# Dialogical System Design

# across

# Cultural Boundaries

System Design out of Africa

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**Hamburg, den 9.07.2001**

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**(Dekanin)**

**Declaration**

I Heike Winschiers, declare that this thesis embodies only my original work, excep where acknowledgement indicates otherwise, and that no part of it has been, or is being submitted for a degree at this or any other University.

**Erklaerung**

Hiermit versichere ich an Eides statt, di vorliegende Arbeit selbstaendi verfass und keine anderen als die in der Arbeit genannten Hilfsmittel oder Hilfe verwendet zu haben.
Ferner erklaere ich, dass ich diese Arbeit noch an keiner anderen Fakultae als Dissertation vorgeleg habe.

To my daughters, Naska and Tamara
and my parents

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# Abstract (English)

Information Technology Transfer (ITT) does not fulfil the expectations of developed and developing countries. The failure of numerous development undertakings, including software development projects, has resulted in much speculation on the reasons and triggered research aimed at diagnosing and improving the situation. This research thoroughly identifies - on a practical as well as theoretical level - the dynamic interdependence of culture and IT-related activities like IT-transfer, the teaching o computer science and system design.

Lecturing experiences in Namibia, a southern African country, revealed tha teaching o computer science involves more than the mere presentation of value-free facts. A number of culture specific difficulties that Namibian students had in assimilating computer science concepts became apparent. In the attempt of a technical solution to the students' problem in acquiring knowledge, a prototype was developed and evaluated for two successive years within an actual teaching context in the Department of Computing at the University of Namibia. After being confronted with an unexpectedly poor and unrealistic outcome of the evaluation, the cultural validity and completeness of common system design methodologies in different cultural settings was questioned.

At present, system design methodologies do not sufficiently account for cross-cultural processes; this thesis therefore attempts to deliver a unique contribution to the cultura validity of participatory system design. In participatory design, the "real problem" as well as the system requirements are best determined through merging the differen viewpoints of the stakeholders involved. However, in a multicultural system design setting, the forming and interpretation of viewpoints, as a cross-cultural judgement, is problematic in that it depends on the stakeholders' perception of the environment. Yet the perception of reality and the structuring and processing of experience depends on our habits that are shaped by our culture. A foreign computer expert understands and models the environment as he perceives it through his personal culture-bound perspective which rarely coincides with the view of the local users. This obviously has a major impact on system design which in this case is based on a misconception of the initial situation, thus leading to the implementation of an undesirable system Diverse disciplines advocate a dialogical approach to resolve or minimise those misperceptions within co-operative tasks. Yet cross-cultural dialogue is predetermined for misunderstandings due to distinct cultural determinants. Differences in the organisation of discourses and expressions of intention have to be considered in the selection of means of communication. Although the importance of communication in system design has generally been recognised and multiple methods have been put forth to facilitate communication between user and system engineer, their validity has not been studied in a multicultural context as yet. It is thus up to the system engineer to determine the stakeholders' intention and communication competency and to accordingly develop and apply culturally valid communication techniques to conduct a successful dialog. In light of this, relevant training programs and methods from the social sciences were investigated and merged into a culture-driven framework for dialogical system design.

# Abstract (German)

Informationstechnologietransfer (ITT) erfuellt weder die Erwartungen der Entwicklungslaendern noch die der Geberlaender. Spekulationen ueber die Gruende von Fehlschlaegen vieler Entwicklungsprojekte, unter anderem auch im Bereich der Softwareentwicklung, entfachte Diskussionen und fuehrte zu Untersuchungen nach Ursachen und Korrigierungsmoeglichkeiten. Die vorliegende Studie arbeitet den dynamische Zusammenhang zwischen Kultur und Informationstechnologieprojekten wie ITT und Lehren von Informatik und Softwaregestaltung auf praktischer sowie theoretischer Ebene herausgearbeitet.

Lehrerfahrungen in Namibia zeigten, dass unterrichten von Informatik mehr ist als nur das Praesentieren wertfreier Tatsachen. Kulturspezifische Problem Namibischer Studenten zum Verstaedniss von Informatik-konzepten wurden deutlich. Ein technischer Versuch zur Unterstuetzung des Verstaendnisses der Studenten wurde als Prototype entwickelt. Dieser wurde zwei aufeinanderfogende Jahre im Lehrbetrieb der Universitaet von Namibia, im Fachbereich Informatik, getestet und ausgewertet. Die Auswertung kam zu einem unerwartet schlechten Ergebniss, was zur Hinterfragung der kulturellen Validitaet und Vollstaendigkeit von ueblichen Systemgestaltunsmethoden in Bezug auf andere kulturelle Gegebenheiten fuehrte.

Da Aspekte multikultureller Entwicklungsumgebungen derzeit von keiner Systemgestaltungsmethodik genuegend beruecksichtigt werden, soll diese Arbeit einen erstmaligen Beitrag zur kulturellen Validitaet von partizipativer Systemgetsaltung leisten. In partizipativer Systemgestaltung wird durch Beruecksichtigung der verschiedenen Sichtweisen aller Beteiligten das Problem erfasst und die Systemanforderungen gemeinsam erarbeitet. In einer multikulturellen Umgebung erweist sich das Erlangen einer gemeinsamen Sichtweise als problematisch, da diese durch die Wahrnehmung aller Beteiligten bedingt ist. Das Wahrnehmen und Verarbeiten von Erfahrungen ist von den kulturbedingten Gewohnheiten der jeweiligen Person abhaengig. So versteht und modelliert ein fremder Systementwickler die Umgebung so wie er sie wahrnimmt durch seine persoenliche kulturgebundene Perspektive, welche wahrscheinlich nicht mit der des Benutzers uebereinstimmt. Dies fuehrt dazu, dass der Fehleinschaetzung der Ausgangssituation die Implementierung eines unerwuenschten Systems folgt. Verschiedene Disziplinen plaedieren fuer einen dialogischen Ansatz zur Aufklaerung und Verringerung solcher Fehleinschaetzungen innerhalb kooperativer Projekte. Interkulturelle Dialoge sind jedoch anfellig fuer Missverstaendisse bedingt durch kulturspezifische Kommunikationsformen. Unterschiede in unter anderem der Diskursstruktur sowie des Intentionsausdrucks muessen bei der Wahl der Kommunikationstechniken beruecksichtigt werden. Obwohl die Wichtigkeit von Kommunikation im allgemeinen in der Systemgestaltung anerkannt ist und viele Methoden zur Benutzer-Entwickler-Kommunikation entwickelt wurden, so wurden ihre unbedingte Anwendbarkeit in einer multikulturellen Umgebung nie untersucht. Es liegt also in der Hand des Systementwicklers, die Intentionen und Kommunikationskompetenzen der Beteiligten zu erfassen und entsprechend kulturadequate Kommunikationstechniken zu waehlen oder zu entwickeln fuer die Durchfuehrung eines erfolgreichen Dialoges. Relevante Trainingsprogramme und Methoden aus der Geistes- und Sozialwissenschaften werden hierzu vorgestellt und in eine kulturbestimmte Methodik zur dialogischen Systemgestaltung eingebunden.

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# 1 Introduction

Information Technology Transfer (ITT) does not fulfil the expectations of developed and developing countries. The failure of numerous development undertakings, including software development projects, has resulted in much speculation on the reasons and triggered research aimed at diagnosing and improving the situation. My experiences in Namibia, a southern African country, first as a tourist, then as a computing lecturer and lastly in the role of a system designer, led me to reconsider communication strategies that are usually taken for granted. However, insufficient research has been carried out on the interdependence of system design and users' culture, and hardly any of the various system design methodologies take account of the typical issues that emerge in the multicultural environments encountered in most African countries. I believe that misconceptions about - and misunderstanding of - system users and their environment are to blame for the often undesirable outcomes and that the ethnocentric attitude of software developers may encourage the implementation of unusable systems.

I therefore aim to present a contribution to system design approaches that are valid in a multicultural setting. Grounded in the experience acquired within system design projects at the University of Namibia, I have developed a framework for system designers in a multicultural environment.

The contents of the following chapters, together with a reader's guide, appears at the end of this chapter.

## 1.1 Background and metamorphosis of this thesis

I feel I should explain how the topic of this thesis developed out of my own experiences so that the complexity and significance of the issue can be better understood. I hope it will clarify the perspective from which I have approached this entire project.

### 1.1.1 Original motivation and objectives

Multicultural upbringing

Born of German parents who worked in Arabic countries, I was brought up in Tunisia and Iraq with a French secondary education. This was followed by a tertiary education in Computer Science at German Universities. I therefore always found myself **BETWEEN** various groups of people with a shared culture. By this I mean a shared set of values, norms and traditions resulting in similar perspectives, attitudes and communication strategies[1]. Ever since, I have been interested in the cross-cultural and inter-lingual exchange of information.

Intercultural misunder-standing

After completion of my Computer Science degree in 1992, I travelled through Namibia as a tourist. While there, I had the opportunity to accompany a European commission exploring the distribution of development aid money for the construction of water pumps in the northern rural area. For a primary estimate of needs, they intended to investigate the composition of the local population and that of their cattle.

[1] The correct way to determine such a grouping, such as whether by ethnicity, nationality o profession, for example, is complex and will be discussed later in the thesis.

*We entered a homestead[2] and went straight to the headman. With the aid of a translator, the Europeans explained their intention and inquired about the number of his cows, and how many children and women lived in his household. The headman ignored these questions and instead started telling stories on apparently unrelated topics. The Europeans became impatient and left the homestead, deciding they did not want to spend any development aid money in that area.*

What went wrong? Why could the Europeans - while respecting all European rules of politeness - not obtain the information they wanted, even though they had come to help? Only months later did I understand that the Europeans had violated some basic rules of courtesy. Firstly, they had failed to greet people in the appropriate manner by enquiring after the well-being of all the family members, and secondly, they had asked an insensitive question about the number of heads of cattle. As cows represent the wealth of a family, such a question is equivalen to asking to see a bank balance in a western context. Would you, for example, be willing to divulge such information to a complete stranger?

This example was a typical case of cross-cultura mis-communication. Could this be one of the main reasons why development projects, such as software development, do not achieve the anticipated results in developing countries

Language, concepts and culture

Back in Europe as a researcher in a German-Bulgarian translation project team a the University of Hamburg, I studied translation problems from both a linguistic and a computer science oriented point of view. I developed computerised solutions for translators who faced difficulties with terminology that had no equivalent in the target language. One example regarded the concepts o 'privatisation' within a formerly socialist or communist country like Bulgaria. I realised that the existence of terms in one language but their absence in another reflects the way in which our conceptualisation of the world is culture-dependent. This led me to think about the relationship between concepts, culture and language and how to explain concepts in a target culture where they had not yet become a part of reality - like computer technology in certain Third World countries.

Based on these experiences, and having read numerous articles about failures in development co-operation, I decided to contribute towards improving the dispersion of knowledge within developing countries by means of a practical and academically relevant project.

Namibia

After a thorough review of literature on ITT to sub-Saharan countries, I decided to locate my case study in Namibia. It seemed to be a challenging country for such an undertaking as it had only recently become independent and was still in the process of building up its infrastructure. Namibia, like many other developing countries, has acknowledged the importance of educational development and the potential of Information Technology (IT) in accelerating educational reform

[2] Consisting of huts which are considered to be "rooms".

[Kia98]. Indeed, IT offers innovative and challenging mechanisms for the representation of knowledge and mediation. My emphasis was on the community-based development of computer-based educational materials to further the transfer and diffusion of technological knowledge within the country.

I completed the necessary formalities, such as obtaining a research permit and liaising with the University of Namibia. I also developed a fieldwork task plan with the help of a sociologist prior to departure for Namibia in 1994. This plan consisted of a tight schedule of phases for the year to follow, but practical circumstances intervened, forcing me to revise the plan many times. The firs change occurred when I was offered the position of computing lecturer at the University of Namibia. Due to a shortage of local computer scientists, the country was - and still is - heavily dependent on foreign computer consultants who are involved in teaching as well as in local software development. I knew this responsibility would delay my research work, but on the other hand it would add considerable value to the quality of my research.

### 1.1.2 Teaching experience at the University of Namibia

In 1995, I took up the post of lecturer in the Computing Department at the University of Namibia. This occupation has given me the opportunity to gain a real inside view of the problems I came to investigate and to work closely wit students over a number of years.

Teaching failure

On arrival, confident of my knowledge of the fundamentals of Computer Science and didactic strategies I had acquired at the University of Hamburg, I started teaching. My first remarkable experience was the atmosphere of discipline and silence amongst students. Having been a quiet student myself, I did not questi this response - only to be rather disappointed after I had finished marking the first test. Except for one student, the class had not understood any of the concepts, although they had learned the material by heart and would repeat the same answer to any question, however unrelated.

Student failure

As reflected in the high failure rates, most Namibian Computer Science students experience difficulty in assimilating abstract computing concepts. The student body changes rapidly in number and cultural diversity. Students' cultural backgrounds as well as their secondary education, which differs from a Firs World education, have clearly influenced learning habits. Therefore, in order to adjust the lectures to the student body, the curriculum and teaching methods had to be revised continuously. I struggled to get more feedback from students, while at the same time trying to find out more about their background knowledge as a point of departure for my course design.

*Self:* *"Do you know proof by induction?"*

*Students:* *"Yes of course, we did this in mathematics."*

*(Once given something to prove, all students failed.)*

*Self:* *"But you told me you knew proof by induction!"*

*Students:* *"We know 'proof by induction' but we don't know how to prove by induction."*

My assumptions about the students were proved incorrect on a daily basis. My understanding of "knowing" and "comprehension" never merged with theirs. Even concepts like the "efficiency of action" implicitly associated with Computer Science could not be taken for granted. Responses to my teaching of complexity and efficiency demonstrated a non-universal truism:

Computer Science and it immanent values

> *Student:* *"Why do you bother to teach us how to make programs more efficient? They are running correctly and doing the job much faster than a human being in any event!!"*

As Van Ryckeghem [Vry94] reports from her Kenyan experience:

> "IT work gains time, but gaining time in itself is of no direct relevance whatsoever. Efficiency is not an objective in itself."

Teaching Computer Science turned out to be more than transferring value-free facts. I realised that I had much to learn about the students' culture before being able to present concepts successfully so that students could reconstruct the within their context

### 1.1.3 System design experience

In attempting to improve students' acquisition of knowledge, I launched the design of a computerised tutorial system in co-operation with the Computer Science students of the University of Namibia[3]. The main goal of the system is to provide the learner with domain-specific information in a culturally acceptable manner. Therefore, it was necessary to analyse thoroughly the background knowledge and the informational behaviour of the possible users within their cultural context

In 1995, I embarked on the exploration of the system environment and its users. I had numerous informal interviews with staff members and students of the Computing Department at the University of Namibia through which I learned about the students' background and the assumed causes for the high failure rates and dropouts amongst Computer Science students. To verify certain hypotheses, I conducted a survey on all registered Computer Science students. The survey methods used for the data collection were basically ethnographical and sociological[4] since I focused on the students' informational behaviour and background knowledge related to thei socio-cultural history and their assimilation of the subject[5].

In 1996, I initiated the specification phase of the instructional system in co-operation with the students. We relied on prototyping in order to determine and meet user requirements. I chose the topic "recursion" - which is part of the second-year curriculum - as a sample application. Each final-year student then

[3] Since 1999, my work has evolved into a current ongoing departmental project to develop a distributed knowledge-based tutorial system funded by the University of Namibia.
[4]Consisting of interviews of students and lecturers, questionnaires and participative observation (lecturing).
[5] The data has been continuously up-dated over the years

implemented one prototype that was evaluated by second-year students, and, based on this, a specification for the next prototype was drawn up.

In 1997, a computer science graduate and I implemented the prototype UDITS (User-Dependent Interactive Tutorial System), which can be described as a user-level dependent learning system supporting an explorative learning approach. The intention was to allow flexible user-dependent access to information and also to allow experimentation with a mother tongue interface. The system has been implemented in Visual C++, with the domain knowledge structured in objects of the class concept, containing data members like terms, super concepts, sub-concepts, parts, definition, etc. The user interface language may be either English or Oshiwambo, the mother tongue of the majority of Namibian computer science students. The students have different options for retrieving information: they can ask for the relationship between two concepts, ask a pre-formulated questi (What is 'recursion'? How does 'recursion' work? etc.) or look for examples on a topic of their choice. Depending on the students' level and language, the system generates an answer. Some of the examples include animated algorithms and are selected from students' everyday lives.

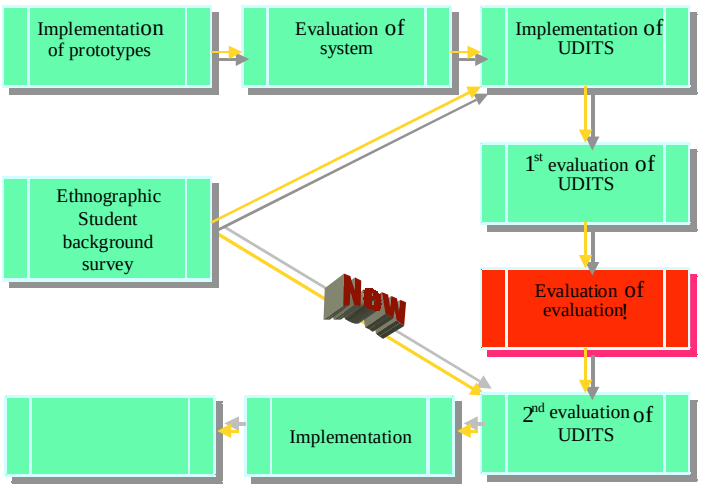
The system was then tested within an actual teaching context. The second-year class was split into two groups, one attending a lecture and the other learning while using the system. Performance was then evaluated through assignments as well as tests, and user satisfaction was rated by means of questionnaires, informa interviews and trace files.

In 1998, I conducted a thorough review of the evaluation of the first prototype since the results did not meet the expected outcome. The evaluation failed to identify shortcomings of the system, and no innovative ideas were generated. Having checked the students' background as I had previously analysed it, I realised the inadequacy of the methods chosen. Cultural factors had not been considered in the data collection method: most Namibian students are not yet accustomed to expressing their opinions freely, nor are they used to shaping their own opinions. Aside from the historically based, oppressive colonial system, the authoritarian and hierarchical social order contributes a great deal to thei submissive attitude. Young people are not expected to confront elders or persons of higher status in their traditional system of hierarchy. As a consequence, students usually indicated satisfaction and expressed little criticism.

In order to overcome the authoritarian gap between students and myself, a peer-to-peer evaluation method was tried. The third-year students familiar with the prototype were now assigned to be the requirement-engineers responsible for further design. They were required to evaluate the prototype by establishing the needs for system changes from the users (second-year students). They were grouped according to their choice of analysis method, which included questionnaires, interviews, in-situ observation or a Future Workshop. The outcome of the peer-to-peer evaluation differed dramatically from the evaluation of the previous year. As students were approached by their own colleagues, their willingness and freedom to speak freely increased.

Figure 1 summarises the development steps of the prototype implementation as described above.

Figure 1-1 UDITS development process




Originally aiming simply to design a computer system to assist technological knowledge transfer, I believed I had only to study the users' culture, implicit cultural values associated with IT and teaching theories as the domain o application. However, during the design process I realised the great influence of the users' culture on the system design process itself. This problem area, previously underestimated, then became the focus of my work.

## 1.2 Research problem: System design across cultural boundaries

Through teaching Computer Science and designing a system, I accumulated valuable experience. Furthermore, by analysing system design in other developing countries - in practice and theory - I began to understand the complexity of the problem as well as the urgent need for a solution.

Inadequate system design methods

For the most part, system design in most developing countries is conducted by a team of experts - usually of a different social status than the average citizen - from developed countries or from within the country itself. Since much of the equipment is obsolete, obsolete software development methods are often applied in the Third World. Decision-makers would argue that constraints like time and budget would suggest a sequential phase model. However, shortcomings inherent in 'sequential' models, such as the waterfall model, have been recognised for some years now, largely due to models' inflexibility and excessive formality. The process of evaluation, embedding and even maintenance is also omitted because often the experts will have returned to their country by that stage or the project is under-funded. Once implemented, the system is simply transplanted or dumped in a particular environment, which will have to either reject or adapt to it.

### 1.2.1 Problem definition or problem creation?

Software development as production

In many cases, software development is still understood to be the manufacturing of a product - a software system - that fulfils a specification based on the requirements determined by the developer team. The software engineers usually see themselves as technologists who provide the technical solution to the defined problem. The reasoning is purely instrumental: starting with a problem to be

solved, the problem is not questioned but the most demonstrably efficient means of solving it is sought.

> "To be a computer person is to possess a certain repertoire of specialised hammers and to be constantly looking out for nails to hit" [Agr97].

But what happens if the material the nails are hammered into is unfamiliar? In a South African context, Braa [Bra96] categorises the situations a foreign expert from a developed country finds himself in:

1. "Uncertainty regarding the context of the system development process. This is the case when problems and solutions are well-known from the First World, but users, organisations and the society in the Third World environment have limited knowledge about, and experience with, IT. "

2. "Uncertainty regarding the goals of development, which includes the problems to be solved and possible solutions. These are problems which are not yet solved in the First World."

