaper with $2,000; $1,000 for network equipment; cost of installation and transport like in 1.
   Software: with donated licenses for the Microsoft products, their procurement would cost zero. Licenses for other proprietary software that is commonly used with Windows do have a cost. The installation of the system may cost about the same as in 1.
   Teacher training: same as in 1.

   (b) Recurrent Cost
   Maintenance: Spare parts for clients would be supplied by having some extra client machines in stock. Spare parts for the server are much less expensive than in 1.
   Upgrading software: if proprietary software is used, upgrades are usually free of charge for a defined period. After this time, a new license must be acquired.
   Teacher training: same as in 1.
   Personnel: the cost in this example should be more than in 1. (a thin client system is designed to be very stable and requires less administrative overhead than any other system)

3.7 Concluding Remark

I have tried to make this thesis round and complete. However, a work like this is never really finished. At some point, you just have to write the final page and call it a document, and the next page will be part of another document. To continue this research, the following topics seem reasonable to me:

- Content for teaching with computers (as basis for a syllabus.) Creating lessons and projects is probably a very interesting part.
- Comparing strategies in other countries (that have a similar background as Zambia.) This is not an easy task: first of all, the basis for a comparison must be found; what is a similar background? And which countries with a similar background have been at a similar state of development with ICTs and education? If they have introduced computers in schools, what are their experiences?
- Research on methods of evaluation that can measure if a strategy proves successful after some years.

A Abbreviations

AISI - Africa Information Society Initiative - http://www.uneca.org/aisi/
AU - African Union - http://www.africa-union.org
AT&T - American Telephone and Telegraph
BSD - Berkeley Source Distribution (a version of UNIX)
CAZ - Communication Authority of Zambia - http://www.caz.gov.zm/
CBO Community-based Organisation
CBU - Copperbelt University - http://www.cbu.edu.zm
CDC - Curriculum Development Centre (a division of the Zambian Ministry of Education)
CMS - Content Management System (a software)
ERP - Enterprise Resource Planning (a software system)
FDI - Foreign Direct Investment
FSF - Free Software Foundation - http://www.fsf.org
GPL - GNU Public License - http://www.gnu.org/licenses/gpl.html
GSM - Global System for Mobile Communications (a cellular phone standard)
HIPC - Highly Indepted Poor Countries (Program of the World Bank which gives dept relief to a number of countries)
HP - Hewlett Packard (a technology company)
IBM - International Business Machines Corporation
ICT - Information and Communication Technology
IMF - International Monetary Fund http://www.imf.org/
ISP - Internet Service Provider (a company that offers internet services)
IT - Information Technology; often used synonymously with ICT
KDE - K Desktop Environment (a popular Linux application)
LUG - Linux User Group
MDG - Millenium Development Goals, set by the UNDP - http://www.undp.org/mdg
MIT - Massachusetts Institute of Technology - http://www.mit.edu
MMD - Movement for Multiparty Democracy - Zambia's current government party
MS - Microsoft
MoE - Ministry of Education
NEPAD - New Partnership for African Develoment - http://www.nepad.org
NICI - National ICT Infrastructure (subject of policies)
NGO - Non-government Organisation
OAU - Organisation of African Unity (was dissolved in 1999 in the creation of the African Union)
OBE - Outcomes-based education
OSS - Open Source software
SAP - Structural Adjustment Programme (set up by the IMF and the Worldbank)

SME - Small and Medium Enterprise
UNDP - United Nations Development Programme - http://www.undp.org
UNIP - United National Independence Party - first government of Zambia under Kenneth Kaunda
UNECA - United Nations Economic Commission for Africa - http://www.uneca.org
UNESCO - United Nations Educational, Scientific and Cultural Organization - http://www.unesco.org
UNZA - University of Zambia - http://www.unza.zm
VSAT - Very Small Apparature Terminal - a satellite technology for computer networks
WSIS - World Summit on the Information Society - http://www.itu.int/wsis
ZCCM - Zambia Consolidated Copper Mines
ZESCO - Zambia Electricity Supply Corporation - http://www.zesco.co.zm