This categorisation demonstrates accurately the ethnocentric approach o projecting every situation/problem on familiar issues in the First World. Braa's first point demonstrates the arrogance involved by stating tha **:**

> **WE HAVE A SOLUTION, BUT IT CAN'T BE APPLIED BECAUSE THE THIRD WORLD IS NOT UP TO STANDARD.**

Ethnocentric software developer

The overseas computer experts arrive, assuming that they know the problem and - obviously - the solution. They implement validating according to their own defined requirements and once they leave the country, the system is not sustained. Speaking in terms of the 'hammer-nail' metaphor, the wrong hammer is used so that the nails bend or loosen and fall out sooner or later. It should be observed how context, function, activities and constraints of the environment differ from those of donor countries of the First World. The common mistake is either to disregard or fail to point out these differences. Braa's first point should then rather be rewritten as follows:

> **THE SOFTWARE EXPERTS DO NOT KNOW THE HISTORY AND CONTEXT OF THE PARTICULAR ENVIRONMENT. THEY SEEK TO APPLY IT SOLUTIONS FOR WHICH THEY WERE TRAINED , BUT WHICH DO NOT MERGE WITH THE GIVEN PROBLEM.**

> "IT remains an acquisition of western science and thus an exogenous element for developing countries. The question is whether compatibilit between this particular technology and a foreign culture can be striven for through implementation processes. Insight is therefore needed concerning the role of culture in development as well as in the conception and/or adaptation of technology. This issue gains even more importance with information technology: since the information and thus the knowledge component is mediated by culture. Values like rationality, universality and functional specificity are associated with economic growth. Traditional culture, associated with opposite values, was consequently deemed the major to-be-vanquished obstacle within the development process"[VRy93].

The importance of studying the embedding environment has been theoreticall recognised by software designers - as Kotonya and Sommerville [KoSo98] poin out,

> "… if the environment is not well understood, it is unlikely that the requirements as specified will reflect the actual needs the component mus fulfil."

The perception of the environment from within which the system design begins is therefore a central issue, as it endeavours to define the problem to be solved. However, if we define a problem as different from the existing one and solve it, we will not have solved the "real" one. Hence the concern is to identify the "real" problem.

Rational software development

According to rational software development, it is assumed that there is a given reality and that software development is based on models that represent realit precisely.

> "The software developer's task is to analyse, to abstract and to elaborate a correct model that can be manipulated by the computer. While this may be difficult to do, the task itself – discovering the correct description - i supposed to be clearly defined and independent of the software developer as an individual" [Flo92b].

According to postulates of modern science, the properties of the observer – in this case the system analyst - should not enter into what is observed. But, as Floyd [Flo92a] states:

Constructive software development

> "All observations are observer-bound, they are expressed in observer-terms and reflect specific needs, values and interests. He can only perceive wha is perceivable to him."

The perception of reality and the structuring and processing of experience depends on our habits that are shaped by our culture. Furthermore, habits - according to Marotzki (in [Nes91]) - are behaviour-stabilising assumptions which, once established, become sub-conscious and develop a rigid steering potential. Nestvogel [Nes91] concludes that ethnocentric limitation is a kind of habit. The foreign software developer will ultimately make choices of what he personally considers to be relevant. His view is focused through his intentions and experiences. In other words, a foreign computer expert understands and models the environment as he perceives it through his personal culture-bound perspective which rarely coincides with the view of the local users. This obviously has a major impact on system design which is based on a misconception of the initial situation, thus leading to the implementation of an undesirable system. It is therefore vital to involve users at the system design stage to correct the software designers' misperceptions.

### 1.2.2 User involvement

Cultural gap

System design in developing countries is strongly characterised by software experts and users with differing cultural backgrounds. The two parties might be from different countries or from socially different groups within the country, meaning from richer or poorer backgrounds, different ethnical groups or differen genders, with a major gap between the associated roles.

In Namibia, for example, most of the local system development is conducted by foreign consultants or by previously advantaged Namibians, whereas the end-users are mainly from previously disadvantaged groups with a different cultural background. Although the two groups grew up in the same country, the gap between them is wide. They did not visit the same schools, they did not walk in the same streets, they did not eat the same food and therefore they do not see the world with the same eyes. The previously over-privileged population still has a rather distorted picture of the other population groups' reality and little respect for other local cultures. In addition to the task-related culture gap between software experts and users, there is a personal affiliation culture gap.

This communication problem is frequently solved through minimising the user-developer interaction. In many software development projects in developing countries, user participation is neglected, partly due to cultural, social, political, economical and language barriers. Odedra [Ode92] reported in her study about 'Information Technology Transfer to African Countries' that the Ministry of Water Affairs in Kenya at a stage had the largest number of computers. The were donated on condition that the donor company's own technician be employed for the installation. As he was a non-English-speaking person, there was no attempt whatsoever to transfer any knowledge to the local people involved.

However, in theory the importance of the inclusion of users in the design process has been acknowledged, although approaches differ in the extent to which users are included. The Scandinavian 'Participatory Design' gives voice to the end-user during design. Floyd [FlEtAl89] however criticises the term "participation" because it suggests a lopsided arrangement where developers still carry the responsibility and have the power for decisions. Floyd [Flo92c] therefore introduces the concept of Dialogical Design, the weaving together of the perspectives of all participants and the taking of design decisions on a joint basis:

> "Dialogical Design calls for the conscious development of a project language, linking the relevant domains of reality in a way that everyone is able to follow."

Recognising the different perspectives involved in system design, the so-called 'viewpoint-oriented' methods evolved. However, their concern is with maintenance and resolution of conflicts rather than the acquisition of viewpoints.

Rules of communication that are taken for granted in a monocultural setting may not be applicable in a multicultural environment. For example, in my case study, the limitations of existing system design methodologies within the Namibian multicultural setting were apparent:

- The Namibian users' post-apartheid "culture of silence" showed little support for a participatory design approach.
- The tradition of avoiding complaints prevented constructive criticism in the evaluation phase.
- The post-colonial and post-war practice o information-hiding hindered adequate understanding of the environment.

According to Fettermann [Fet89],

> "Using a highly structured randomised design without a basic understanding of the people under study may cause the researcher to narro the focus prematurely, thus eliminating perhaps the very people or subjects relevant to the study. Such a misdirected study may yield high reliability but extremely low validity, undermining an entire research study."

Questionnaires, for example, are a highly effective, quantitative method in a western context in line with the predominant values of time-saving, the tradition of writing and data integrity. Yet, looking at indigenous cultures with an oral tradition, with little value attached to time and no moral bounds to truthfulness, the validity of the collected data becomes extremely low. As familiar data gathering and modelling methods might be ineffective in a multi-cultural setting, culturally valid methods must therefore be identified and developed. In other words, even if the user is involved in the system design, if non-suitable communication methods are chosen, the outcome is often invalid.

### 1.2.3 Culture and system design

Hardly any system design methodology accounts for the issues arising in multicultural environments as encountered in most African countries. As expounded above, system designers have a misconception of "the real problem", followed by misunderstandings between software experts and users due to cultural differences which then results in the implementation of non-sustainable systems.

Therefore software development can no longer be viewed as a function which maps problem to solution. It should rather be considered as a learning process involving the unfolding of a problem [FlEtAl89] in the software engineer's mind, as well as an understanding on the part of users of what is computable and how it would affect them. The needs, skills and interests of users therefore need to be considered in the design stage of the system and not purely from the point of view of the requirements of the system. Some models do acknowledge the importance of the users' environment by including an analysis and eventually a modelling process of the current users' reality. However, the cultural background of the user does not only influence the requirements of the system, but also the parameters for the system design methodology itself. Bearing in mind that the "real problem" and the system needs are co-operatively constructed within the design - through mutual learning between software experts and domain experts (the user) - it is essential to give special attention to intercultural learning in a multicultura context.

At present, system design methodology does not yet include the study of users and their environment, nor does it ensure that the design is appropriate to both from the start. More research needs to be carried out on methods facilitating a mutual learning process aimed at a choice of appropriate design methods and joint problem definition.

## 1.3 Research aims and objectives

To start off with, I intend to demonstrate the influence of the cultural variable within computer-related projects like Information Technology Transfer, the teaching of computer science concepts and system design in a cross-cultura context. Since most system development projects involving different cultures are reported to have failed, this thesis is aimed at making a contribution towards the promotion of culturally valid system design. While investigating the limitations of current system design methodologies with regard to cross-cultural issues, I aim to enhance the effectiveness of these methodologies.

Across cultural boundaries

System design "across cultural boundaries" reflects the fact that software experts and users from different cultural backgrounds will be jointly designing a system A "common" reality, serving as the foundation for a joint requirement definition, has to be constructed out of the different, culturally biased perspectives. This can only be realised through a mutual intercultural learning process undertaken by both software experts and users.

Yet, how can mutual learning be realised if mutual misunderstanding dominates the interactions? Techniques have to be discovered to support a culturally valid design process. I therefore anticipated that I would have to identify and incorporate relevant results and methods from related disciplines like ethnology, education theory and psychology.

My objective is to merge these findings within a culture-driven framework o system design which would then be valid in an multi-cultural setting. In general, I aim to contribute towards a theoretical and practical improvement of system development in diverse cultural settings, based on a Namibian case study.

## 1.4 Research method

The theoretical background to this thesis is based on a qualitative research strategy known as "grounded theory". It involves the collection of a small amount of data and the subsequent exploration of concepts. Theories are derived from the data and later applied to a larger set of data. The first set of data is analysed, and thereafter the researcher is able to decide in which area additional or differen types of data are needed. The researcher does not leave the research field to analyse the dat [6], unlike traditional empirical research where data are collected in one phase and analysed in a later phase "at home". The "grounded theorists" then builds up a theoretical framework from within the data. In other words, when using "grounded theory", no pre-defined theory is used to guide the analysis. In the qualitative research community, "grounded theory" has been criticised for its integration of relevant literature after category development - although the "grounded" researcher does have to start with a theoretical sensitivity [Sjo94]. However, I believe that to approach a new setting with a pre-defined theory hinders the formation of an unbiased viewpoint. Moreover, the relevant literature

[6] All data accumulated and analysed in this thesis were collected during my stay in Namibia as a researcher and lecturer in the Computing Department of the University of Namibia from 1995 to 2000.

can only be identified once in the field since – inevitably - unexpected events and questions arise.

I started my research with a broad study of the relevant literature followed by a case study in Namibia. The latter comprises an ethnographic study of both users and the development cycle of a system. The system is implemented according to principles of case-based co-operative prototyping. A thorough analysis of the processes explicates the cultural determinant in system design and the mutua learning processes involved. An experimental phase of prototype evaluation - including methods like Future Workshop, observation, interviews and questionnaires - was conducted. The evaluation of the empirical data i complemented by a thorough study of the literature of the relevant social sciences in order to allow the development of a practical theory of culturally valid syste design.

## 1.5 Results

This research thoroughly identifies - on a practical as well as theoretical level - the interdependence of culture and IT-related activities like IT-transfer, the teaching of computer science and system design. At present, system design methodology does not sufficiently account for cross-cultural processes and, as a result, the majority of cross-cultural software development projects have been deemed to be failures. This thesis attempts to deliver a unique contribution to the cultural validity of participatory system design.

Various viewpoints of stakeholders have to be identified and managed during the design stage. Yet the forming and interpretation of viewpoints as part of a cross-cultural judgement involves problems and difficulties which can lead to misperceptions that affect design decisions. I therefore suggest a dialogical approach to cross-cultural system design. However, cross-cultural communication is vulnerable to misunderstandings due to its distinct cultural determinants. Common methods of user/system engineer communications can no longer be taken for granted. A system engineer therefore has to be equipped with specific methods and skills to master a cross-cultural dialogue. In light of this, I have investigated relevant theories from the social sciences and merged them into a culture-driven framework for dialogical system design.

Ethnographic study

A further outcome of this research is a thorough study of the Namibian IT infrastructure. Having identified IT education as major weakness, I investigated factors impeding IT knowledge acquisition by Namibian students. I therefore include an ethnographic study of Namibian students.

Prototype

Even though the design of a prototype of a tutorial system was an additional by-product of this part of the research, at no stage was it my intention to develop a research version of a ‘state-of-the-art’ knowledge-based information system or a commercial product. Although the prototype has been used as learning-aid for a specific module at the University of Namibia, it requires further technical and conceptual improvements.

Publications

Partial results of this thesis have been presented and discussed at conferences in southern Africa, revealing scope and complexity of the problem. Relevan material has been published in the following papers:

1. "Computergestuetzter Wissenstransfer in Entwicklungslaendern", Newsletter No. 10, Fachgruppe Informatik und Dritte Welt, Gesellschaft fuer Informatik e.V.,199

2. "Information Technology Diffusion in Namibia", Proceedings o Simposio de Informatica - Informatica e desenvolvimento-, Maputo, Mocambic, June 1996

3. "Knowledge Acquisition in a computing environment", Proceedings of the 27th Southern African Computer Lecturer's Association Conference, Sout Africa, 22-24 June 1997

4. "User Dependent and Computer Assisted Knowledge Transfer", Proceedings of the 12th Annual M & PhD Conference in Computer Science, University o the Witwatersrand, Johannesburg, South Africa, 26-27 June 1997

5. "Experiences in the co-operative design of an Instructional System", Technology in Interactive Education Congress, University of Natal, Durban, South Africa, http://www.un.ac.za./tie , 27-28 January 1999

6. "Reflections on teaching Computer Science to ~~previously~~ disadvantaged students", Proceedings of the 29th Southern African Computer Lecturer's Association Conference, University of the Free State, Bloemfontein, South Africa, 27-29 June 1999

7. "User centred system design in a multicultural environment", Proceedings o the 14th Annual M & PhD Conference in Computer Science, University of the Free State, Bloemfontein, South Africa, 29-30 June 1999

## 1.6 Structure of the thesis

The structure of this thesis follows my research methodology. In the first chapters I introduce the case study, zooming from a broader context into a detailed description of system users and the system developed - elaborating on the problems along the way. In the second part, a search for solutions through a thorough study of the literature available in related social sciences is presented. All findings are merged in the final chapter to form a complete framework.

### 1.6.1 Synopsis

Chapter 1

Chapter One comprises the introduction to my thesis.

Chapter 2

In Chapter Two, I discuss the political context of Information Technolog Transfer (ITT) in which this researc evolved. In most Third World countries, substantial software development projects are part of ITT, and they are largely funded and/or conducted by foreign donors/consultants. In developing countries,

a small number of projects include foreign software engineers, while other projects are out-sourced to other countries. Therefore, any applied system design methodology corresponds with its embedding ITT strategy. However, controversial debates on the appropriate form of technology transfer did not lead to successful and sustainable ITT in the past, and a report on the African experience reveals the shortcomings experienced in practice. Apart from politica and economic reasons, the transfers generally made little allowance for the socio-cultural system of the target country or the transfer of knowledge to that country With these problems in mind, I aim to present a vision of an improved ITT as a theoretical and practical framework for sustainable and valid system design in multi-cultural environments.

Chapter 3 Chapter Three outlines the IT infrastructure of Namibia, the country hosting my case study. Namibia faces similar post-apartheid problems to other multi-cultural countries in southern Africa. In line with a political commitment to "Education for All", the issue of Information Technology has become more pressing than ever, yet local computer education is evolving slowly and no countrywide IT policies have been formulated. Namibia remains heavily dependent on foreign consultants for teaching computer science and development of local software.

Chapter 4 Chapter Four describes my experiences in the Computing Department at the University of Namibia and demonstrates that the teaching of computer science involves more than the mere presentation of value-free facts. Through my lecturing practice and intensive discussions with students and lecturers, I became aware of a number of specific difficulties that Namibian students had in assimilating computer science concepts. For students emerging from a largel practical, slowly changing culture, studying computer science - an abstract and rapidly evolving subject – turned out to be problematical. Hoping to improve teaching methods as well as introducing a computer-aided learning system, I firs conducted a survey to thoroughly investigate those factors and their sources which appeared to impede the acquisition of knowledge.

Chapter 5 Chapter Five introduces an attempted technical solution to the students' problem in acquiring knowledge. Relying on case-based, co-operative prototyping, a system was implemented in co-operation with the computer science students o the University of Namibia. The prototype was tested and evaluated for two successive years within an actual teaching context in the Department o Computing at the University of Namibia. After being faced with an unexpectedly poor and unrealistic outcome of the evaluation, I questioned the cultural validity and completeness of common system design methodologies in different cultural settings.

Chapter 6 Chapter Six conveys an understanding of system design as a co-operative process. The "real problem" as well as the system needs are incorporated in the design through merging the different viewpoints of the stakeholders involved. However, in a multicultural system design setting, the forming of viewpoints as a cross-cultural judgement is problematic in that it tends to lead to misperceptions which affect design decisions. Diverse disciplines advocate a dialogical approach to resolve or minimise those misperceptions within co-operative tasks. Yet, the success of a cross-cultural dialogue is predetermined for misunderstandings due to distinct cultural determinants. Differences in the organisation of discourses and

expressions of intention have to be considered in the choice of means o communication. Although the importance of communication in system design has generally been recognised and multiple methods have been put forth to facilitate communication between user and system engineer, their validity has not been verified in a multicultural context as yet. It is thus up to the system engineer to determine the stakeholders' intention and communication competency and to accordingly develop and apply culturally valid communication techniques to overcome communication difficulties.

Chapter 7 In Chapter Seven, I present cross-cultural education and training programmes for the acquisition of knowledge, behavioural strategies and affective aptness to prepare system engineers for intercultural encounters. Yet certain culture-specific knowledge of users cannot be formally taught prior to the system design context. The system engineer has to explore locally and therefore needs to be equipped with specific methods. In this regard, ethnography appears to be a promising approach to inform about the users and their environment. Ethnography, as applied in current system design processes, has only been considered to be of value to the specification of the software product yet not to the design process itself, e.g. to decide in the first place the means of interaction and the choice o design methods in a specific design situation. This is a new challenge: to integrate ethnographical studies into system design.

Chapter 8 In Chapter Eight, results of the thesis are synthesised into a culture-driven framework for dialogical design. Recommendations for system designers working in multicultural setting are formulated as a guideline. Considerations for the Namibian computer education an system design context are drawn up. The epilogue opens the floor to a new field of study across disciplines and cultures.

The appendices contain detailed data of the case study, e.g. questionnaires and prototype evaluations.

### 1.6.2 Brief readers guide

Who should read this thesis? If you already find yourself paging through this, then of course you should read it. It is of general interest and written in a commonly understandable way which also makes the material accessible for amateurs in the area of computer science, ethnography, education, psychology or communication theory.

Depending on intention and background of readers, different chapters of this thesis are of more importance than others, yet it may serve as guideline for system engineers or computer teachers working in cultural settings different to their own. The discussion is culture-general and therefore country-independent. It is just as valid for a German system engineer going to work in India as for an Indian system engineer going to work in Germany. Further, the framework may be applied to any cross-cultural project, whether related to Information Technology or not, as long as a co-operative process is envisioned. This thesis lays the ground for cross-cultural dialogue.

Cross-cultural course design is one of the numerous applications of this reasearch. Especially the immanent values of Information Technology were explored - and their influence on the assimilation of target groups.

# 2 Information Technology Transfer

Information Technology Transfer is multifaceted and may therefore range from such activities as dispatch of computer equipment to training and education of local experts or consultation and technical assistance in system development and implementation. Past controversial debates on appropriate Information Technology Transfer has not led to desirable and sustainable Information Technology infrastructure in many developing countries. There are many reports on failures of information systems in Third World countries. Beside political, economical, and technical reasons, the transfer mainly lacks mediation of relevant knowledge and sufficient consideration of the target socio-cultural environment. Taking this state of affairs into consideration, a vision of an improved Information Technology Transfer is presented as basis for sustainable system design.

## 2.1 The what, why and how of Information Technolog Transfer

**Information Technology Transfer to be, or not to be?**

This can no longer be a relevant question, especially when a "Digital Divide" of the "Information Society" is being discussed in the "Global Village". No nation can afford to reject information technological development. The current decade is dominated by the transformation of industrial society to a society of information and knowledge. In the past, development was measured in terms of economic growth; in the present, it is evaluated by how much information or knowledge a society generates, saves, updates and uses rationally [Elm92]. At a stage, the disinformation was spread that even in developing countries, Information Technology would contribute to rapid economical growth.

> "There is a general consensus today that Information Technology can play an important role in the economic and social development of the Developing Countries, including those of Africa" [Woh92].

However, as the expected success was not attained, controversial debates arose on the appropriateness o existing information transfer.

### 2.1.1 The problem of definition

There is generally some confusion about what ITT really is. Here I am no referring to the distinction of IT transfer between university to industry or one country to another [The89], but rather to the transferred content. In developmental politics, technology is understood as the technique itself; consequently, from this perspective ITT consists of sending equipment only . Taking into consideration the etymology of the word, " techno-logy" is the science of technical applications. The Oxford dictionary [Oxf95] defines Information Technology as:

> "the **study or use** of electronic equipment, esp. computers, for storing, analysing, and distributing information of all kinds, including words, numbers and pictures".

ITT would thus be the transfer of the study, the knowledge itself or use of IT applications, without explicitly taking into account the equipment itself. This has been recognised by various authors, e.g. Lewis [Lew93],

"Technology transfer is the process of transferring from one country to another the knowledge required to use and apply a technology. This may or may not include the transfer of 'hardware' (machinery, equipment)."

Not all dictionaries uphold the above definitions. To quote the dictionary o Information Technology [Dic96]:

"**technology** *noun* applying scientific knowledge to industrial processes;

**information technology** = technology involved in acquiring, storing, processing, and distributing information by electronic means".

In this interpretation, the emphasis lies on application rather than on knowledge or equipment. To the same degree that the understanding of ITT varies, the implementation strategies and goals diverge.

### 2.1.2 Information Technology Transfer strategies and goals

In the discussions of the last couple of decades, many concepts were considered to be the "correct" technology transfer strategy for developing countries [The89].

Middle Technology transfer

In the Seventies, the idea of transferring "Middle Technology" [Sch77] came up. It is considered to be a more powerful technology than the traditional one of developing countries and also as simpler and cheaper than the highly sophisticated westernised technology. Developing countries held against the introduction of this technology that, in their view, the westernised countries attempted to withhold the best and hand over old-fashioned material

Adapted Technology transfer

Later, "Adapted Technology" came into discussion. It is defined as a "Middle Technology" with the following additional criteria:

- mutual inter-dependence of technology and culture
- temporary validity
- abandonment of exclusiveness
- technology as part of a system (research, development, financing, production, sale, maintenance)
- more emphasis on knowledge, technical training, production experience, organisational skills

However, for political, economical and other reasons, the implementation o "Adapted Technology" with its aim of diffusion of knowledge and lower unemployment rates was not achieved in any developing country.

Self-defined technology transfer

At present, many development organisations set their own goals and strategies. The BMZ (Bundesministerium fuer wirtschaftliche Zusammenarbeit), for example, declared the following goals:

- it should be related to the requirements of the majority of the population
- it should contribute to the development of productivity
- it should be adapted to the specificity of the production in the countr

Further recommendations were made by UNESCO-BREDA (in [Laz98]) in 1984, e.g.

- The national development plans have to prioritise the education of computer experts and training of users.

- The use of IT in all sections of education requires:
  - Pilot projects to identify educational and socio-cultural problems
  - Training of teachers
  - Adequate curricula
- The usage of IT in education has to be supervised in order to avoi educational failures
- Universities should actively be involved in the introduction of IT in primar and secondary educati

Autonomous technology transfer

Common to all these strategies is the claim of donors that they assert the appropriateness of technology transfer. However, the approach of autonomous technological development formulated by recipients differs radically. In order to gain freedom from postcolonial technological dependency, a South American author pointed out that:

> "We cannot forget that there is a great stigma about technology and that it appears through unbalanced relationships among people who have technological knowledge and people who do not. In a higher level, we have international technological dependency – in which a whole nation is not capable to decide autonomously about its own destiny. In a lower level, this dependency can be noticed in many institutions and even in interpersonal relationships" [RaFa97].

The science and technology conference of the UN in 1979 already suggested the formation of national committees for the evaluation, selection, purchase and adaptation of technology and expertise from outside countries under consideration of local economies, ecologies as well as social and cultura environments.

The theoretical approaches are numerous, and the above-mentioned serve to illustrate their variety. Looking at the naïve formulation of ambiguous and ambitious goals, failures are intrinsic.

### 2.1.3 Failures of Information Technology Transfer

Two authors, Moussa and Schware [MoSc92], analysed diverse causes o Information Technology Transfer deficiencies from the recipients' side. Here follow their findings based on projects in Africa that were funded by the World Bank and incorporated elements of Information Technology:

Table 2-1 Core factors constraining use of information technolog [MoSc92]

| Core factors | Symptoms | Consequences |
|---|---|---|
| Institutional weaknesses | Insufficient planning | Inadequately designed systems;<br>Cost overruns of varying degrees |
| | Lack of management commitment to and responsibility for informatics programme | Implementation delays and chaotic development;<br>Unclear objectives and priorities;<br>User dissatisfaction |
| | Impractical strategies | Improper sequencing of activities;<br>Tendency for "quick fix" |
| | Inappropriate technology | Unpredictable absorption capacity;<br>Resistance to change |
| Human resources | Shortage of qualified personnel | Insufficient support;<br>Problems in operation |
| | Inadequate compensation of technical staff | High turnover |

| | | |
|---|---|---|
| | High turnover of technical and competent managerial staff | Implementation delays |
| | Insufficient counterparts of external consultants | Risk that project may come to halt;<br>Technical know-how not transferred |
| | Lack of professional training programmes of career profiles | Isolation of sources of technology;<br>Inadequate user's awareness |
| Funding | Underestimated project costs | Unfinished projects;<br>Implementation delays;<br>Lack of recurrent expenditure;<br>Higher costs of software development |
| Local environment | Lack of vendor representation | General lack of professionals to solve technical problems;<br>Lack of back-up equipment, spares;<br>Implementation problems and delays |
| | Imbalance between private/public sector wages | High staff turnove |
| | Inappropriate procurement policies and practices | Inappropriate or mis-procurements |
| | Inadequate site preparation | Equipment problems and implementation delays |
| Technology and information change | Limited hardware and software availabilit | Dependence on individual suppliers |
| | Incompatible hard-software technology | Data not shared |
| | Inappropriate software | Over reliance on customised applications;<br>Uncontrolled costs |

Some of the named factors might be unique to Africa, yet most are also valid in other Developing Countries. It is remarkable that the majority of symptoms are related to improper embedding of the system, i.e. the target people and their organisational and broader environment were not taking in consideration. Cases are reported b Cyranek [Cyr92b], [Cyr94], Quarshie, [Qua90], and Woherem [Woh92], in which tasks were computerised that should not have been computerised at all - considering the organisational or cultural context

Odedra [Ode90]/[Ode92] differentiates between three channels through which Information Technology Transfer takes place, namely the acquisition o technology, technical assistance, and education and training. Based on her experiences in Kenya, Zambia and Zimbabwe, she reports on the problems o each channel.

Acquisition of technology

International organisations like UNESCO and UNIDO work on specific problems of African countries in relation to IT. They assist with software and hardware, yet they do not have enough expertise in applicability of IT. Half the computers in Africa were donated by international organisations. Unfortunately, the context was not taken in consideration and, for example, training of users was neglected or the necessary technical infrastructure was lacking. In 1990, a Zimbabwean ministry had 200 computers of 14 different non-compatible types. Many of them are no longer in use, although they provide a home for mice and cockroaches. This differs little from Namibian ministries where thousands of stand-alone personal computers - acquired haphazardly - are dispersed.

Add to this that the sub-Saharan computer market is predominated by multinational companies like Bull, IBM, ICL and MicroSoft. Yet, slowly, a few

small local companies are forming, but prizes and taxes still remain too high on technical products for them to be successful.

Technical Assistance

Most of the IT consultants are from developed countries and have no expertise with regard to regional circumstances. In most cases, they are unable to impar their technical knowledge to local employees. Foreign experts frequently state that "they are not able to understand", "they are incapable of learning", "they do not have the necessary preliminary skills". Or, as a British training manager, unconscious of his own ethnocentrism, expressed:

> "Our African engineers do not 'think' like engineers, they tend to tackle symptoms rather than view the equipment as a system" [Hof86].

Furthermore, since there are only a few local programmers, in most cases the consultants are doing the programming themselves. Odedra describes the following cases:

The information system department of the ministry of finance in Kenya received computers from USAID, yet more technical consultants than locals were employed. After seven years, the local personnel still was incapable o implementing own applications.

At a stage, the ministry of water affairs in Kenya had the most computers. company donated them on condition that its own technician was to be employed for the installation. As non English-speaking person, there was no way for him to transfer any knowledge.

The bank of Zambia was forced to employ an ICL technician for the installation of donated computers. The technician did not have any knowledge of the banking system or the software package. After two years of training he started using the computer without ever transferring any knowledge to locals.

Education and training

Although most of the local universities offer degree courses modelled on western examples, their equipment (computers, books) does not correspond with western standards. Due to insufficient local technical infrastructures, knowledge like CAD[7], AI[8] and VLSI[9] cannot be applied. On the other hand, sending students abroad has the effect of them acquiring non-applicable knowledge which migh lead to so-called brain drain. In addition to this, multinational companies maintain economical dependency by limiting training to application level with no maintenance or development skills, while private companies offer computer courses at very high rates.

Odedra sees the lack of appropriate training of local staff as one of the major sources of failure of Information Technology Transfer. At the IFIP[10] 94 workshop "Computer and Communication Technology for the Developing Country: Is TT

[7] Computer Aided Design: software that allows a designer to accurately draw objects on screen [Dic96]

[8] Artificial Intelligence the design and development of computer programs that imitate human intelligence, providing basic reasoning and other human characteristics [Dic96]

[9] Very Large Scale Integration system with between 10 000 and 10000 components on a single integrated circuit [Dic96]

[10] International Federation for Information Processing

the Answer?", the importance of TT for the future of Third World countries was pointed out. IT was discussed as cheap medium for the diffusion of knowledge within countries. Yet, before it can be applied adequately, an appropriate IT infrastructure has to be established. Emphasis was placed on the education o local experts in order to disrupt the existing postcolonial dependency and to promote development. TT does not have to be understood as the sending of hardware and software only, but technological knowledge has to be emphasised in order to achieve sustainable and autonomous development for developing countries. However, as Odedra [Ode93] points out,

> "Training is often neglected in projects and scholarships may involve travelling abroad to learn about something which is not relevant or applicable to the country".

In fact, this statement conveys more than one message. The obvious one is that for local staff, appropriate training and education is not provided. The other message is that institutions abroad impart irrelevant knowledge to differing loca contexts, and therefore any expert from abroad is automatically ill-equipped with knowledge applicable to his own context. It thus becomes questionable which knowledge should be transferred. As Hofstede [Hof86] remarked years ago,

> "The know-how supposed to have led to wealth in an industrial country is not necessarily the same that will bring wealth to a presently poor one. This point has long been made by people involved in development process […], but there are strong forces that perpetuate the transfer of irrelevan knowledge".

The difficulty of knowledge transfer lies in the determination of its relevancy and applicability. However, some trends in systems development indicate that no relevant and applicable knowledge can be transferred directly.

> "In systems development […] there has been emphasis on the importance of learning about the context of a computer system in order to make it useful (Bjerknes et al., 1990; Floyd et al., 1989). This knowledge does not exist before it is developed locally through praxis, and as a consequence, i cannot straightforwardly be transferred" [BrEtAl95].

As a result, donor-formulated Information Technology Transfer strategies have to be revised. Ojo [Ojo92], a Nigerian author points out,

> "The complexity of the socio-cultural and organisational context with which IT applications take place in the country requires IT experts with appropriate knowledge and skills to deal with that context. It requires the availability of a better trained cadre of indigenous IT professionals who have a clear understanding of the social, economic, organisational and cultural conditions of the country".

Though I do not agree with the author that the IT professional necessarily need to be native (as will be discussed later in the thesis), I do agree that contextua knowledge is required. In the following I elucidate the dependency between culture and Information Technology.

## 2.2 The dynamic interdependence between culture and Information Technolog

**"TECHNOLOGY AND CULTURE ARE IN A MUTUAL DEPENDENCY."**

**"...CONSIDERATION OF CULTURAL ENVIRONMENT."**

Many statements of this kind can be found in formulations of Information Technology Transfer strategies. Yet the variety of definitions of 'culture' leaves much room for interpretation and possibilities of implementing a so-called culture-sensitive Information Technology Transfer.

> "Crucially important here is the question to which extent cultural aspect (may) have a role to play in the implementation and use of IT - as a product of Western culture - within an African context"[VRy94].

Mostly, when culture is practically included within a project, culture and Information Technology are considered as constants rather than interdependent variables. As Van Ryckeghem [Vry94] criticises:

> "Studies on IT transfer to Third World countries generally place less emphasis on culture in favour of policy and environment. And whenever culture is given more attention, the dynamic aspect of the culture-IT relationship is not, or insufficiently, examined"

Culture

Some definitions of culture that are relevant to this context emphasise the dynamics of 'culture' itself, which all too often is considered to be a static variable.

The psychologis Wehely [Weh95] understands

> "culture as a dynamic construct that includes the values, beliefs, and behaviours of people that have lived together in a particular geographic area for at least three or four generations".

According to Auernheimer [Aue90], culture can be seen as orientation syste which, in order to keep its purpose, has to evolve with the changing living conditions based on the traditional orientation systems .

The cross-cultural psychologis Boesch (1980, 1991) translates the definition of culture into action-theoretical terms by

> "considering culture as a field of action (which contains man-made objects as well as institutions, ideas and myths), which offers possibilities of actions but which also stipulates conditions for action. It circumscribes goals as well as proposing means, but it also establishes limits for correct, possible or deviant actions. As an action field, culture not only induces and controls action, but it is also continuously transformed by it. Therefore, culture is understood as much as a process as a structure."[Eck97]

Information Technology Transfer correlates with the cultural field of action. Van Ryckeghem [Vry94] thoroughly analysed the dynamic interdependence between the cultural variable and Information Technology during her research in Kenya. Indigenous cultural elements like time perception, oral tradition, pragmatism and conformism interact with the imported Information

Technology value system of efficiency of action and progressive, rational and instrumental thinking. Van Ryckeghem expresses the interdependence through the following equations[11]:"

- Culture as an independent variable:

$$IT = IT (Policies, Environment, Culture, ...)$$

- Culture as dependent variable:

$$Culture = Culture (IT, Policies, Environmen , ...)"$$

Culture as independent variable implies that Information Technology is influenced by a couple of variables of which culture is one. Culture as dependen variable shows the effect of Information Technology and other variables on culture. However, to emphasise the dynamic aspect of this correlation, the equations should be as follows:

$Culture_{t2} = Culture_{t1} (IT_{t1}, \ldots)$
Culture at a time t2 is the result of the influence o IT on its preceding culture at time t1 (<t2).

$IT_{t2} = IT_{t1} (Culture_{t1}, \ldots)$
Information Technology at a time t2 is the result o the influence of culture on its former Information Technology at time t1 (<t2).

Culture and Information Technology evolve while mutually influencing each other as shown in the following recursive equation:

$Culture_N = Culture_{N-1}(IT_{N-1,} \ldots)$
$=^{12} Culture_{N-1}(IT_{N-2}[Culture_{N-2}, \ldots]).$

Culture at a certain time N evolved through its preceding cultures influenced by Information Technology, which in turn has been influenced by its embedding culture.

The impact of Information Technology culture

For a long time people believed that science and technology are value-free. Especially engineers and scientists were trained to separate facts from values [Flo92a].

> "When IT is introduced in developing countries it will typically be in the form of applications and systems that are "first world solutions" to "first world problems". Such IT solutions are most easily exploited in areas of developing countries that are at best only imitations of the first world - the modern industrialised sector. Successful transfer of technology will often rely on the transfer of the entire context of the technology, including work routines and organisation ( Kerbal, 1991). Consequently, technolog transfer is also transfer of culture and worldviews, in general, and of ways of solving problems and of defining what problems are to be solved, in particular" [Bra96].

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[11] She identifies a third interdependence: Culture as 'mediating" factor: $Utilit_{Culture} = Utilit_{Culture}$(IT,Policies, Environment,..)

[12] $IT_{N-1} = IT_{N-2} (Cultur_{N-2}, \ldots)$

The transferred technology does not only facilitate the satisfaction of needs in the new environment, but also the creation of new needs. Theierl [The89] calls those new needs false or artificial as they cannot be identified with the basic necessities of developing countries[13]. He exemplifies it with thirst, which in developing countries is often no longer the need to drink, but the need to drink Coca-Cola. In conjunction with technology, new life patterns and also values of donor countries are imported. TT promotes global standardisation of lifestyles (uniformity of world culture) and thus endangers the diversity of cultural traditions. Therefore, at the world conference on cultural politics in Mexico in 1982, the internationa union defined its task as the preservation of the cultural identity of each nation. Yet cultural identity cannot be viewed as a static variable. Cultural phenomena are not quantitative, and therefore no objective scale exists upon which to wei old values versus new values. One could diagnose cultural development as "creative destruction". Development is not to be considered as creative if - through a too speedy advancement of outside influence - the indigenous culture is destroyed [The89].

The impact of culture on Information Technology

On the other hand, the success of Information Technology development within a country also depends on whether the embedding culture is favourable or resistant towards it. This has been confirmed for diverse settings by various authors, e.g.,

> "The driving force behind Computer Science was the rapid advance in technology, accompanied by a public willingness to attribute far-reaching powers to the computer. [Flo92a]"

> "A lot of systems fail in Africa as a result of the cultural mismatch between the systems (as they bring Western culture with them) and the recipient African culture"[Woh92].

Considering the development of the new industrial countries in East Asia, the dominating value system of Confucius - with high productivity and self-discipline - favours the introduction and assimilation of technology. This is sufficiently illustrated by the present IT status of those countries.

As part of Information Technology Transfer, it is therefore important to conscientiously consider the target cultural context. However, exceptional care should be taken before drawing general conclusions. Consider this report:

Lack of culture of maintenance

> "Most African countries are littered with machines, factories, buildings and other kinds of technical artefacts that are no longer in working order; or that worked only for a short time before they were abandoned" [Woh95]

The author explains this phenomenon with a long (post-colonial) history of lack of a 'culture of maintenance'. Not only in the IT sector, but in most other development areas like health care, water supply, road constructions of sub-Saharan African countries, in can frequently be found that systems have deteriorated into a state of disrepair.

> "The problem of lack of maintenance of systems in Africa is both socio-cultural and technical. On the one hand, it is due to som socio-cultural problems like, e.g. a callous and irresponsible attitude towards any work that belongs to someone else, and what could simply be described as an

[13] This somehow suggests that Developing Countries are only supposed to have basic needs

unexplainable mentality of going for a new one instead of repairing the ol one. Sometimes, it is due to unethical behaviour. On the other hand, it i also a problem of lack of knowledge of the technical artefacts and how to repair them"[Woh95].

A much more differentiated analysis of abandoned projects is crucial in order to improve future development projects. Perhaps the receiving community never supported the idea of the project in the first place, or the funding was cut, etc. The following would be valid general questions:

- Which conditions might be necessary for successful and sustainable Information Technology Transfer to different developing countries of today
- Which imported values collide with indigenous ones and lead to destructive cultural development?

## 2.3 A vision of an improved ITT

A diagnosis and evaluation of Information Technology Transfer failures and other ITT-related problems suggests a need for reviewing and reframing curren approaches – with incorporation of socio-cultural dimensions. A point of concern would be, for example, autonomous assimilation of technology in order to disrup prolonged dependence on developed countries.

Criteria for socially and culturally acceptable and adapted IT have to be developed within Third World countries. Already as long as a decade ago, Theierl [The89] pointed out that without an infrastructure capable of evaluating technology offered from outside or inside the country - in order to adapt existing technology to a given environment and to use it for own further developments - the imported technology remains alien because it is not absorbed and does no contribute to the technological development of the country. To overcome cultura dualism, which leads from continued dependence on developed countries to the destruction of local cultures, developing countries have to gain a new identity by synthesising their indigenous life patterns with the influence that industrial countries have on them. As Woherem [Woh92] states, the recognised benefits of IT

> "led to calls for African countries to develop national IT strategies/plans in alignment with their national economic development policies. In order for IT to benefit towards the development of African countries, it needs to be adequately assimilated, diffused, mastered, utilised and, where possible, effectively transferred. For African countries to benefit from this new technology they need to develop a "culture of IT"; i.e., a culture that is aware of the technology and its different functionality/uses and that utilises it in different governmental, industrial and service sectors. A state of "successful IT-use" is that which engenders changes that ensure a healthy assimilation, adaptation and development of the technology to suit not only existing needs, but also present economic and manpower capabilities of the country."

Yet nearly 10 years later, many African countries still have not developed national IT strategies and therefore remain dependent on plans from other countries. The only long-term solution remains the development of an indigenous

cadre of IT experts. However, Ramos and Fagundes [RaFa97] point out that learning without autonomy actually furthers dependence.

"
- We are making people more and more dependent on the ones that know how to use the technology;

- Economically it will be very expensive and inefficient since the changing in the environments brings the necessity of more and more training.

If we are not able to make people learn autonomously and co-operatively all the revolutionary promises brought by the computers (development o the intelligence in the ordinary man, efficiency in production, more security, more democracy) will not be more than dreams" [RaFa97].

A change would have to take place in education and training patterns if indigenous, autonomous IT experts are to emerge. Czap [Cza87] denotes that developing countries can only participate in global knowledge and technological development if possibilities and ways are found for them to acquire this knowledge in their own language. Here, language has to be understood in a broader sense, namely as the whole system of modelling and comprehending the world, as culture. Therefore the assimilation of knowledge is only possible if it is formulated in a culturally adequate manner. However, a successful knowledge transfer requires a multiplex translation in order to adapt the knowledge to the socio-economic and cultural contexts of receiver countries. Karcher [Kar98] suggest that the translation ought be done by individuals[14] mastering the domain knowledge as well as the economic, social, cultural and political implications in industrial and non-industrial countries.

"There is thus a considerable amount of evidence indicating that technolog cannot be understood as pure artefacts which may be 'transferred'…Technology has to be learnt rather than transferred" [BrEtAl95].

Instead of the present concept of IT transfer, I envision an Information Technology development co-operation. This would include autonomous partners involved in a mutual learning process of merging their contextual cultural and technological knowledge. Hence - for a balanced development co-operation - it is necessary to set up guidelines for successful TT [Cyr92a]. For this, case studies have to be considered, taking into account the diverse backgrounds of the different developing countries. In the following chapter I present the Namibian information-technological infrastructure as the embedding national context of my case study followed by a chapter on technological learning in Namibia.

[14] This individual has to be aware about his/her role in the process of knowledge transfer.

# 3 Namibia and its growing Information Technology infrastructure

Namibia, the country hosting my case study, achieved independence on 21 March 1990 after more than a century of colonial history. It still manifests a great disparity in many points of views like the distribution of population, income, living standard, infrastructure, education, and history. The past of many Namibians of today is marked by struggle, injustice, and uncertainty. The young multicultural nation, with its inherited inequality, follows a strong policy of reconciliation. Among the priority aims of the government are the creation of jobs opportunities and equal development of basic education. The diffusion of Information Technology as related to even development within and across borders becomes more pressing than ever before. The Information Technology infrastructure is of a high standard compared to other African countries - however unevenly distributed within the country - and nation-wide Information Technology policies are missing. The local computer education is slowly evolving, local experts are rare, and therefore Namibia is still highly dependent on foreign computer experts involved in teaching and local system development.