B Web Addresses for Open Source Software

Linux Distributions (p. 13 ff)
Debian http://www.debian.org
Red Hat http://www.redhat.com
SuSE http://www.novell.com/linux/suse
Turbolinux http://www.turbolinux.com
Redflag (Chinese) http://www.redflag-linux.com/eindex.html
Ubuntu (South Africa) http://www.ubuntulinux.org
Impi (South Africa) http://www.impilinux.org
Knoppix (a "live" CD) http://www.knopper.net/knoppix/index-en.html
IPCop (a firewall) http://www.ipcop.org
Skolelinux http://www.skolelinux.org/portal/index_html
Puppy Linux (a minimalistic distrib.) http://www.goosee.com/puppy/
"Damn small Linux" (a minimalistic distrib.) http://www.damnsmalllinux.org/

General Software (p. 20 ff)
Sourceforge (a site for many OSS projects) http://sourceforge.net
Freshmeat (a site for many OSS projects) http://freshmeat.net
GNU Software http://www.gnu.org/software/software.html
XFree86 http://www.xfree86.org
KDE http://www.kde.org
GNOME http://www.gnome.org
Apache http://www.apache.org
BIND http://www.bind.org
Squid http://www.squid-cache.org

PHP http://www.php.net
Perl http://www.perl.org
MySQL http://www.mysql.com
CVS https://www.cvshome.org
Mozilla http://www.mozilla.org
Open Office http://www.openoffice.org
Tex / Latex http://www.ctan.org - http://www.latex-project.org
Gimp http://www.gimp.org
Samba http://www.samba.org
WINE http://www.wine.org
rdesktop http://rdesktop.org

Educational Software (p. 128 ff)
Schoolforge (a site for many OSS projects) http://www.schoolforge.net
SEUL application index http://richtech.ca/seul
KDE educational software http://edu.kde.org

Abiword http://www.abisource.com
Centre http://www.miller-group.net
Claroline http://www.claroline.net
eGroupware http://www.egroupware.org
Firefox and Thunderbird http://www.mozilla.org
Free Pascal http://www.freepascal.org
GnuCash http://www.gnucash.org
Gnumeric http://www.gnome.org/projects/gnumeric
Gnuplot http://www.gnuplot.info
G-Tablix http://gtablix.homelinux.org/wordpress
Imendio Planner http://developer.imendio.com/wiki/Planner
JChemPaint http://almost.cubic.uni-koeln.de/cdk/jcp
Kalzium http://edu.kde.org/kalzium
KMatPlot http://kmatplot.sourceforge.net
KTouch http://ktouch.sourceforge.net
MediaWiki http://www.mediawiki.org
NVU http://www.nvu.com
Pauker http://pauker.sourceforge.net
Open Administration for Schools http://richtech.ca/openadmin
OpenBiblio http://obiblio.sourceforge.net
OpenGrade http://www.lightandmatter.com/ogr/ogr.html
OpenSIS http://www.opensis.org

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BBC News 08.01.2002
http://news.bbc.co.uk/1/hi/world/africa/1748595.stm

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Speech at the Wizards of OS Conference in Berlin (in German)
http://wizards-of-os.org/index.php?id=486

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Struik Publishers, Cape Town, Second Ed. 2000
A Travel guide (pretty much the only one about Zambia besides the Lonely Planet)

[FINNIDA] **Practical Subjects in Primary Schools** - Ex-Post Evaluation of Finnish Support to PS in Zambia
Finnish International Development Agency (FINNIDA), Helsinki 1993
The book contains two reports that show different viewpoint:
One about the 1993 Ex-Post Evaluation of the Zambia-Finland Practical Subjects Project for Upper Primary Schools in Zambia from 1974 - 1990, which was written by B. Cracknell, R. Kaulule and A. Kiiskinen, and attempts to find reasons for the failure of the project
and another about a Study on the Impact of Practical Subjects Teaching on those most directly affected, i.e. Teachers, Ex-Pupils, Parents and Employers, which was carried out as a joint effort by FINNIDA and UNZA, and shows that the views of many people towards practical subjects changed from negative to positive.

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Undervaluing teachers - IMF policies squeeze Zambia's education system
http://www.oxfam.org.uk/what_we_do/issues/education/gce_zambia_imf.htm

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Bundeszentrale für politische Bildung, 2. Edition 2004

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