## 3.1 Namibia

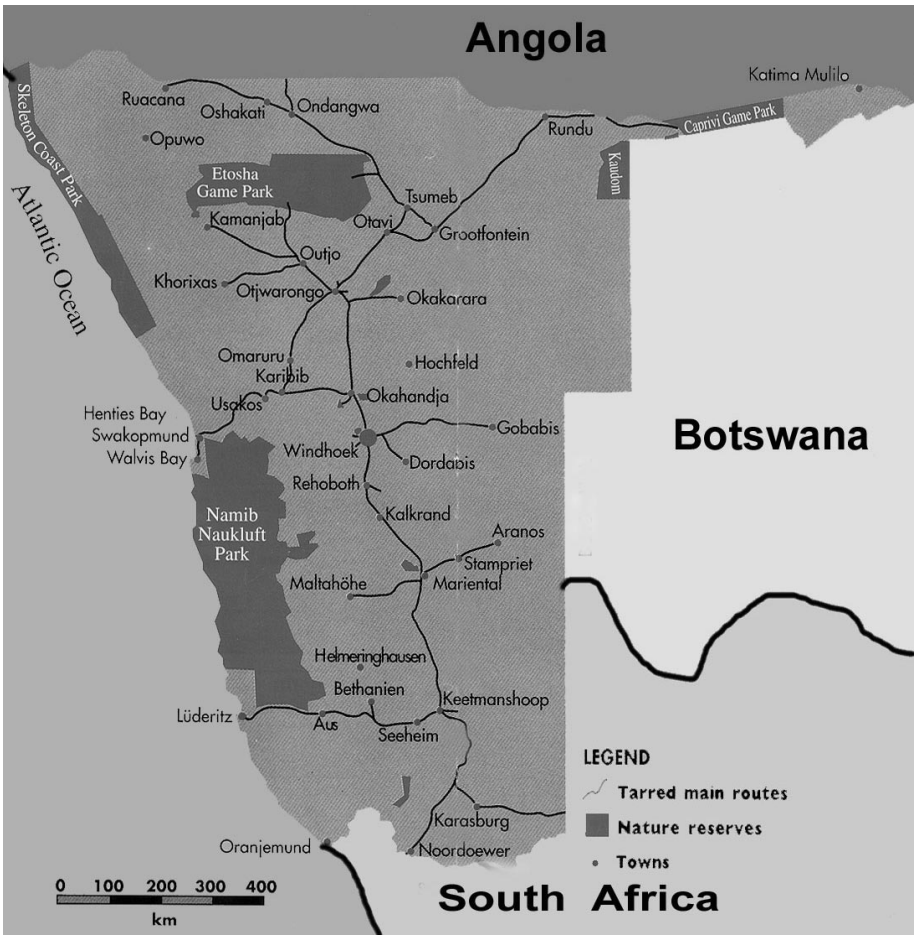
Namibia amazes in many ways by its extremes, be it the vast arid landscape with a low population, its dualistic economy, its long liberation struggle or its post-independent reconciliation politics with an education-for-all strategy and a world-oriented language policy

### 3.1.1 General information

Topography

Namibia, with an area of 824 295km, is situated in the southwest of Africa. It borders the Atlantic Ocean to the west and has a coastline of about 1300km. It is a dry country with the Namib Desert in the west occupying almost 15% of the area, and the Kalahari Desert in the east. The rest of the country is a plateau. It has inadequate and unevenly distributed rainfall in many parts of the country, forcing its population of approximately 1.8 million people to live in few parts o the country.

Namibia map




Economy

From many points of view, Namibia is a prosperous middle-income country: with its per capita income of nearly US$1,615 (in 1999, [economy.com.na]) and a highly developed physical infrastructure and telecommunication systems in towns. However it has one of the most uneven income distributions in the world, with the majority of the population having a per capita income of US$85 per year [Nam92], living under inadequate conditions without potable water, sewerage, health services, or education in rural areas and townships. The society is divided into a dual economic system. One comprises mostly traditional subsistence agriculture in which about 55 percent of the whole black population is involved. The other consists of modern, market-oriented activities in which whites occupy most positions of responsibility [newafrica.com]. Namibia has a very smal manufacturing industry and is therefore highly dependent on imports, mainly from South Africa.

### 3.1.2 Namibian (hi)story narrated by Namibians

Rather than quoting out of numerous existing history books, I chose to collect accounts of Namibians about their own history. I believe this reflects best the view of the people [15] who lived the recent history themselves. The reader can therefore gain an invaluable insight into the background and perspectives of prospective Namibian system developers or system users.

[15] I am perfectely aware that once more I can not present the entire spectrum of Namibian views as I failed to consider minority groups. However it should reflect on the most likely set of people involved into system design in one way or the other.

"People have lived in Namibia for thousands of years. In those times long ago, people lived together in small communities. Their lives, however, were similar to the lives of people in other parts of the continent. They lived by hunting wild animals, gathering roots and fruits and cultivating the land. They learned how to tame animals, make pottery and hunting weapons, and some other tools from stones, bones and wood. They used the animal hides to make clothes and blankets. They had lived like this before intruders came.

Intruders

From the late 18th century, European foreigners came to Namibia. First, Portuguese sailors wanted to find a sea route from Asia to Africa. Later, people came with different intentions. They came as traders, missionaries, exploiters and explorers. Traders exchanged ammunition, clothing and alcohol for cattle, metals, ivory, and skins with the Namibians. Then there were missionaries: they did no come to plunder resources or make short visits, but they came to stay. They studied the people and the country in order to find easier ways of spreading European religion. The missionaries believed that people could not be Christians unless they were given European names, clothing and ways of life. This forced the customs and values of the daily life of Namibians to change. They co-operated with the Europeans and totally changed their way of life to resemble or to at least conform to the one that the Europeans have. Missionaries set up schools in Namibia. The mission schools had helped create a small class o educated Africans who shared common European languages such as German, Finnish or English and Afrikaans, and a common religious faith - Christianity. Most of them became teachers and ministers of religion, usually in the church where they were educated. They opposed unfair treatment for their church members. The other group of people that came were the explorers. They were supported by the European organisations, which wanted to know more about foreign countries in order to spread the European influences. The explorers studied the people and the country, and they wrote books containing information for other Europeans intending to come to Namibia. At about the same time, there came a group of plunderers of marine resources. They began to exploit the natural resources along the coast of the country.

Namibia under German rule

German's occupation of Namibia as a colony officially began in April 24, 1884. [MbNo88]. The Germans tried to divide Namibian communities so that the communities would be opposed to each other and so that the Germans would find it easier to control the country and its people. Even though som leaders e.g. chief Hendrick Witbooi tried to struggle for the unity of the Namibian communities, the colonialists did everything to prevent any form of unity of Namibians. The gave weapons to some communities and refused them to others. In this way, the communities could easily fight each other, while the Germans were exploiting the country's resources.

As the years went by, some communities felt that the Germans were exploiting them by taking their cattle and not giving any protection at all. More and more Germans were coming to Namibia. The Namibians later on got tired and started to protest. In early 1890, the German protection force was formed to stop the Namibians from protesting. But they never established control over the northern part because of the resistance of the people in those regions. The Germans did not want to risk a war against the north, because the Ovambo community, which lives

in the north had a large population. The Ovambo community was armed wit modern weapons which the got from their foreign trade.

Many Namibians' land and cattle were taken away from them by the beginning of the 19th century. They suffered from oppression and injuries, poor working conditions, low wages, and constant harassment by the police and government officials. The ethnic barriers between black Namibians began to narrow as the shared the experience of oppression. But it was a slow and painful process as the fight together for their country

By 1904, many Namibians realised that it was important for them to regain control over their country. Thus, a War of National resistance against German colonial rule was started, which lasted until 1908. The main causes of this war were: Land robbery, robbery of cattle and brutal colonial oppression.

Namibia under South African Rule.

In 1914, the First World War started in Europe. South Africa was part of the British Empire, which was fighting against the German Empire. The South Africans sent troops to Namibia to fight the Germans. Only months later, in 1915, the German troops surrendered to the South African forces.

In 1920, the League of Nations decided that Namibia should become a mandated territory. It was decided that South Africa should "promote the material and moral well-being and the social progress of the inhabitants". The South African white leaders were quite happy with the mandate. But from the very beginning, the South African government had not intended to liberate the Namibian people from colonial rule. Their aim was to replace German colonial rule with their own. However, Namibians resisted South African rule and pleaded for international pressure.

Until 1950, Namibia had no schools or colleges where African students could obtain education at secondary or higher levels. A few got the opportunity to study in South Africa where they came into contact with South African nationalist organisations such as African National Congress (ANC). When Namibian students returned, they organised a student body, which later became a cultural organisation, giving Namibians a new way of making their views known.

By 1959, South African authorities were trying to impose their homeland policy in Namibia by forcing Namibians away from the areas they were interested in, moving them to areas with poor soil regardless of how long the Africans stayed there. The townships were divided into separate ethnic zones for differen Namibian communities. The purpose was to reduce contact between the communities and to thus make it difficult for Africans to co-operate. The relocation was opposed by the people, especially women who had their homes and friends there, and they had buried their ancestors there.

The South African whites believed black Africans were not particularly hardworking and wanted to put pressure on them to seek employment wit whites. They also put a new tax on dogs, which were needed for hunting, to force more Namibians into employment. African workers also faced many difficulties and hardships. It was a crime for Africans to live, travel, seek or accept a job outside the reserves. Anyone found beyond the reserve or place of residence of employment had to show his pass to the police or to any white person who asked for it.

Strict rules were introduced for them. Some of these were:

- Black Namibians were prohibited from being in the white areas of towns between 9pm and 4am without a special pass.

- Blacks were tolerated in white towns only when they served the needs of the white population.

The past of today's Namibians is marked by terror, suppression, discrimination, fear, struggle and insecurities, whether in exile or within the country.

The Liberation Struggle

South West Africa People's Organisation (SWAPO) was founded on April 19, 1960 with the aim of liberating the Namibian people from colonial oppression and exploitation; its founders resisted against colonial oppression earlier and had many supporters. It had branches all over the country. It decided to fight against South Africa rule and to overthrow that government

"Soon after the founding of SWAPO, the colonial police began to arrest SWAPO leaders and activists. Some were deported to the regions of their birth, banned or restricted in their movements. Others were forced to leave the country – which means they had to go into exile. Some had to spend long periods in jails in Namibia or South Africa because of their political activities" [MbNo88].

By mid 1960, SWAPO was the main political group fighting against Sout African rule in Namibia. They sent their first fighters to be trained in Egypt. Several other bases were set up in Namibia. On 26 August 1966, SWAPO's Plan fighters and South African forces were engaged in a battle that started the armed struggle for liberation in Namibia.

In the late 60s, many SWAPO leaders were arrested, detained and imprisoned. Some were killed or died in prison. They were all severely tortured and sentenced to long-term if not life imprisonment. They were jailed on Robben Island, South Africa, the

"notorious prison for opponents of colonialism and apartheid oppression in S.A and Namibia". [MbNo88].

Meanwhile, public meetings were not allowed in Namibia, so SWAPO had to operate underground. This forced many of SWAPO members to cross the borders and go into exile. They mostly went to supporting countries like Angola, Botswana, Zambia and Zimbabwe. One of the Namibians who then left the country narrated about his journey

Going to exile

> *"It was a cold Sunday evening of 1970. Everybody was getting ready for the evening devotion that was to be held at a school, which normally took until 30 minutes before supper. My friends and I pretended we did not want to go for supper. After everybody had left, we crept behind the walls, going to the fence and we set off in the northern direction. We were heading for Oshikango, where we will meet another group of people to cross the borders to Angola. We found some SWAPO fighters in the region. Their aim was not only military, but*

*they were instilling politics in people's minds. When we told them that we wanted to cross the borders, our ideas were welcomed whole-heartedly. Life on the other side was not as pleasant as we had expected. You could go for days without food, but people did not complain. They concentrated rather on strengthening the national identity of the people. They sent some people back inside the country on a regular basis to encourage the people inside to strike and resist oppression. They also recruited and trained more and more people in the army."*

"The community inside the county was very co-operative with the fighters. The had given them food and water and valuable information about the South African army bases, their movements and plans. They have hidden and protected wounded guerrillas. Many people who could afford to give more gave cattle and mahangu to the fighters. But the South African army realised it and came up wit a plan. They recruited and trained some Namibians and incorporated them in the army. They then send their Namibian supporters to the community, pretending they are SWAPO fighters. They would ask for food and help. Once they found out who the SWAPO supporters were, they would beat them up, severely torture them and destroy their belongings. But as time progressed, the community learned to differentiate between SWAPO fighters and South African Army.

Church

The church inside the country also opposed injustices done to the Namibians. They criticised all acts of oppressions. They recorded and published all forms o injustices and crimes committed against the Namibians. They also gave assistance to political prisoners and found lawyers to defend them.

Information hiding

Growing up inside the country was one of the difficult experiences. People were not united, and the community was selfish and lacked interest in community affairs. The people were forced on one hand by the South African army to give information about their brothers and sisters outside the country and the plans and schemes they were using to overthrow the government. On the other hand, those who were in exile forced them not to give the information to the army, as thi might cause problems. So whenever the army heard or saw that those in exile came inside the country, they would quickly rush to that place and start interrogating people. And if people did not give out the information (which they were made to swear that even if it leads to death, they should not revea anything), they would beat them up, imprison them, apply electric shocks to the and even kill them. Many Namibians were killed because they would not testif against their brothers. This information-hiding and mistrust was so strong that it is still prevalent in the community and may take long before it is eliminated.

Ethnical separation

There was overemphasis on one's ethnic origin. This is because people from some ethnic groups were thought to collaborate with the South African army and might dish out any information they had to the enemy. This ethnicity was first enforced by the colonial rulers by making sure people from different ethnic groups had conflicts and fought one another, so that they could not unite and stand up together against the army. So, in everything that happened there was always an emphasis of ones 'ethnic origins'. This discrimination was so terrible that even inside the ethnic groups, people were still discriminated on the basis of

the colour of their skin and their sex, having males getting better treatment in with regard to education, health, employment, etc., than females, who were considered as second- or even third-class citizen in whatever ethnic groups they lived."

Schooling during the struggle

Because of a lack of schools in the densely populated regions, between 15 - 20% of school-age children were not able to attend school. Of those who were privileged to go, not many reached matric level, let alone tertiary level. The apartheid system divided education services into eleven administrations or authorities, each serving a different population group. The allocation of resources to the ten non-white authorities, representing 90% of the population, consisted of only one tenth of those for whites in terms of spending per capita [Kia94a]. Black learners were often trained for specific jobs that the colonial powers needed a that time. This affected their knowledge to some extent and very often discouraged them from studying, as learning institutions and materials were unavailable to them. The illiteracy rate was then estimated to be 50-65% among black adults, which represents the highest in the region.

*"I still remember when I first got enrolled at school. It was always a conflict between my mother and my father, having my mother want me to get enrolled, pass school and start working so that I can one day help the family. On the other hand, my dad thought school was a waste of time, and suggested that I rather go to the cattle-post, look after the cattle, and become man enough to be able to have my own house one day. This resulted in my parents having to compromise, meaning that some cattle had to be brought down home, and I had to share responsibility in taking care of them. Thus, I had to attend school three out of five days, spending two days in the veldt looking after the cattle. I was a fast learner. But other learners who are slow and went through the same treatment had a hard time. There was nobody and nothing to motivate them. Learning was not fun then, because the colonisers were intimidating the teacher in front of the class. They would come everyday to our class, wearing their uniform and carrying a gun. The moment you look at that gun, you know there are no jokes to be made, no tricks to be played or even mere laughing, because it might end up in a big thing.*

*Near our school, there was a river swamp that only had water during rainy seasons. It happened that during that autumn, the river was full. We were on our way to school when we heard the sound of approaching kaspirs (the army cars they used). We decided to run to the nearby bushes to hide because even though we had done nothing, we knew the consequences. They had three watchdogs with them. We decided to run to school, climbed the school fence and got inside. Unfortunately, my sister fell down while she was running and they set their watchdogs on her. She was badly injured. They did very little to stop the watchdogs. Later they took her to the Casper even though she was badly bleeding and without first bandaging her wounds, they came to school to identify us and interrogate us.*

*The black teachers around that time mobilised us to sing mourning songs, and they told us that we should pretend nothing happened. But if you know that your own sister was just under a heavy attack a few minutes ago, and did not get any feedback of how she is doing, how on earth are you supposed to concentrate? This was a big mental torture, something that will remain in my conscious for the rest of my life.*

*When we finished primary school, we progressed to secondary school, a thing that, thank god, my father did not resist. I liked mathematics and science quite a lot, especially chemistry. It is only that there were no resources and enough books to read or research on. But we were not even motivated to read books, since most of the subjects we had forced us to memorise. My teachers told me I was not clever enough to do mathematics and science, since I am African, and Africans are half-humans. He told me if I wanted to succeed in life, I should take music and art.*

*But thank God, through the help of the church I was able to go to a university in South Africa, where I graduated with a bachelors of science. I am now proud of that."*

The education of children in exile however was different, as narrated by one Namibian who grew up in exile:

*"During the liberation struggle for Namibia, some natives took refuge in the neighbouring countries such as Angola and Zambia as well as in many other overseas lands. So this was the reason why I was born in Finland. My mother made me aware of the war in Namibia as soon as I got the understanding of war and of the African continent on TV. So it was easy to know about my roots. However, I got the real picture when I arrived in Angola, where the liberation movement SWAPO had based its headquarter. There I came to learn about other refugee settlement camps in Kwansa Sul province and the military headquarters in Lubango, Southern Angola. There I got politically brainwashed and got motivated to heed if called to sacrifice myself for my country. Because of my juvenile age I was sent to another settlement camp in Nyango, Zambia. I was eight when I had separated from my mother who was staying behind to work at the SWAPO headquarter in Angola. The Nyango camp was an education centre for about 300 children; I started primary school again since leaving Finland. In fact this is where I learned English first as a medium of instruction. In Zambia I was focused on education rather than war. In 1988, I passed an examination that would book my ticket to then People's Republic of Congo (Congo-Brazzaville) where SWAPO had established a more advanced secondary school in Loudima with vocational*

*subjects. Various development-funding agencies such as NAMAS (Norway), WUS (Denmark), SIDA (Sweden) and Finnida (Finland) funded this school. In Loudima, I was exposed to quality education that emphasised on independent thinking and well-qualified teachers from mainly Scandinavian countries. The Loudima school was highly organised so that life in many ways resembled that at a university campus. Without my parents, I learned to be independent in decision-making. When I came to Namibia for the first time at the age of 17, I realised many people do things according to the trends. Although I am not highly qualified in any profession as yet I feel like I was enlightened about various situations in life with the education I received in exile. As far as I can see, many of today's school leavers cannot think independently; I blame this entirely on the education system that governed Namibia before independence. As for the new system, I consider it a betterment of the previous one, however, for me it is still insufficient to produce independent-thinking school leavers."*

On 21st March 1990, finally the Namibians reaped their first fruits of the struggle by becoming independent. The people who were in exile were repatriated back to the country and the first free and fair national elections in the country were held. SWAPO won the elections. The president of SWAPO, Dr. Sam Nujoma, was elected as the first president of the country. However independence was not the end of the struggle as many inherited inequalities still have to be overcome. First, there was a reunion between the people who fought from outside the country and those who were inside. Since people did not trust each other that much during the war, the confidence and support of each other still needed to be won. There were also economic problems, since Namibia depended on the South African economy for too long. There were also many political, social and personal problems within individuals in the country, which are still evident among the middle-aged and old Namibians today. So, the problems can only be overcome if we Namibians will have to go on working to make the country a safe and peaceful place.

As you can see from the history and the stories, the struggle did not end when Namibia became independent. "And probably for the next few years, there will still be problems to overcome. So, it is really up to us, the Namibians to work together and find common grounds on how to resolve problems internally."

### 3.1.3 Post-independence

The young nation, with this inherited inequality, follows a policy of national reconciliation. Among the priority aims of the government are the creation of job opportunities and the equal development of basic education.

#### 3.1.3.1 "Education for all"

Sam Nujoma, the President of the Republic of Namibia, states in the introduction of the policy document on education [MEC93]

"Education in our country used to be enjoyed only by the privileged few

whom apartheid and colonialism considered worthy of it. In other words, i was not the right of every citizen to have access to learning and its benefits.

However, since independence my Government has placed education at the top of our national priorities. It is the key to better life and therefore fundamentally important. Consequently, access to education should not be limited to a select elite, but should be open to all those who need it - especially children and those adults who previously had no opportunity to gain education."

The major goals in educational development are "toward education for all" with access, equity, quality, culture and democracy. There is still a long way to go as the old colonial structures have to be dissolved. The distribution of staff and facilities, among schools and regions is still very uneven ten years after independence. As from 1993, the schools are getting volunteer teachers to come and help train more qualified learners. This has helped to bring the previous uneven distribution of staff in the country to a better distribution. These volunteers are mostly based in previously disadvantaged areas of the country. Facilities like computer equipment are, however, still unevenly distributed in the country. Schools in town are far more developed, having access to internet, scanners, etc., while schools in rural areas still have to suffer because they lack even the most necessary equipment such as typewriters and photocopy machines, in the worst case even buildings.

To manage the reform process, a National Institute for Education Developmen (NIED) was established within the Ministry of Basic Education and Culture. It is mainly engaged in curriculum research, development and implementation, professional development through pre-service and in-service teacher training, as well as the development of instructional materials [Kia98].

In 1994, there was a switch from the old South African Cape Matric to the International General Certificate of Secondary Education (IGCSE), established by the University of Cambridge Local Examination Syndicate. The IGCSE certificate can be obtained after eleven years of school compared to the Matric after twelve years. The IGCSE is enough to qualify for the Namibian University but not any other University out of the country. To fit in with the South African university system, the higher IGCSE equivalent to Matric has been introduced.

In 1995, NIED conducted a global assessment of the new system to evaluate the result of the reform. It was noted that the number of students sitting for grade twelve was six-fold within a period of five years. But in general, a lack of qualified teachers and the inefficiency of teachers in some schools were discovered. Common core subjects cannot be offered in all schools yet. The availability of textbooks represent an enormous problem, the few in use are from Britain and therefore of little relevance to the local situation [Kia98].

#### 3.1.3.2 Language policy

The Namibian population is comprised of ten ethnical groups (seven Bantu and three non-Bantu) having their own culture and languages. English was chosen to be the national language, although it represents the mother tongue of only seven percent of the population [Ale94].

The following extract from the language policy document [Mec93] gives a background on the CRITERIA FOR LANGUAGE POLICY FORMULATION in Namibia:

> "190. Language policy formulation in multilingual society is a difficult task. What is required is a fair balance between the abilities of individuals to choose their medium of communication and the public interest in a common language to facilitate citizen participation and decision making in a democratic society.
>
> 191. Language policy evolution and implementation in the context of present day Namibia is further complicated by our historical past. Ours has been a history of the have–nots and haves, the excluded and the privileged, the ignored and the high-profiled, the them and the we. This historical experience has greatly fragmented our national consciousness. Ours is a story of two nations.
>
> 192. During the apartheid era what were referred to as cultural rights, specifically the choice of language, were used to legitimise the divisions in our society and the inequalities of power and privilege. Consequently, today much of the public perceives the demand by groups in our society for special consideration for particular language use to be an attempt to perpetuate the power and privilege of those groups. In practice, most Namibians simply do not have the resources needed to establish and maintain schools to teach in their mother tongues. Quite simply, opportunities are not equal. To act as if they were is to disadvantage those groups with fewer resources and thereby to extend into the future the inequalities of the past Language policy formulation and implementation are thus bedevilled by the ghost of apartheid.
>
> 193. Language policy in general and in education in particular is thus necessarily a compromise. It is for this reason that the Ministry o Education and Culture has sought a national consensus. The Ministr considered carefully the views expressed by various groups. In addition, in formulating its language policy, the Ministry has also been guided by several fundamental understandings:
>
> - All national languages are equal regardless of the number of speakers or the level of development of a particular language.
> - All language policies must be sensitive to this principle.
> - All language policies must consider the cost of implementation.
> - All language policies must regard language as a medium of cultural transmission.
> - For pedagogical reasons it is ideal for children to study through thei own language during the early years of schooling when basic skills o reading, writing, and concept formation are developed.

- Proficiency in the official language at the end of the seven-year primary cycle should be sufficient to enable all children to be effective participants in society or to continue education.

- Language policy should promote national unity.

194. It is important to note here that we regard English as an evolving language in two senses. Like all active languages, it changes as people use it. Beyond that, regionally specific variants of English have emerged. People in Australia, Canada, and the United States have all diverged in important way from what is heard in England. Over time we expect there to be one or more African versions of English. For us, English is a language of international connections, not foreign cultural domination."

The decision of one national language as opposed to South Africa's decision of many languages is certainly more economical as well as beneficial in terms of a global and local unification. However the consequences on personal level are diverse. The great discrepancy in information access on a professional, personal or public level has been demonstrated in a study by Prof. Wresch [Wre94].

## 3.2 Information Technology infrastructure

Namibia is among the most advanced sub-Saharan countries, considering the Information Technology infrastructure. Considerable use of computers, including Local Area Networks and access to the Internet are being established in differen sectors.

### 3.2.1 Use, Supply and Services of I

The use of IT in the private and service sector is comparable with the use in western European countries. Banks, shops, travel agencies, insurance work with computers and word processing, accounting programmes, stock control systems, banks, mining companies, training institutions and municipalities have Loca Area Networks (90 estimated in the country in 1994). Banks also have Wide Area Networks.

There are more than 30 companies supplying computer equipment. No hardware is manufactured within the country. A number of hardware providers assemble computer parts ordered from all over the world. Several problems occur and cannot be serviced properly. Brand computers remain very expensive.

A big demand for off-the-shelf software exists, e.g. MSOffice, Informix, Progress or MS Windows98. People use all means to get the software and only a few people acquire legal copies. Special systems, like Decision Support Systems, Management Information System, and CAD/CAM are hardly ever used.

A couple of companies and consultants offer the service of system analysis and application development. Most of the applications are developed with Visual Basic, FoxPro, 4$^{th}$-generation-based accounting systems linked into other MS productivity tools.

### 3.2.2 IT in the Government

The distribution of computers among the ministries is very uneven. Thousands of stand-alone PC´s, acquired haphazardly, are spread throughout the ministries. The last ICL mainframe has been singled out within the Y2K campaign. The government is making use of several PC networks, which run subsistence and travelling allowances, creditors information, and budgeting, among other activities. The computerisation varies tremendously between the ministries. Few ministries have major application systems, 80% are of secretarial use only. On the other hand, individual departments, like water affairs, have implemented their own LAN, Windows NT, which is one of the most sophisticated in Namibia, running Informix, MSOffice, ERWIN, and others.

Because of this diversity and incompatibility as well as a lack of resources, a policy was set up for standardisation, diffusion and optimisation of exploitation of IT. A Directorate in the Prime Minister's Office was established in 1991 and given the responsibility of co-ordinating computer uses in the governmen [KiTj95]. It is planning to have distributed inter-ministerial networked systems for data sharing and security [PSC93]. Another focus is on the human resource development since 95% of the ministries do not have qualified computer professionals. [KiHa94] The Directorate of Public Service Information Technology Management is initiating government-wide online computer training courses, ranging from computer literacy to specialised courses in diverse computer application areas [Kia98].

A major problem will be the supervision and the co-ordination of the implementation of policy plans. Because of a lack of communication and co-ordination, millions are spent on foreign consultancy, although some computer experts in different fields are within the country and can be consulted.

### 3.2.3 IT communication and organisations

Especially in a fast developing area like IT, the exchange of information is essential to keep up to date. Individuals produce ideas concerning the implementation and use of IT in Namibia. Public relations work is rare, hardly any media reports or publications are made. Basically, an understanding for the necessity of co-operation and exchange of information is lacking. There is no organisation to register computer experts in the country to make a more efficien use of skills available locally. Instead, experts from overseas are still called for consultancy

Technically, the possibilities are given as access to the INTERNET is provided since 1995 by a non-profitable organisation. Namibia has become the country with the second-highest number of online servers in Africa. Three commercial Internet providers are on the market, connecting approximately 2000 private users each. The connection goes via South Africa to the USA. The government decided to link straight to an Internet provider in the USA rather than making use of one of the local Internet providers.

In 1996, the private users were mainly expatriates who were used to access INTERNET in their home countries. Only a few NGO´s and the local newspapers were using the information retrieval and publishing facilities on the INTERNET

on a daily basis by then. However, the private and business use has increased rapidly and continuously. Especially the tourist branch uses the internet for promotion outside the country.

SchoolNet, an NGO, planned to link all schools within the country to the Internet. The organisation provides donations and technical support to schools.

Namibian Information Technology Association (NITA), founded in 1991, is attempting to promote information exchange between computer specialists of different sectors within the country. It aims to link the educational sector with the ministries and the private companies but with rather low success. Communication is at an individual level based on personal relationships. This has serious consequences on a co-ordinated implementation and diffusion of IT in the country.

Some other interest groups have been formed, e.g. NamGIS (Namibian user o Geographical Information systems), ITMA (IT Manager Association), TUG (Telematics User Groups) and ISNAM (Internet Service Providers). They hold irregular meetings and organise workshops with speakers from outside the country.

## 3.3 Information Technology Education

The backbone for a sustainable development of Information Technology is local computer experts. At this stage, the number of Namibian computer experts is very low and does therefore not satisfy the market needs. Namibia is one of the countries which still depends on foreign IT specialists. Very few qualified computer teachers exist, no Namibian lecturers at a tertiary level, and ministries are highly dependent on consultancies from abroad.

There are also not sufficient computer-literate people in the country. In most o the administrative job advertisements, computer literacy is requested. Computer literacy courses are now offered at the University and at the Polytechnic for students of most courses (science, economics). For the public, eight organisations - additionally to the University and the Polytechnic - offer short introductory computer courses on a regular basis, e.g. Introduction to PC, Word-processing, Spreadsheets, Databases, etc. Currently two companies, NIIT[16] and Damelin, are

[16] NIIT Limited the leading international IT Training and Software company, opened an IT Education and Training Centre in Windhoek under the auspices of the Rt. Hon. Hage G. Geingob, Prime Minister of th Republic of Namibia on the 2nd of September 1998.
For more information visit ou Headquarters and to advance your career visit NIIT NetVarsity
**Why you should get trained at NIIT**
Founded in 1981, NIIT has a unique synergy between its computer training, software solutions and educational multimedia business. With education centers in 3 continents, NIIT offers programs of study to create new Information Technology (IT) professionals as well as re-skill existing professionals. Across media, across audiences, and with the most current circular content.
NIIT has successfully worked on consulting, systems Integration and software development projects with companies across the globe on a wide range of hardware and software platforms. Some of these companies are AT&T, Sun Microsystems, World Bank, Deutsche Bank, Jardine Fleming, Sony, and Komatsu.
NIIT is ***ISO 9001 certified*** for Training, Software Solutions and Educational Multimedia. For Microsoft, NIIT is the only independent courseware developer outside the USA. And being the ***Premier Training Partner for Microsoft***, it trains young minds to become highly skilled professionals who can handle Microsoft technologies. It is now among the select 80 software organizations in the world, having been **assessed at SEI Level 3 on the CMM model (Carnergie-Mellon) for Software Process Capability.**
At the core of each NIIT course, there is a set of ***carefully structured modules***, which have been created taking into account both current and emerging technologies.

offering the MCSE (Microsoft Certified Software Engineer) programme. In some of the companies, in-service computer courses are given.

### 3.3.1 Computer education at secondary level

In 1995, out of a total of 1440 schools, only 32 offered computer literacy courses (grade 4-7) which aims at familiarisation with the keyboard and word processing. Computer practice (grade 8-10) offered by 25 schools introduces spreadsheets, databases, and Basic Programming. Computer Study (grade 11-12) at IGCSE level as offered by a total of twelve schools covers computer architecture, structured programming, system development and social impacts. Opposed to the technical emphasis o Matric, the IGCSE course offers a broader field of interest [Mue94]. Yet I found the study material obsolete and the examinations too rigid. Students are still forced to learn keywords examiners are looking for by heart. The HIGCSE for computer studies still has to be designed locally. Most of the schools offering computer courses at a higher level are located in the capita Windhoek (7 in Windhoek, 4 in central, 1 in the north of Namibia) this is hoped to be changed once the SchoolNet is operating.

In 1994 Mueller [Mue94], a Namibian computer teacher recognised tha computer studies is a key subject that should be rated as important as English and Mathematics, as it touches most spheres of life/work. Yet the Ministry of Basic Education and Culture does still not emphasise on computer education at thi stage. Objections were, whether the country can afford to provide computers when the government cannot even afford to put a roof on some school buildings. But as there will never be a time when all basic needs in education are satisfied, the country has to investigate in IT in order to cover the widening gap between developed and developing countries [Kia94b].

Considering the students potential and the few resources, it becomes obvious that a computer education policy should be developed. The UNESCO office in Namibia provided funds to develop a computer education policy under NIED's direction. A draft of a computer education policy was discussed at a workshop in 1995 and finalised in 1996 [Kia98]. It aims to [MEC95]:

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Microsoft Certification Programs
Training towards Microsoft technology certification is also available if you would like to become a Microsoft Certified Professional ***(MCP)***. There is the Microsoft Certified System Engineer ***(MCSE Track)*** and the Microsoft Certified Systems Developer ***(MCSD Track)***.
Career Programs
NIIT offers career courses for those wishing to become computer professionals and those seeking additional professional qualifications to upgrade their skills.
Advanced Certificate in PC Applications (APA)
This is a six-month course designed to turn you into a power user of networked PCs. It consists of the following subject areas;

- Graphical User Interface (GUI)
- Networking Concepts
- Internet
- Spreadsheets
- Word Processing
- Databases
- Presentation Graphics
- Applications Development
- Electronic Mail

Corporate Training Programs
NIIT specialists can develop training programs that address your specific processes and procedures. The NIIT team will work with you to determine the goals and objectives of the training. With the ability to extract information, the NIIT team will present the training in a format from which the audience can learn.

- promote the use of IT by teachers in order to improve the quality of education
- provide the opportunity for all students graduating from tertiary education and from secondary education, in long term, to be computer literate in order to
- deliver the required number of computer-literate employees and computer specialists in the country.

Only in 1998, the NIED computer curriculum committee met to discuss on the improvement of computer education at both primary and secondary level. The committee proposed to change the present computer curriculum, which only caters for grades 10 to 12. It has been discovered that many learners find computer courses difficult, which was also reflected in the high failure rates in the computer exams. This could be put down to the fact that there is no continuity from primary level onwards, as no curriculum has been worked out and not man schools offer some sort of courses. As a consequence, learners tend not to enro for computer courses in school or even later at the university (60 computer students as opposed to 300 biology students).

To encourage learners to enrol for computing courses, the committee has proposed the following to the Ministry of Basic Education:

- Computer courses must be offered at primary level (grade 1-7) and secondar level (grade 8-12).
- Computer courses should not be examinable. But at the end of secondary education, a learner who feels confident is free to register for recognised examinations, e.g. IGCSE, International Baccalaureate or Microsoft Certified Exams.

It is hoped that the application of the proposal will attract more learners and raise the level of computer literacy within the country. Furthermore the transition from secondary to tertiary level will be facilitated and as a consequence raise the output of computer experts from the University

The education policy is still at a discussion level and the implementation may take a few years. The financial and human resource implications are considerable. The purchase of computer equipment, additional security measures and maintenance costs are involved. Discussions about donating old equipment to schools can be considered to be contra-productive. Who would want to lear programming with avi editor using a 12-inch black and white monitor

Already in 1994 Kiangi and Hamutenya [KiHa94] point out the lack of qualified teachers. Yet 7 years later, no tertiary curriculum for computer teachers has been designed and no training is provided to upgrade practising teachers. This could delay rapid implementation of approved proposals.

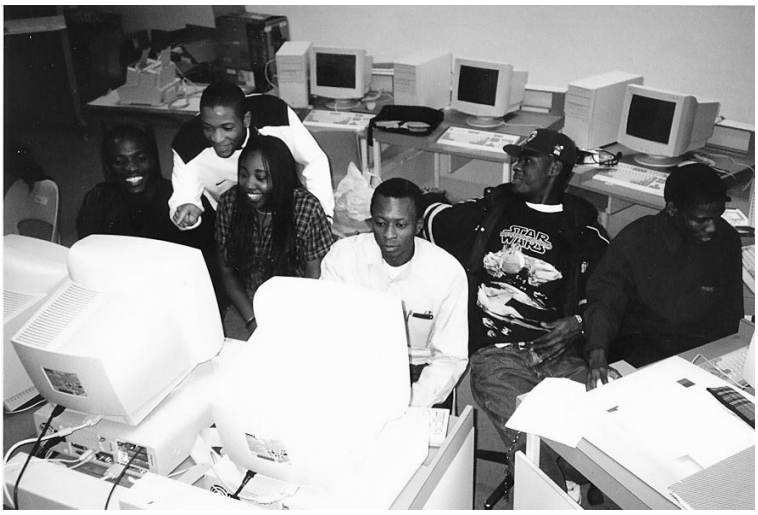
### 3.3.2 Computer studies at tertiary level

The University of Namibia (UNAM) and the Polytechnic of Namibia annuall enrol about 3000 students each. The number of computer students increases slowly. At the moment, only about ten computer students' graduate per year and not all of them will be working in their study-related field. One reason is that most of those students had a government bursary which obliges them to work for the government after studies. But the government did not budget for posts in the

relevant departments, they rather use outside consultancies, and so the student end up being employed in other positions.

### 3.3.2.1 Computer studies at the University of Namibia (UNAM)

Computer Science students at the Universit of Namibia



As the secondary educational system of Namibia has been modified recently, the Computing Department, among other science departments, experiences a tremendous change in the number of students admitted, their knowledge level and their socio-cultural diversity. In 1996, three times more students[17] than the previous years enrolled for first-year computer science. These students are the first generation of IGCSE students. One of the major roles of the Faculty of Science of the University of Namibia is to overcome the deficits of secondar education. Although the curriculum has been revised, high failure rates still exist.

Courses

The University does not offer a degree in computer science but offers a four-years Bachelor of Science degree, where one of the major subjects may be computer science. The students have an average of six hours of lectures and four hours of practical per subject per week. A core curriculum with Elementary Mathematics, Statistics, English and Computer Literacy was introduced for all science students. In the first year, students are introduced into computer architecture, logic, algorithms and basic programming. In the second year, algorithms and their complexity are studied as well as advanced and object-oriented programming concepts. In the third and fourth year, the principles of data modelling, software engineering, operating systems and networking are taught. Each student has to do a final-year project and present it to the public.

An African Virtual University (AVU) programme for computer literacy was launched at the University of Namibia in 1998. Lectures are currently transmitted via satellite from the USA. (It is supposed to be interactive, however the bandwidth is insufficient, therefore it is only broadcast). It is planned to offer a computer science degree programme from September 2001 on.

Facilities

UNAM has a campus wide network linking academic, librarian and administrative sections. The network has three servers running two Linux servers and one SCO-UNIX running an ORACLE database. The university is linked t the INTERNET, through which services like, e-mail and ftp are only available for

1[17]In 1996 60 students where enrolled compared to 20 students in 1995

staff members at the moment. The library provides students with access to the INTERNET for information retrieval. As there are only eight computers available, students have to book Internet access times in advance for a maximum of an hour at a time. The worst shortcoming of the Internet access is the far too low bandwidth of only 64Kb/s.

In 1994, 1112 learners were registered for distance education courses [Kia94a]. TV and radio broadcasting is mainly used. At the end of 1996, the University attempted to examine how computers can be used for correspondence education. The University, the United Nations Office of Outer Space in Vienna and twelve other African countries are developing a computerised satellite system within the COPINE project. The planning for this system is fairly advanced [Kia98].

In 1998, the University opened its second campus in the North of the country where most of the population is located. It is mainly used as a resource centre for students of correspondence education courses and the public. Computer short courses are given to the public and staff members. The computers are linked to the Windhoek campus network and to the Internet.
All other UNAM campuses will be linked up with the main campus at a later stage. Plans are made to deliver lectures in computer-related courses to students who are in the North and South of the country through video conferencing facilities.

Tertiary education level discussion

The adjustment of the tertiary education to the actual need of the working marke and/or to the international level, which cannot always be realised simultaneously is still under discussion. A high demand of networking specialists, dynamic web site and database programming has been identified in Namibia.

Among university students, fears exist about not coping with the demands fro their future working place. Students prefer to be educated in a more job-oriented way than academically oriented. This tendency is supported by the Ministry of Higher Education which defends a diversification of education rather than expanding the academic education at university level. It reflects the general tenor of the human resource-developing plan in the country: of broader education of the mass rather than specialisation and further studies of few individuals.

But the aim of computer education at the University should - besides giving students a basic knowledge - be enforcing the ability to create innovative computer applications. The graduated students will be responsible for the forthcoming of IT in the country and not only to use the existing computer facilities. In these terms, Namibia should create a sufficient budget for IT research, otherwise the country will always stay one step behind countries wit applied research. The country could then be able to evaluate, take over and develop its own solutions.

#### 3.3.2.2 Computer studies at the Polytechnic

In 1990, validated and accredited Business computing courses provided by the National Computing Centre (NCC) of Manchester were introduced at the Polytechnic of Namibia. The inauguration of these courses, based on the Cambridge secondary educational system, was a quick way of implementing

education at a tertiary level. However it proved to hinder the development of actual and locally practised relevant education. The quality of the material is questionable and frequently not updated. For example, as instructional programming language the course is still based on COBOL as opposed to the local and international demand for languages like C, C++, and Java. Additionally, high costs are related to participation at the course. As the examinations are marked in the UK, too much emphasis is put on the linguistic correctness rather than on the conceptual side, not forgetting that English is not the mother tongue of most of the students.

In 1997, the curriculum was totally revised separate from the NCC model. The Polytechnic offers a three-year's diploma course in Business Computing. The course comprises programming (1-3) in C and C++, databases, software engineering, operating systems, networking and business skills.

In 1999, the curriculum was further revised on demand of the local industry. After the first year of studies, a certificate in Information Technology is offered. The students can then specialise in Business Computing, Information Syste administration, or Software Engineering for the following two years before receiving a diploma. If so desired, they may study for another year in order to get a Bachelor Degree.

Concerning the staffing, the department went through different phases. In 1995, the department consisted of five staff member and approximately 35 students. In 1998, the Department of Information Systems consisted of only two German lecturers and experienced enormous recruitment difficulties. About 70 students were then enrolled for the diploma course. [Gre98] Currently, the departmen grew to a size of 13 lecturers (5 Germans, 3 Kenyans, 1 Zambian, 1 Indian, 1 Zimbabwean and 2 Namibians, including 3 female and 10 male staff members).

## 3.4 Information Technology development

In Namibia, in most Information Technology projects, foreign consultancies are involved in one way or the other. Many of the computerisation-initiation projects are funded by First World organisations. As part of the programme, one or more consultants are sent and a local computer company has to be involved. The organisation mostly funds only the development, excluding training of users, embedding of the system and maintenance. Some ministries and educational institutions contract long-term (one to six years) overseas' consultancies to establish their Information Technology infrastructure or short-ter consultancies from abroad are recruited for specific projects/tasks.

### 3.4.1 Consultancies

In most cases, an agreement between the Namibian and the expatriating organisation is made. Each ministry seems to have one or two associated countries like Asia with one ministry, Britain with another and France again with another ministry. The selection of the consultant lies in the hand of the expatriating organisation. Highly experienced computer specialists may be sent, as well as newly graduated scientists.

CIM

CIM (Centru fuer Integrierte Migration und Entwicklung/Integrated Experts Programme), a German Organisation, is operated jointly by the Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ GmbH and the Bundesanstal fuer Arbeit (BA/Federal Employment Services). CIM implements the Integrated Experts programme on behalf of the Federal Ministry for Economic Co-operation and Development of the Federal Republic of Germany. The main areas of concern are the educational sector and water affairs. Within the scope of this programme, German experts are assigned to positions of importance for development in institutions in developing countries. However, German experts may only be placed provided that local personnel cannot fill the vacancies and that the work makes a special contribution toward the economic and social development of the country. Organisations in the developing country have to apply for assistance.

CIM sent two computer experts as lecturers to the Polytechnic and three as system administrators and developers to the Ministry of Water Affairs. The experts are generally contracted over a period of two years, extendable to six years. After that, local personnel should take over the positions. This is only a theoretical concept, in the case of lecturers, for example, the requirement is a Master's degree, whereas the education only goes up to Bachelors Degree or Diploma; it means that students have to go abroad for further studies. Yet most good students are holders of government bursaries and are therefore obliged to work for the government first before going for further studies.

Volunteer services

Mostly British and American volunteer organisations co-operate with the Ministry of Basic Education, whereas Church organisation send volunteers directly to Namibian schools affiliated with the church. However because of financial advantages, employers do not seem to be critical in the recruitment o staff. For example, at one of the schools a teacher qualified in African ethnolog taught computing at secondary level. It seems to be more a matter of luck, as in other instances the Namibian government has to pay high consultancy fees for highly qualified people whose volunteer contract expired, while no Namibian counterpart was trained in the meantime.

Short term consultancy

The government (frequently) uses short-term consultancies from overseas. Unfortunately, most of these consultancies are employed from developed countries where problems are of a different nature. Ideally, the government woul first consult locally, if not possible regionally and only then internationally, but currently it is the other way around. This would save enormous costs and be more context-sensitive. The benefit of overseas' short-term consultants is highly questionable as they are hardly sufficiently informed about the state of the country; in most cases they arrive with ready-made solutions grounded on the experience within their own country. Foreign consultancies come up with the most impressing proposals that can hardly be implemented in the country. Like one American consultant suggested to someone of a ministry: that they ought to be their own Internet provider instead of making use of the local ones, disregarding the lacking human resources to maintain such a project.

### 3.4.2 System design

The scenery of the system design process change depends on the consultant and the local people involved. Two extreme situations are conceivable:

- Either there are those consultants who think to know what is right for the local community and in the worst case have already decided on the outline of the project before coming to the country. Then they will impose the specification on the local development team without further changes.
- Or the consultant is supposed to be the intermediate person between the local developer and the users. Then user participation is included in the design process to a certain extend.

The first situation is obviously predetermined to be one of those numerous non-sustainable project failures. However even the second situation bears difficulties. Firstly, in many projects, the pre-defined scopes are ill defined, the development under-budgeted and sometimes resources are mismanagement. Projects ge delayed and time and money is saved with regard to user participation.

In the cases where users participate in the design process, certain factors often are ignored, causing failures in communication between the parties. Firstly, consultancies, local developers and users are mostly from different socio-cultural backgrounds. In Namibia, not only a cultural gap between the consultancies fro overseas and the local people involved can be found, but also between the developer and the user. Usually the developers would be the previously privileged population which could afford education abroad. The users are the people from previously under-privileged population. Although growing up in the same country, their respective realities were differen [18]. The two parties involved have mostly distorted views about the other group, which makes a co-operation rather difficult. Further factors affecting the developer-user co-operation can be listed, e.g.,

- The users are not motivated to interact for diverse reasons. Mostly the users cannot see the need for a change as they have been doing their job for some time. In many cases they are frightened to be left behind and dismissed at one stage or not to be able to cope in a new working environment.
- In other cases, the users are offended by their supervisor seeming to be so euphoric about the consultant/developer (whether from abroad or within the country) ignoring his working place competency that he/she would end up boycotting the whole project. Or the other way round, the supervisors are threatened by young computer literate subordinates and are also boycotting computerisation projects.
- Another issue is the grade of competency of the user in order to be useful in participation. A serious problem in the ministries is the high turnover , meaning people would not stay very long doing a certain task. It comes back to very few experienced people in whatever position.

In those cases, users are taking it lightly to provide the system analyst with correct information which obviously affects the validity of the resulting system Those users then like to blame the computerised solutions later on.

[18] They went through different educational systems, had different living standards and different rights.

For sustainable software development it is therefore important to consider the mentioned difficulties and work out a framework for better co-operation. One local system developer appeals for building up an open relationship with the users, so that methods and advantages and limitations of computers systems can be discussed prior to the system development process itself.

Namibia has a well-developed technical infrastructure, which gives an excellent basis for a successful IT diffusion. Nevertheless, the assimilation of IT is being hindered by a number of factors. The IT sector is lacking policies and organisations in order to co-ordinate an even diffusion of IT. At the moment, the country is mainly a user of IT and not a producer. There is still a long way to go in order to assimilate IT and to implement own solutions. Local computer experts are scarce, and system projects are often managed by foreign consultancies. Only two institutions offer higher-level computer education. The students of these institutions are expected to form the new generation of computer experts, and therefore they are responsible for the development and proper implementation of IT in the country. An important investment for the benefit of a sustainable IT implementation in Namibia is therefore the human resource development. The country should invest in computer education and research. Solutions for a proper assimilation of the knowledge should be found, so that a sustainable culturally adequate implementation of IT will be guaranteed. In the next chapter, I will therefore present my experiences in teaching computer science at the University of Namibia.

# 4 Teaching Computer Science in Namibia

Teaching Computer Science turned out to be more than teaching value free facts. Through my lecturing experiences and intensive discussions with students and lecturers, I became aware of a number of specific difficulties Namibian students have with the assimilation of abstract Computer Science concepts. I therefore conducted a survey with the aim of improving teaching methods and materials. I investigated the factors which impede the students' knowledge acquisition. For students coming from a practical and slowly changing culture, studying Computer Science, an abstract and rapidly evolving subject, seemed to be problematic. Lecturers' misperceptions about the students as well as their ignorance of values associated with Computer Science aggravate the situation.

## 4.1 Students are from Mars[19] Teachers are from Venus

*Little Hangula[20] lives in a traditional homestead together with his family, consisting of his parents and ten brothers and sisters. He goes to a rural primary school in Northern Namibia. Like all his fellows, he is a quiet boy, not questioning the authority of his teachers. When he comes home he has to look after the cattle, fetch water and obey any orders given by the elders. He is one of the better students and therefore goes to a secondary boarding school. He does not discuss any school problems at home as his parents don't speak English and never went to secondary school. He matriculates and gets a government bursary to register at the University of Namibia in Windhoek. His elder brothers told him to do Computer Science, as he would earn good money later to support all his non-earning family members.*

*He starts his computer courses at the University. The European lecturer uses the example of an automatic cool-drink machine to explain the concept of a loop: "You insert coins until the sum is the required amount". But Hangula has never seen a cool-drink machine. The lecturer asks "Any problems?" No answer. The lecturer therefore assumes everybody has understood. A test follows. The question is:*

[19] The title is a metaphorical expression conveying the vast cultural chasm between student and teacher. In analogy to 'Madams are from Mars Maids are from Venus" a popular South African Cartoon out of the Madam and Eve Collection [FrEtAl97] originally derived from the book: "Men are from Mars, women are from Venus"

[20] The name is fictive and the story is a combination of the live of several real students, the same applies to all stories in this chapter, presented in the same font.

*"Explain the following program:*

```
s = 0
Do
        input x
        s = s+ x
until s = 100
```

*Hangula's answer: "The program inserts 100 coins"*

Any body amazed about this answer? How should a learner understand a concep explained with example concepts that he doesn't know? Why didn't he say he did not understand? Perhaps he thought he understands, in terms of he was able to memorise. Perhaps he was too shy. Perhaps ... If the lecturer would have known how Hangula grew up. If the lecturer would have ...
But why should we bother about this case?
The answer is clear: because this story is not exceptional in the Southern African context, it is the story of more than half of the computer students at the University of Namibia. Looking at the statistics reveals the unpleasant truth. Since 1994 the number of first year computer students at the University of Namibia has been continuously increasing, while the number of graduating students has remained constant during the same period. In 1994 there were about 20 first year students while in 1995 there were 60, but still only 3 students graduated in 1999. This is a horrifying figure. We have to identify causes and develop solutions urgently.

One Namibian computer student commented as follows:

> *"Usually, students are excited as they are being introduced to computers and their capabilities. But as the year progresses, Computer Science students slowly but surely drop out of the course. Several reasons could be attached to this drop out. One is tempted to think that the gap between university and high school is a contributing factor. Also, some students had done basic programming before, whilst others had not. This causes the lecturer to try to balance the two groups, which usually does not work out, so the course becomes too difficult for the students to grasp."*

Previously disadvantaged students

Nine years after independence the effects of apartheid are still manifest in the education system of Namibia. The political development in Southern Africa affected the educational system as reported by Sanders et Al. [SaEtAl97] in the South African context.

> "In the late 1970's the changing demographics of the student population led to serious rethinking about how the University could best meet the needs of the rapidly changing student body. From 1980, with increasing numbers of educationally disadvantaged students entering the sciences, academic support tutors were appointed in many of the science departments to provide extra tuition for 'at-risk' students."

These measures did not lead to the expected success, as two decades later the problem of 'at-risk' students from a 'disadvantaged' background is still an issue in South Africa and its neighbouring countries. The universities still admit a great number of so-called 'previously disadvantaged' students, but the annotation of 'previously' seems to me ironical. It suggests that the students are no longer disadvantaged. However, students who have received a low quality secondary education, due to their ethnic background, are still educationally disadvantaged. They commence tertiary education with a weak background knowledge and often still lack access to resources like books and computers. The University of Namibia being well aware of the deficits in the students' secondary education, recently changed from a three year to a four year modular Bachelor of Science degree. A core curriculum with Elementary Mathematics, English, Statistics, and Computer Literacy was introduced for all Science Students. Nevertheless, students still experience numerous problems in the acquisition of (Computer) Science concepts, which is reflected in the high failure rates. Classes consist of students with a great variety of different background knowledge and curren personnel resources. The disadvantaged students, again find themselves incompatible with the obsolete tertiary educational system, lacking sufficient flexibility to adapt to the new demands generated through the different background and skills of the students entering University. [Win99a]

Educational theory

A study conducted at the University of the Witwatersrand [SaEtAl97] revealed that lecturers believed that some of the educational problems experienced there could be alleviated or solved, and learning made more successful, if academics based their teaching on educational theory. The most significant factor identified by educationalists, is to recognise the importance of prior knowledge to learning. As Auspel (quoted in [SaEtAl97]) remarks:

> "The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly."

What the learner knows is not reduced to the previously studied subject knowledge but comprises all-round knowledge and informally acquired skills. In other words, the students' background has a major impact on the students' learning success.

> "The concept of background may be understood as that socially constructed network of relationships and meanings which are the result of the learner's lived past history (Skovsmose, 1994)" [ViSk97]

Vithal and Skovsmose [ViSk97] recognise the students' background as important in understanding their achievement, performance, attitudes and motivations but see the students' foreground as of equal importance.

> "Foreground may be described as the set of opportunities that the learner's social context makes accessible to the learner to perceive as his or her possibilities for the future (Skovsmose, 1994). …
>
> The point is that the (low) achievement in school of children with a 'poor' background is not only to be explained by reference to their background (meaning that those children, because of their 'weak concepts', etc. need to have some 'special training'). Their (low) achievement also has to be

explained in terms of the 'poor' foreground which society reveals for these students. By understanding achievement also as a consequence of the students' interpretation of their actual foreground, the social and political nature of differences in achievements is opened….

Both the background and the foreground interact and are interpreted and organised by students in whatever meaning is given to school or classroom activities"[ViSk97].

My role as a lecturer is therefore to ascertain the students' background, foreground and resulting learning habits relevant to Computer Science in order to develop and present course material accordingly.

## 4.2 Problem diagnostics

To understand the conceptualisation problems of a Namibian student studying Computer Science, it is not appropriate to consider the student as the only entity within the learning system but also the subject itself as well as the mediator. Any learning system consists of learners/students, being the input to the system, and the study of the subject controlled by the lecturer with knowledgeable and non-knowledgeable students as output. The desired output is a maximum number o knowledgeable students.

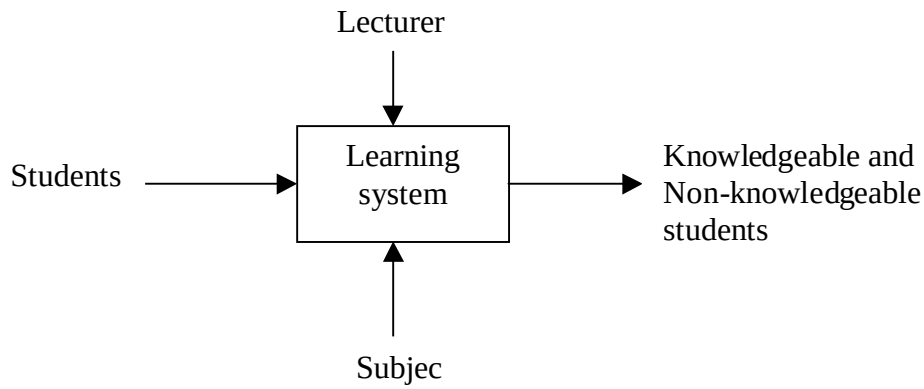



Figure 4-1 Learning system

In other words the knowledgeable student is the desired output of the learning system with one constant argument: the subject and two variables: the lecturer and the student.

Knowledgeable student = learning_system(const subject, lecturer, student)

The maximisation of emerging knowledgeable students can be achieved through improving the learning system in an argument dependent manner. It is in this light that I will analyse the constant and the two variables. First I will look at the subject Computer Science (4.2.1.), and then I will analyse in more detail the student (4.3-4.7) and the lecturer as perceived by the student (4.8.).

### 4.2.1 Computer Science and its values

"The aim of teaching is simple: it is to make student learning possible. Teaching always involves attempts to alter students' understanding, so that they begin to conceptualise phenomena and ideas in the way scientists,

> mathematicians, historians, physicians, or other subject experts conceptualise them – in the way, that is to say, that we want them to understand them" [Ram92].

The belief in the neutrality of science has long been out-dated. Teaching a subjec like Computer Science not within its own development context necessitates teaching its associated values. Values, like the efficiency of action, are taken for granted and not reflected in computer-oriented societies but represent a major obstacle to assimilating computing concepts in other societies. The following quotes summarise well the implicit values associated with Computer Science, as discussed in the literature.

Rational thinking

First of all Computer Science views itself as a formal and an engineering science, relying strongly on the traditional scientific paradigm:

> "The traditional way of thinking in science rests on dichotomies contrasting, for example, man and nature, mind and matter, facts and values.... It emphasises analytical thinking, experiments and proofs as basic elements of scientific methodology. Scientific interest serves to further the domination of man over nature and over fellow human beings" [Flo92b].

Instrumental problem solving

Computer Science as well as

> "Engineering has sought to institute a form of reasoning that is objective because it is external; the rationale behind a technical design can be laid ou on paper and argued through in a public way, at least within the community of engineers and their expertise. This reasoning is instrumental; starting with a problem to be solved, it does not question the problem but simply seeks the demonstrably most efficient means of solving it. It claims to social authority lie not in the choice of problems but in the methods for their solution" [Agr97].

Progress

The ideology that all problems, including social ones, have technical solutions [Bro97] became a strong driving force for further development. At the same time the rapidly evolving technology - Software as well as Hardware - fulfils the current pressure of progress.

> "New things have, of course, always happened and will continue to happen. But what's unique about the current period is how we conceptualise 'new things that happen'. We value their newness per se. We maintain progress as a conscious goal. It is assumed that whatever is newer is not just different but somehow better. Over the long term, so it is believed, our society does not merely repeat itself but somehow improves" [Bro97].

Computer experts are under constant pressure to upgrade their skills continuously. They have to take risks by guessing the direction that industry is going in and chose further training accordingly. [Agr97]

Efficienc

Technology and progress are centred on the idea of convenience, which nowadays implies an understanding of space and time.

> "Technology is not only equated with labour-saving; it also means time-saving. … The ability to organise time and space is an important aspect o power in both its enabling and restraining capabilities" [Mar95].

> "IT has been developed out of a functional rationality. IT is a tool that has to serve work in the first place and its utility should be primarily economic. IT has been precisely invented to increase the productivity per time unit [Vry94].

The resulting cult of effectiveness is expressed with the following phrase:

> "If some act can be shown to foster efficiency, usually nothing else need be said to justify it. It is simply common sense (or has become so) that the most efficient is the best thing to do" [Bro97].

Efficiency increases the work per time unit. Trying to enforce such a working attitude often leads to what Van Ryckeghem's [Vry94] report on Kenyan organisations:

> "Setting time limits to work execution and/or work organisation (policy) has not resulted in faster, but in longer work (culture). The work pace has not changed and neither have work attitudes. When work volume is increased, workers keep on reading the newspaper or chat with their colleagues. When the deadline approaches, one settles in overtime work."

Efficiency as such has no value in the African culture. Namibian students judge efficiency as relevant yet without attempting to apply it. For example, most Namibian students do not see the necessity to work on the efficiency of programs. Once a solution is found they would not spend any effort on optimising it. The time a computer needs to process data is seen as very fast compared to human beings and therefore efficiency seems to be irrelevant as the use of a computer is already efficient in relative terms. One student told me:

> *"Why do you bother to teach us efficiency, if the program is correct, it will do the job faster than a human being anyway."*

Abstraction

The vision of progress and efficiency through technologically oriented action leads to the reinforcement of unworldly perspectives. As Bromley [Bro97] states:

> "This peculiar manner of action has brought all sorts of benefits, from the availability of answering machines to the eradication of smallpox. Yet at what cost? Freedom from the past, from the claims of nature, and from the claims of other persons, also means isolation from those entities."

Over and above all, Computer Science is associated with the concept o abstraction, which is related to formal operational intelligence as the highest level of cognitive ability. As Nestvogel [Nes91] remarks, this over-evaluation excludes the acknowledgement of two factors:

- The higher social relevance of experienced knowledge in certain social conditions.

- The fact that abstract thinking, in terms of experience independent thinking, represents a cognitive one-sidedness, similar to the colonisation and destruction of worldwide values.

Once more it reflects the dominating perspective of the industrial countries towards the rest of the world.

Networking

The dominating view of industrial countries is further spread through the world wide web. Electronic networking is suggested to be indispensable in the industrial, academic and entertainment world. Yet an overrepresentation o western information devalues local unpublished knowledge. A mono-directional communication can be observed[21]. Limited accessibility promotes the so-called digital divide aggravating the gap between the 'have' and the 'have-nots'.

To summarise, the values Goulet (in [The89]) associates with technology in general are applicable to Computer Science as an engineering science:

- A problem-solving attitude towards nature and human beings with a (exaggerated) functional view of the world, where natural forces and human artefacts are only seen as things to be used
- the method of rational realisation
- efficiency of action

and can be completed with:

- progress and rapidly evolving technolog
- abstraction
- networking

### 4.2.2 Presentation

A complex interrelation exist between the students' peculiarities, which is shaped by their background, and the assimilation of values immanent to Computer Science. An overview of the chapter is presented in the following graph. I have isolated characteristics such as analytical skills, critica thinking, originating from the students' identified background, foreground and learning habits relevant for Computer Science studies. The background of Namibian students consists of an era of oppression (Chapter 4.3), the multi-lingual society (Chapter 4.4) and cultural beliefs (Chapter 4.5). The foreground (Chapter 4.6) is presented as the pressure exerted by the society on the student. The section on learning habits (Chapter 4.7) illustrates the clash between different learning approaches. The lecturer (Chapter 4.8) is described from the point of view of the students. The resulting characteristics of the student are set in relation to the concepts associated with Computer Science. For example, the student who grew up during the era of oppression has weak analytical skills which negatively influence the problem-solving attitude associated with Computer Science. The emphasis of this chapter is to present the students' perspective of confronting Computer Science.

[21] For example, comparing the amount of sites Namibian internet users access overseas and vice versa shows a clear unbalanced information flow favouring from overseas to Namibia.

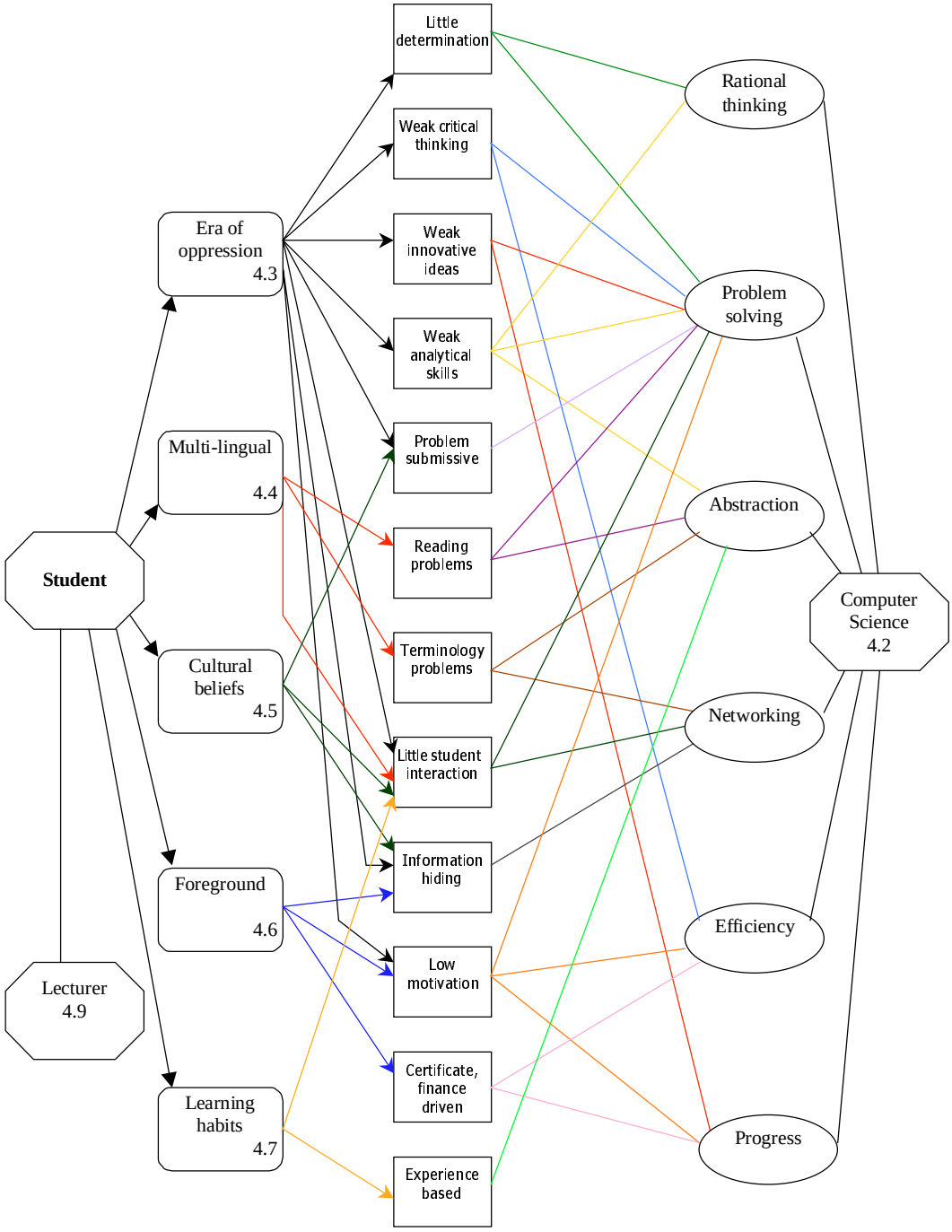



Figure 4-2 Namibia students and Computer Science

### 4.2.3 Method

I started my research with a quantitative study. On one side I wanted to get a picture of where do the majority of students come from, what is their mother tongue, what is their scholar background, etc On the other hand, I intended to verify statements made by colleagues about the failure reasons, like “students who visited schools in Windhoek are better than students from rural schools”, “the students from the north (rural areas) who did not touch a computer are less capable than the computer literate/educated ones”.

Following the principles of questionnaire design [Att93] I drafted the questions I intended to ask. I identified one student, who was keen to assist me with the design of the questionnaire. Cultural and linguistical misunderstandings and

misinterpretation of questions could be eliminated in this early phase. After a test run the questionnaire was distributed to all Computer Science students registered at the University of Namibia in 1995. Questions were grouped by the students' education, information sources use and preferences, opinions and interests (see Appendix for the questionnaire and the answers). The relation between learning problems, cultural values, scholar background, language abilities, motivation and general attitude towards Computer Science were verified.

Looking at the results of the quantitative study I realised that numerous assumption – or should we call it hypotheses - had to be rectified. For example, the statement that students from rural disadvantaged schools are weaker than the ones from privileged town schools did not hold at all. Instead a relation could be found between the language students were taught in at school and their failure rate at the University. Further hypotheses about failures like, "the students are not committed and therefore not motivated", "the students do not do any self enquiry but always look for guidance and always blame others for their failures.", "there is no interaction between students of different ethnical groups" cold not be verified with quantitative methods. I therefore decided to involve into qualitative methods and to have a closer look at the causes of conceptualisation difficulties.

I conducted an ethnographic study from 1996 to 1999. The study is centred on the observation of conceptualisation problems of Namibian Computer Science students that I made during my teaching period. Searching for causes and solutions I conducted numerous informal interviews with students as well as colleagues and I reviewed the available literature. Having many Namibian friends, I further had the opportunity to visit families in the northern rural areas to participate in everyday life and traditional ceremonies, to gain an inside of how most of my students grew up.

In order to increase the validity of my statements I wrote the following part of the chapter in co-operation with Namibian Computing students. I report whatever we found to be relevant concerning the learning context I substantiate my points with publications from lecturers at the University of Namibia, including Prof. Kiangi (Computing Department) [Kia98, 94b], Mr. Hengari (Faculty of Education) [Hen98. 95], Dr. Kober (Psychology Department) [Kob97], and Mrs. Zappen-Thomson (German Department) [Zap99] as well as visiting lecturers like, Ms. Bittner [Bit94] and Prof Wresch [Wre94].

In order to capture as many perspectives as possible and evaluate the conclusions the text was cross-checked and commented on by an anthropologist and severa representatives of the Namibian population. One student noted that it was the first time he had seen an attempt to present the computer conceptualisation in an objective way. Nevertheless, I am perfectly aware that it is still biased, with a European Computer Science teacher's perspective. I have included the origina examples and quotes in order to allow the reader to reinterpret the circumstances. I was seeking for origins and explanations of the students' conceptualisation problems, in order to identify a new way of teaching Computer Science considering the students' background, foreground and resulting learning habits, as an important variable in the course design.

## 4.3 Era of oppression - Culture of silence

Submission

When I began teaching in Namibia, a post-colonised Southern African country [22], the first thing that struck me was the silence of the students. By silence I mean that no questions were asked during or after the lecture and no criticisms were made as I was used to from my experience in Germany. The students seemed to be totally submissive. One student explained me:

> *"The culture of apartheid seriously hindered communication and exchange of ideas in our country. Unfortunately its legacy still persists. I found it rather difficult in the beginning to relate to lecturers to ask questions."*

An educationalist introduced me to the work of Paulo Freire [Fre73], the Brazilian educationalist who has done exceptional work [23] on educational methodology grounded on his own experience of the 'culture of silence'. Through his involvement in literacy programs, he discovered soon that most of the rural proletariat and slum inhabitants of Brazil appeared to be non-educable. Literat people fell back into illiteracy because the wrong teaching method had been used. Westernised educational A similar setting can be observed in the Southern African context:

> **ESTABLISHED WESTERNISED EDUCATIONAL INSTITUTIONS FAIL WITH THE RECENT ADMITTANCE OF DISADVANTAGED MASSES.**

The similarity of the proble lead me to have a closer look at Freire's work.

Oppression

Analysing the cultural invasion of the oppressors, Freire explains the inner submission of the oppressed, who have been deprived of their own language and cultural identity. The most important method of oppression is institutional as well as informal education, accompanied by fear and brutality. The resulting culture o silence of the masses guarantees the remaining position of the privileged "knowing" minority. This discovery leads Freire to the basis of his educational theory: education can never be neutral. Or it is a tool to free human beings, or it is a tool to oppress. Which tool it is depends on the educational method used. Freire criticises what he calls educaca bancaria" (depositor education) which can be compared to a feeding process. In a colonial or postcolonial context depositor education is causally related to the depreciation of the collective cultura experience, identity and language and the implantation of foreign experience, words and identity criteria. In the case of depositor education within a cultura group, no alienation takes place as the content is the group's own cultura experience. But in either case the educational method serves the adaptation of the learner to an existing power structure. The power structure as perceived by norm originators in the post-independent Namibia have been expressed b Kober [Kob97]:

> "The manner in which the norm originators' analysis becomes suffused with the discourses of powerlessness and helplessness, and especially by the discourse of fear, may be hypothesized to be indicative of how in post-independence Namibia it has become much more difficult to distinguish between 'oppressor' and 'oppressed'; in pre-independence Namibia this

[22] see chapter 3.1 of this work
[23] He tested and proved his methods in practise working as an UNESCO expert.

> distinction would have been widely seen as coinciding almost exactly wit a racial division. The fear seems to be closely connected with the perceived facelessness of the new oppressor."

The Namibian educational system of today has been shaped by the Traditional African, the Missionary Education, the German and South African colonia education. This of course reflects on the students who went through this ver unique education. Hengari [Hen98], a Namibian lecturer remarks:

> "The past education systems were meant to mould a competent, obedient, punctual, honest, ordered and cheap workforce which the colonisers needed to carry out their settlement plans...Academic learning was suppressed...To enforce the inferior and subservient education for Blacks, teacher training was deliberately neglected."

The inferior education given to Black people in Namibia led to a low level of confidence and self-esteem for most of them.

Parent-child oppression

The child's own parents contribute to the enforcement of authoritative structures.

> "The parent-child relationship reflects the objective cultural conditions of the surrounding social structure, if it is rather authoritative, hard and ruling it intensify the culture of oppression. "(Freire in [Hen98])

In Namibia we still find very oppressive of parent-children structures. As a Namibian student told me:

> *"Our fathers have been taken out of our families for contract work. Sometimes my father was away for more than a year. When he came back he had been exposed to so much humiliation and dagradation that he himself became an oppressor at home."*

Teacher-learner oppression

This parent-children relationship is transferred to the teacher-student relationship:

> "The parental view of the child as passive recipient of the teachers' teaching: Teacher talks and the learner listens. The teacher chooses the programme content, the learners adapt to it. The teacher has authority and the learner must respect this authority. ...The parents as a source of authority (cultural-traditional or by virtue of parenthood) could be seen to prescribe to their children expected school behaviour that could result in learners becoming passive recipients of knowledge, or empty containers to be filled by the teachers." [Hen95]

Thus the relationship between a learner and teacher is in most cases a one-wa relationship in which the learner accepts and absorbs the wisdom of the teacher. Lessons are presented in the form of a lecture. The teacher reads the book aloud for the students and in some cases translates it into the language of that region. Kiangi [Kia94a] states that the advantage of this method is the enforcement of discipline on the students and the need for fewer material and time resources.

> "Young people internalise this authority from their relation with the parent and later at secondary school level and tend to repeat it once they are in the position (Freir ,1973)" [Hen98].

Rote-learning

The oppressive patterns of today in Namibian schools and homes are justified through praising discipline as a valuable attitude of a child or learner, rather than to encourage inquiry. One of my students explains:

> *"The concept of discipline almost all over the continent was designed to facilitate collective upbringing of the children so as to implant uniformity and conformity within the community based on "who will be able to take care of my children if I die" philosophy. The parents try by all means to make sure that if something happens that incapacitates them or renders them unfit anyone can continue taking care of the child as the behaviour is the same at community level. It is against this background that any education system that seeks to achieve full emancipation and empowerment of the student should do so without setting students against their teachers as they are also regarded as parents."*

Nevertheless, the consequence of oppressive teaching methods is that students do not question anything but rather learn by heart. Unfortunately, some lecturers, even at university level, apply those teaching methods, as one Namibian student narrates:

> *"Properly warned by my father about tertiary education I took everything serious. I went to the library every day and studied so many books, as references. But my life changed shortly after I realised I didn't have to study that much and didn't need any references as in any way the lecturer would only credit me for what he had written on the board in one of his endless lectures, where we were not allowed to query anything. So all I needed to do was memorise the subject although I didn't quite understand the theme, and I would pass with distinctions"*

Sanders et Al [SaEtAl97] discovered the consequences of rote learning in a study on the learning problems of first year Biology students of the University o Witwatersrand in South Africa.

> "The problem with rote-learning is that the learner will delude himself into believing he has really grasped the precise intended meanings when he has only grasped a vague and confused set of generalities and no real meaning whatsoever (Ausbel) ... Students accept the new meaning but fail to make the mental links essential for the meaningful learning to occur" [SaEtAl97].

As Eckensberger [Eck97] remarks, in order to assimilate the knowledge

> "We all have to reconstruct individually what we are taught."

The missing assimilation is then revealed when the student is asked to apply the knowledge:

> *In one of my courses I explained the different data structures and among others the stack with its pop and push functions. Later I gave the students an assignment where they had to create functions for a seat reservation in an aeroplane. What I got by some of the students was a little transformed function of push (passenger) and pop() passengers out of their seats.*

Weak analytical skills

As a practical consequence of the apartheid system, schools were inadequatel equipped and were staffed with unqualified teachers, which led to inefficien teaching of science. Teachers applied the conventional teacher-centred learning methods, which have been proven to be the poorest method of learning science. The significance of skills and reflection has not been acknowledged. In Mathematics, emphasis was placed on training procedures to follow rather than understanding. This education failed to provide the pupils with the ability t analyse and structure problems and to deduce new facts from learned concepts. High drop-out rates at various stages in the Science and Mathematical subjects was recorded [Kia94a]. Frankenstein and Powell [FrPo94] believe that the reason for oppressed people, including many women and people of colour, being 'mathematically silent' is because of the prevailing eurocentric, and male-centric, myth that can be found in many Western 'his-stories' of mathematics. Instructors and oppressors made sure to transmit those beliefs. One of my Namibian friends told me:

> *"They used to tell us that black people are too stupid to learn mathematics"*

Fear of critical thinking

Mergner [Mer91], who is opposed to oppressive teaching, remarks further that learning without confidence in the students' own power and hope for change in their living conditions results in common, authoritarian drills, individual failure, or in collective resignation. This is why Freire [Fre73] sees the central problem in: How the oppressed as divided, unreal creatures[24] can contribute to the development of an education towards their own liberation. But during his work with oppressed people, Freire [Fre73] discovered their fear of freedom and their inability to criticise, as I also noticed with the Namibian students. At least a third of the Namibian computer students would always believe what was written in a textbook, not accepting that authors, as human beings, can make errors or tha there could be printing errors. This becomes problematic when critical thinking is required for academic exercises like validating a program.

> *The students were given an algorithm to prove or disprove its correctness. One student wrote: "This algorithm is correct because it is in the book", although his friend, an exceptionally critical student, disproved the correctness of this same algorithm.*

Uncritical thinking is equally present at the level of reflecting about Computer Science itself. Most Namibian computing students tend to express no negative feelings about Computer Science and computers. They associate computers with positive attributes. Only one student, questioned in my first quantitative survey, thought of a negative impact on social life. When asked about computer-assisted teaching, 65% of Namibian computing students registered in 1995 thought i would help a lot and nobody thought negatively about it, even though they had no experience of it.

Non innovative thinking

Dominique van Ryckeghem [VRy93] concluded from her research on IT and culture in Kenya that

[24] being like the oppressors

> "distorted knowledge about IT potential and task oriented IT utility results in interpreting IT utility in automating benefits and formal aspects only."

In the Namibian case Computer Science is reduced to computer literacy. Most o the Namibian Computing students could only think of programming and information storage as possible computer applications. Computer students do not see computers as a dynamic development but rather as a static tool you use like a toothbrush. They take it the way it is given, without criticising, and/or seeking better solutions.

Motivation

In my search for further factors hindering the learning process I had the following discussion with a student:

*Self:* *Tell me, what do you think hinders the success of learner?*

*Student:* *Generally the lack of commitment on both sides, the lecturer and the student. We are not motivated because we are not really challenged. For example, in our first year we are only given ready-made Q-basic programs to type and run although we already wrote our own Pascal programs at school.*

*Self:* *What would then be a challenge to you?*

*Student:* *If I would get more pressure to finish an assignment in a certain time.*

*Self:* *So are you saying that you would be more motivated if you were getting more pressure?*

*Student:* *Yes.*

In educational theory, motivation is viewed as one of the most important prerequisites for successful learning. However through this and other discussions with Namibian students a different concept of the term "motivation" appeared. In a Western context motivational learning is associated with enjoyment. For example,

> "The Web is said to motivate learners, simply because of the integration o music, voice, still pictures, text, animation, motion video, and a user-friendly interface on a computer screen" [Ree99].

Meanwhile, in the Namibian context motivation is associated with pressure. This was confirmed by a statement made by another student:

*Self:* *Let's say you are a project leader and you have to work with a bunch of disinterested people, how would you go about motivating them to co-operate in your project?*

*Student:* *What is there to motivate? I would put pressure on them.*

*Self:* *But motivation for me has to do with enjoyment.*

*Student: The concept of enjoyment does not exist in our culture. I have been looking after the cows since I was three years old, want or not.*

This showed me once more how deep the postulate of oppression has been internalised even by the new generation of Namibians. Motivation is extrinsic and the activities remain valueless therefore no intrinsic motivation evolves, no intentionality from the student him/herself.

## 4.4 A multilingual society

Weak skills of expression

At the University of Namibia a compulsory English course was introduced, as Science Students showed a weakness in expressing themselves in English. The difficulties could have two sources:

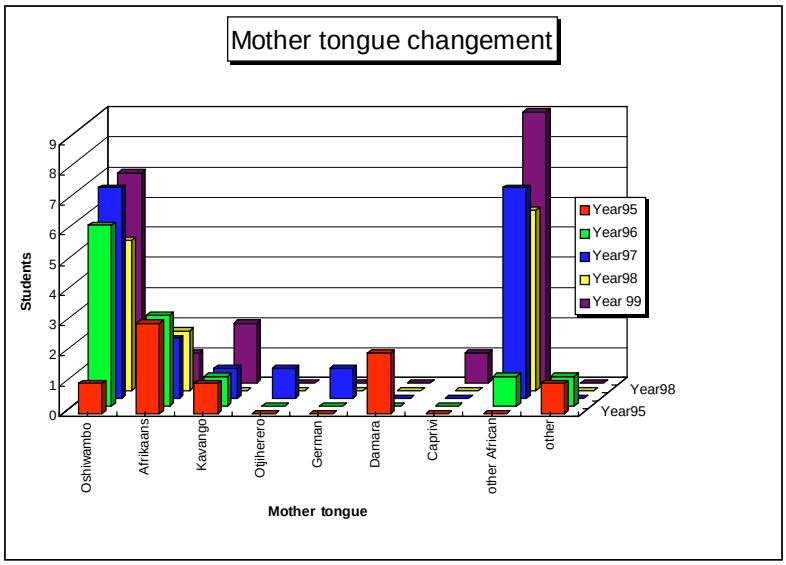
- The oppressive formal and informal education, where learners had to rote-learn rather than to understand and reformulate in their own words.
- The students linguistic background

The first point has been sufficiently discussed in the previous subchapter. I will therefore try to illuminate the students' linguistic background.

University classes consist of students with different mother tongues and linguistic development. The following graph represents the distribution of the students' mother tongues in the second year Computer Science classes between the years 1995 and 1999. Each year is represented by one colour and shows the distribution of mother tongues within one class. Following the y-axis the change of presence of a particular language can be followed over the years. First of all, it can be observed that not a single student is a native English speaker. Furthermore, the development towards the domination of one Namibian language, Oshiwambo[25], (one student in 1995 and seven in 1999) and other African languages (none in 1995 and nine in 1999) becomes apparent.

As most of the foreign students are fluent in English and do not seem to have difficulties I will only consider the Namibian students in the following discussion.

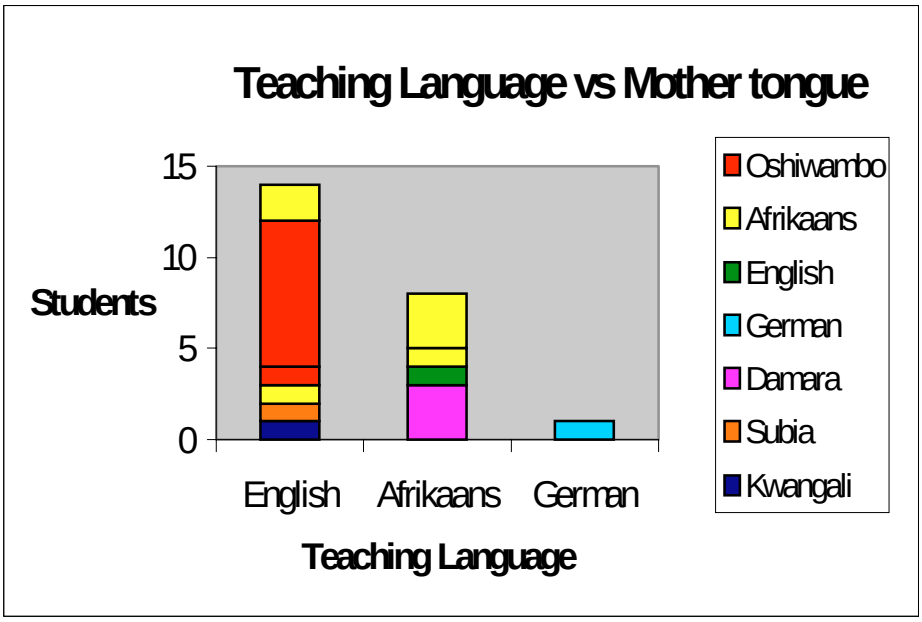
Figure 4-3 Mother tongue class distribution




[25] language of the major ethnical Namibian group

In Namibian schools, Afrikaans, English and German were used as languages of instruction which to many learners were second or even third languages. The results of my survey showed that the failure rate of students who were not taught in English at school was higher - as shown in the following figure-. The grap represents the computer students registered in 1995 with their different mother tongues languages they were taught in. The crossed part represents the students who failed to pass to the next year. The higher passing rate of students who were taught in English than in Afrikaans or German, speaks in favour of the governmental decision of having English rather than Afrikaans as national language of instruction[26]. However, the consequences of teaching in a second language should be looked at. For example, the graph also shows that the failure rate of Afrikaans-speaking students taught in Afrikaans (in their mother tongue) is lower than the ones who were taught in English (in their second language).

Figure 4-4 Teaching language versus Mother tongue




Poor reading culture

Namibian computer students generally struggle to study on their own using printed material. Hengari [Hen98] conducted a survey on reading difficulties at school. Hengari sees the major reason for difficulties in learners not being taugh how to read in their mother tongue. He bases his findings on Jim Cummins' linguistic interdependence hypothesis (McLaughlin 85 in [Hen98]), which states that the level of competence a child attains in a second language learned in a school context is a function of certain competencies attained in the child's first language. Therefore, the development of vocabulary and concepts in the first language are important determinants of success in a school situation where instruction is in a second language.

> "A lower literacy achievement may therefore stem from a mismatch between the culture of the home and the culture of the school. The literacy problem in a multilingual society such as in Namibia, could be explained in terms of language differences which stem from cultural differences." [Hen95]

[26] see language policy in chapter 3.

Terminology problems

However, the problem of meaningless reading and therefore meaningless learning affects the assimilation of computing concepts. In science subjects numerous paradoxical jargon terms are used. Words have two meanings: one everyday English and one specific technical, which is frequently derived. Learning withou meaning – equivalent with rote-learning - will stay an isolated fragment of information and can therefore not be applied in other contexts. However, even many school teachers are not sufficiently acquainted with English and therefore only read books to the students without even being able to explain or understand them.

As far as application programs like IBM-works, Qbasic-editor are concerned, for half of the students the language used presents a problem, especially among the failed students. However, only 60% of the students asked would like to have the human computer interface in their mother tongue and none wanted the subject to be explained in his/her mother tongue, although outside the classroom students explain the subject to each other in their own languages mixed with English terms.

Student interaction

As a consequence a selective communication of students, especially between different ethnic groups, remains. A student having a problem first or only goes to a student speaking the same home language. Students from minority groups therefore experience difficulties when looking for help. For example, in 1995 al minority groups[27] failed to pass the first year Computer Science course, as shown in figure 4.4. Especially in group work language becomes a barrier.

> *Four students were given a project. Three students were Afrikaans speaking and one not. The three dominating the group would always fall back into their mother tongue and hereby exclude the other student who ended up being frustrated and not participating in the project.*

The development of mother tongue distribution in the classes (figure 4.3.) indicates the movement from a multi-lingual class to a tri-lingua class which will obviously have a major impact on the students' interaction and the difficulties for minority groups.

## 4.5 Cultural beliefs

Information hiding

Namibian society is characterised by an extremely high practise of information hiding.

> "The socio-political context influences whom people believe they can trust and the degree to which individuals believe they can predict their environment (Triandis 1985). When people struggle to survive on a day-to-day basis for prolonged periods, they will not view the environment as predictable, and they may find it difficult to trust outsiders" [Weh95].

Furthermore, fears of revealing more information than necessary has its roots in the colonial time but as well as in the indigenous culture. In every society information is linked with cultural values. Information, which may seem valueless in one culture may have strong cultural connotations in an other. For

[27] This means all women, or all ethnic groups with less than four representatives.

example, age in African cultures is linked with respect. As a consequence when asked for their age, an African may try to estimate the age of the enquirer and give a number greater to it, to enforce respect. In European culture politeness is often the reason for hiding or altering information. A survey which was conducted without knowing such codes of conduct would inevitably lead to invalid data. Any planning or design based on wrong assumptions ends in mis-planning no matter in which field of application, be it development aid, course material or system design.

Witchcraft

Namibian students of today find themselves in a transitional culture between indigenous and western life values, between tradition and modernism.

> "Missionary influence in Namibia was particularly strong with 98% of the population considering themselves Christian. Nevertheless, belief in the spirit world and ancestors often coexisted side by side with Christianity" [Lum96].

Having a closer look at the European, abstract, natural scientific thinking mode shows that it is not as "pure" as it pretends to be. Similarities between socia organisations and orientation of thoughts and perceptions can be identified among civilised and primitive cultures. Magic, non-linear, circular thinking, imitation learning and identity learning are part of it. Combinations of magical and scientifically thinking, binary logic, myths and modern science can be found. Movements can be identified in the modern society were a trial to reintegrate the repressed is made. As Europeans, Namibians are little confident about values o indigenous beliefs will first tend to deny any belief in witchcraft, yet will later in the conversation narrate about bewitched people: like a very rich man who suddenly became poor, or a very bright normal person becoming psychoti [28]. The fear of witchcraft goes as far as influencing the students' attitude towards their peers especially those from different ethnical groups. As one student reported:

Student interaction

> *"I used to give my notebooks to any student who asked for it until my friends told me I should not give them to people of a certain ethnic group because they are well known for bewitching people they are jealous of."*

Problem submissive

Most Namibian Computer Science students believe in the omnipresence o superior powers, such as God or witchcraft, which leads to an extremely submissive attitude when problems seem unsolvable. As a Namibian friend told me:

> *"As the network administrator could not get the network back up and running he reported to his supervisor that he cannot do anything as the network has been bewitched."*

[28] One student commented as follows: "It should be noted that the concept of witchcraft as stigmatised as it is now was not part of the African society. It was coined by the missionary, as an equivalence of the European witches where burning of this people characterised the Dark Age of the European. In Africa, at least here in Southern Africa these people were usually referred to as "knowledgeable", "elder" etc and must be treated with respect. These were people, who could predict enemy movements in war, talk to ancestors, etc. These people including the so called black smiths were mystified and humiliated by the missionary by branding their work a paganic etc, so they resorted to doing their work in the background."

However witchcraft can also be interpreted as a differen problem solving attitude as one of my students related:

> *"Some of us still believe that witchcraft can be used in a positive way just like the so-called modern science can be used for the advancement and destruction of humanity."*

The belief in the witchdoctor using his positive power to combat the evils o modern science is satirised in the famous South African cartoon *Madam &Eve* [FrEtAl97]


## 4.6 Foreground

Disorientation

In general, Namibian students can be characterised as rather disoriented, no knowing what they are aiming for. One lecturer explains this with the long struggle for freedom and the recent independence. However, it is my belief tha the major problem is the current transitional culture the students are in. Students act according to what they believe society (or their family) expects from them as well as their own wishes and perspectives. However the young generation is not quite clear about what is expected of them and they are not well informed when it comes to matching subjects and skills with career choices.

If we analyse the students' motivation for choosing Computer Science and thei professional perspective we can explain the students' study expectation and consequently their attitude. As a lecturer I have noticed that students show a general disinterest in the subject itself. Students believe that the subject is not complicated, but it needs a lot of commitment and hardwork, which they are not always ready to invest. I was only able to perceive the reasons for this after I analysed their foreground.

Family pressure

First of all, I noted that the majority of students enrolling for Computer Science are male. However, since I have been teaching in the department there has been an increase of female students reaching a senior level. These students state having a female lecturer as an example has encouraged them to work hard and continue with the subject, although they often feel inferior to their male colleagues. The percentage o students who registered for Computer Science because their father or other family authority suggested, advised or even forced them to is high. This is especially the case for the female students. Male students tend to opt for Computer Science in the hope of a prosperous life and out of fear of being less competitive on the labour market. Below is an account of a female student followed by a conversation between her and a male student. They illustrate the spirit of incoming students well:

*"I was a privileged young Namibian lady to get a place in the University of Namibia. Having grown up in an educated family, I knew how important it was for me to get educated. My father always made sure I understood my schoolwork. My father understood very well the importance of encouraging me to study, not only to pass but also to learn. He advised me to study Computer Science in order to be a system analyst and follow in the footsteps of my uncle who studied Computer Science in Germany. As I believed this would bring me closer to my secret plan of shrinking one of my uncles, who was harassing me, I agreed. My fathers' goodbye sentences were: "You are going to go to the university my dear. I will not be there to guide you or help you with your schoolwork. I will not be there to see how you are progressing academically or talk to your lecturers when they treat you unfairly. I will not be present to tell you to study for the exams and tests. But God will always be there with you. May Goodness and luck follow you all the days of your life. " He made it quite clear that lecturers are busy beings, who care more about what they believe in than in stupid students who don't want to learn or are not motivated. "*

*"As I was talking to some of my male friends:"*

*I: What do you hope to achieve by studying Computer Science? What do you intend to do with it?*

Prosperity

*Hafeni: It is mostly to get my certificate and get hooked up with some multibillion-dollar company. All I think of this time is the economic status of the country, certificate and position I hold in the future.*

*I: And what about the skills?*

*Hafeni: You must be joking. Does anybody need that? What we need to do is get some very nice certificate to show off with, and we will soon drive a Mercedes Benz.*

Certificates

This last comment reflects the higher importance attached to a certificate than computing knowledge and skills. This is understandable in terms of the salary structure of the government, which works according to qualifications so that the higher the degree, the higher the salary. One of the implicit pressures on most African students is the expectation that they will support a couple of non-earning family members[29] once they start working. The number of unemployed Namibians is high and social aid from the state is minimal, so families are extremely dependent on working members. Once a person is working he or she has the moral obligation to send money to their parents and pay school fees for younger brothers and sisters. As soon as a graduate can afford a place to live

Financial pressure

[29] Family member is a very broad term in the African context. For example cousins are considered as brothers and sisters.

family members will come and live with him or her. This reflects back on students' attitude towards their studies:

> *"I would feel guilty if I enjoyed myself while I was studying knowing that some of my brothers and sisters were suffering. I have to succeed in order to support them."*

Kober [Kob97], a Namibian psychologist, has analysed this phenomenon under the concept of solidarity:

> "'Solidarity' becomes material obligation, that is, being obliged to provide material support, and it is constituted along ethnic lines."

As she demonstrates with the statement of one of her interviewees:

> *"You cannot say sorry you have no money. They say but now you are a big guy you could help me here. I need a horse and he needs cattle ….he must pay for the grandfather's funeral. Who's going to pay for the coffin?" [Kob97]*

Governmental bounds

In Namibia the need for Namibian computer experts is high but the number of graduates is low. From this one would conclude that studying Computer Science would guarantee successful employment. However, reality is different. Most Namibian students are financed through governmen bursaries which oblige the to work for the government after graduation for the same number of years they have been funded for. Yet, due to lack of planning the government does not budget for adequate positions and as a result is not always able to employ those graduates in their field of expertise. This means that computer graduates may end up working in other areas, such as teaching. However, if a graduate is luck enough to obtain a suitable governmental position they often have to face a power struggle. The hierarchical system of the civil service facilitates oppressive behaviour by seniors towards newcomers. The seniors, fearing their positions and usually having no computing expertise, ignore the computer graduates' suggestions and thereby boycott their work. In extreme cases the newcomers are not assigned any authority at all, as in the case of one computer graduate I spoke to,

No computer expertise required

> *One local network in the Northern rural part of the country is administered by the capital Windhoek although a computer graduate has been locally employed (as a teacher). However he is not even given the authority to install a network printer.*

Working in the private sector is not an affordable alternative as young graduates are not paid enough to enable them to free themselves from their bursary debts.

The possible perspectives currently given for Namibian computing graduates do not encourage the students' desire to gain computing skills beside certificates, as in any way the knowledge will not come into play and only very few students desire to study further in the field of Computer Science.

Short term computer caree

Several Africans I spoke to told me that they intend only to work up to the age of 40 and then to move to farming or small scale businesses.

> *"Some times I ask myself why I should study so hard if I end up being a farmer anyway."*

This shows the half-heartedness with which Computer Science is studied in Namibia. It does not coincide with the belief in progress through continuity and specialisation which characterises the computing world in the west. Hence the students are then satisfied with studying computer science at a superficial level. Some are seeking no more than basic computer literacy[30].

Computer Literac

There is a common understanding among Namibian computer students of the importance of computer literacy. Most computer students state that computer literacy should be part of peoples' general knowledge and more Namibians need to become computer literate. A computer literate person is considered to have an advantage on the job market. However, computer students go as far as demanding to be taught applications rather than computing concepts. The students want to be prepared for life in a global society in their future workplace and therefore the regard it as sufficient to be skilful in Internet and Microsoft applications. Mos Namibian computer students do not aim to learn more than the basic computer concepts and to acquire some technical skill to assemble and repair computers. Although nearly all computer students agree on the importance of knowledge and progress, only a few aim to be computer experts. These individual aims are directly reflected in the success of the student. For example, in a sample of failed students, the percentage of students who dislike programming is very high and the percentage who like programming is very low.

## 4.7 Learning habits

Skills relevant to Computer Science are not only acquired formally but also informally. Informal education, which manifests itself in different forms, plays an important role in any society. Informal education includes learning by experience, by watching, doing, listening, reading and playing. Skills and abilities are acquired in everyday life as opposed to formal education. Every society, with its underlying values and norms, always has an implicit educational intention and therefore steers the process both informally and formally. Moreover, each society facilitates the learning of those skills which are considered indispensable to the continuation of its particular values.

Western informal education

In a technologically developed information society, the training of specific skills can be observed in everyday life. The societal educational aims are mainl supported by the book, game and computer industry. It reflects the paradigm of enjoyable learning.

As a particular approach of creating and solving problems within an information society (as discussed in subchapter 4.2.). Computer Science is associated wit certain values. A wide range of popular games exemplify and teach these values:

- the problem solving attitude with analytical and deductive skills (Detective games, like Cluedo)
- the method of rational realisation
- the efficiency of action (Magic cube)
- progress and rapid evolving technology (computer games)
- abstraction (Labyrinth of the masters, Towers of Hanoi

[30] This includes the knowledge about word processors, spreadsheets, low level databases and usage of the internet.

- networking (networked computer games)

The main method of gathering information in a Western society is through reading books rather than asking elders[31]. For example, many households have encyclopaedias, where terms are looked up within informal discussions at home. More and more households have access to the Internet which is another commo source of information.

Western formal education

The western formal education system goes hand in hand with existing informal learning practices. However, formal education is often so over-that informa learning is taken for granted. The assumption that where no formal instruction takes place, no education takes place, can be seen in many World Bank studies as well as the practices of educational development aid:

> *In Namibia lives an indigenous population, the Bushmen, who are well known for their exceptional ability to read tracks[32]. Along comes a development project of formal education for bushman children. Among other things they teach the animals and their tracks with the help of a board displaying pictures of tracks and the corresponding animal beside it.*

Honestly I have never seen something as odd: Is the orally transmitted traditional knowledge only valuable if it has been taught with western formal methods? It seems mocking to introduce formal instruction in order to replace a traditiona way of teaching which, has been proven to be successful over all those years (in the worst case to prove that these people are less intelligent than others).

Africa informal education

Traditional African informal education still continues to nourish the majority of Namibian children before they are exposed to the formal education syste through schooling [Hen98]. A look at informal education in southern Africa shows how different it is from Western informal education. The trend in the west is to make learning as enjoyable as possible, while in Africa learning is associated with seriousness. At this stage whether games nor computers nor books have invaded the African informal educational market. In countries with a high literacy rate, most children have been read numerous stories before learning how to read themselves. In Namibia, on the other hand, learners are often not exposed to books at home.

> "Traditionally many parents transmitted their cultural heritage orally to the younger generation." [Hen98].

Hence many Namibian computer students do not know how to use a book in order to retrieve information to solve a given problem. Students tend to read the introduction and the table of contents rather than trying to look up the term in the index.
As one of the more successful Computer Science students narrated:

> *"Growing up in the house of a scientist and an English teacher was a great thing for me. My mother (an English teacher) taught us English at a very young age and we were able to express ourselves better than other kids or even teachers at*

[31] as in any way it is believed they would not have the necessary knowledge
[32] They identify the animal as well as for example the time the animal has been at this location

*school. On the other hand, my dad challenged me every day with new questions about nature, he taught me mathematics and science in the evening, and he in turn encouraged me to teach my younger brothers."*

As a consequence of the oral tradition a great number of Namibian computer students come to ask the lecturer for assistance. As Van Ryckeghem [Vry94] classified the approach of Kenyans when confronted with an IT problem, students ask for assistance and learn from solutions.

I believe it is about time that we officially recognise the value of informa education as well as its interdependency with the formal system. Differences in informal education have to be considered whenever formal education is introduced and designed, otherwise the formal education system will keep on facing acceptance problems in developing countries. As stated in a grade four Namibian teaching textbook:

*Indigenous (native) people did not want their children to go to school as they taught them according to their traditions and customs. The children also had to work in their communities and parents felt that time at school kept them away from their duties.*

This statement sounds as if it is referring to the last century. However, such attitudes are still current today. Some of my students told me that when they wen to primary school they regularly missed classes because they had to attend to household duties. Some parents do not consider the knowledge transmitted at school to be of relevance to everyday life.

Abstraction

The gap between African informal education and Western formal education becomes especially apparent in the field of abstract concepts. In teaching Computer Science abstraction becomes relevant in two different ways: One as the key activity within Computer Science itself and two as the method of explanation. As one student stated:

*"Computer Science is difficult because it is so abstract. At school everything the teachers explained was touchable."*

The student understands abstract in the sense of "not touchable" which is in line with the definition given by the Oxford dictionary [Oxf95]:

"a) Existing in thought or as an idea but not having a physical or practical existence.

b) General, not based on any particular person, situation, etc…compare concrete."

However embracing the aggregation of synonyms, like conceptual, unpractical, essence, summary, complex, separate, and theoretical transmits a fairly good feeling for the concept of abstraction. An English-Kwanyama (one of the Namibian languages) dictionary [ToTu91] translates 'abstraction' as 'tongola'. Asking numerous Oshiwambo native speakers they explain 'tongola' as the process of only picking certain things out of an assortment, but always applied to

a practical context like, picking the calves out of the herd of cattle ( tongola uutana kengombe).

Abstraction Intelligence Experience

Like any other concept, abstraction is not value-neutral , it is associated with certain meaning and therefore perceived differently in different cultures. Abstraction and intelligence are closely related in the western society. Abstraction is associated with formal operational intelligence as the highest level of cognitive ability. On the other hand, Wober (quoted in [Nes91]) states that the concept of intelligence is associated in "our" society with fastness, coolness, calculation and abstraction as opposed to other (more traditional) societies in which intelligence is associated with slowness, warmness, measurable, and experiencable. In other words, western society associates a high value with abstraction as it is related to intelligence whereas more traditional societies, like current African societies, affiliate a higher value to the opposite concept to abstraction, namely experience.

In the African context, abstract processes have to be translated into experience-based activities in order to become valuable and understandable. As one student relates:

> *"When my father explained me things, for example the evaporation of water he embedded it in a story. So I would always remember the story and know that when the sun shines there is evaporation of water."*

Having realised that an abstract method of explaining concepts encounters resistance from the students' side, I decided to use more examples and explain in a more practical way.

> *When I taught the concept of pointers I tried to make it as tangible as possible by drawing boxes and arrows. But still the students could not grasp the idea. Coming to the lab I then found one student writing a computer program that would print out the values of the pointers, addresses for that matter, to see where they are pointing to and whether he could really make them point to the same address through certain operations.*
>
> *In order to explain recursion I then implemented a computerised interactive "Towers of Hanoi" animation with the algorithm aside and indicating the position. However, all the students did was to memorise the animated sequence without understanding the algorithm.*

The problem proved to be that when I used examples to explain abstract concepts or processes, the students memorised the examples without conceptualising. Perhaps my choice of examples was to blame, or perhaps it was the students' habit of memorising examples with no abstraction process.

Application problem

Following the difficulty of abstracting from a given example, is the difficulty o translating abstract concepts into practical applications. Students state as one o their major problems:

> *"Applying what I learned in class to my practicals"*

This includes exercises like translating an algorithm in a program. Two sources o difficulties can be thought of:

1. the student has not understood the algorithm
2. the student has experienced difficulties in the activity of application (de-abstraction).

However at this point in time I cannot see how computer skills can be properly taught without an abstraction process between a given example and the application within a new context. It is therefore my suggestion that the teaching of abstraction has to be emphasised.

Moreover teaching object-oriented programming involves the teaching o abstraction itself, as a class is defined to be the abstract characterisation of an object and specifies an abstract data type[33]. Many Namibian computer students have difficulties differentiating between an object and a class, between an objec being a data member of a class or a class being a subclass o an other class. Avoiding abstract teaching methods is feasible although difficult for a western lecturer. However, the different levels of abstraction inherent in Computer Science, as in object-oriented programming still have to be taught and assimilated by the student. Therefore, the problem of how to teach the concept and application of abstraction remains.

Co-author

## 4.8 The lecturer

Teacher-learner interaction

The role of the lecturer becomes of major importance in regard of presenting the course content in a learner-friendly way. Lecturers state that Namibian students tend to blame others for their failures without any self-enquiry. Therefore become insensitive to the following kind of remarks from students:

[33] A data type is abstract if the high-level operations appropriate to the data type are isolated from the low-level implementation details associated with the data type.

*"I failed because the lecturer hated me, for which reasons I didn't know"*

Yet lacking self-enquiry on the lecturer's side leads to the following statement:

*"The students are too lazy and not serious with their studies that is why they fail."*

While on my lecturing position I can not remember that any of the colleagues told me:

*"I failed to explain the concepts in a student adequate manner."*

Although I am a lecturer myself, I intend to reflect the students' perspective here rather than justify my failure. I will therefore print the opinions on lecturers with as little interpretation as possible.

First of all I asked one of my students, who has been working with me on this chapter to write a small stereotypical story about foreign lecturers. This is what got:

*The story of Prof. Woods*

*Woods is professor of Computing Science with special interest in African culture. Prior to his appointment he did extensive reading about African culture and looked at tourist videos. Fascinating to Prof. Woods was the story of the ostrich, he really took of his hat for this tall, two footed African bird therefore he decided to use it to explain the concept of the loop to his African students. The story depicted a migrating ostrich: Southern Africa being a semi-arid region where water becomes scarce from time to time so animals have to migrate to other areas in search for water. Unfortunately, this poor ostrich had eggs, so it had to migrate with its eggs, it can only carry one egg at the time, so it had to go and come over and over again until the eggs are finished. Prof. Woods thought that there could be no any other example to explain the concept of a loop to somebody (according to the movie) who grow up with ostriches. So he boldly went to class and presented a lecture using the above example. He was surprised to know that 90% of students had never seen an ostrich. The movie that he saw was from the Kalahari where only a small part of the population lives.*

The student explained:

*"I don't attempt to give an impression that the example used was bad but it was rather not relevant to that particular student body. Forgetting that this vast continent of 53 nations is very contrast and hence has different needs not only from one country to another but also from one region to another. There is no African culture as perceived in the west;*

*henceforth any system should be tailored not only to a specific continent, but also to a specific region/country.*

The student's major concern was the stereotyping of students by the lecturer. As I wasn't too clear on the message of his story, he told me:

*"I wanted to say, those lecturers are trying to adapt but they do not really know what to adapt to, as they do not know us and do not really try to understand us."*

Another student, with whom I was working on this chapter, was kind enough to tape a conversation he had with three of his friends who dropped out of the course:

*Kamati : Tell me, why didn't you guys continue with Computer Science up to fourth year?*

*Guilt: I know that Computer Science is an interesting subject and you get a lot of money when you pass it, but it wasn't just for me. I was really struggling.*

*Luke: Oh Ya, it gave me quite a tough time I am glad I dropped it soon because so many people are failing it*

*Kamati: But where do you think the problem lies? Is it with the subject, with the lecturer, with the students or where?*

*Guilt: You know the lecturers are not very good. I don't quite get their pronunciation. And the way they teach is not systematic... they jump from one topic to another and you would get lost. Believe me Kamati, I didn't even know which topics we were doing which weeks because you don't even have any means to follow.*

*Kamati: But didn't the lecturer introduce the topic as he taught them?*

*Guilt: I don't know whether he had a hard time presenting the subject or the subject itself is maybe difficult to present. I didn't see any introduction of topics, only definition of terms.*

Meaningless lectures

*Luke: You know what Kamati, those people teach us things we don't know as if we already know them. Even if they are introducing a new concept, they use such a high level that the normal people like me would not understand. They do not give an introduction to an introduction. And we don't even know why we should learn some of the things they teach us (e.g. binary numbers) whilst they neglect important things as showing how a CPU looks like.*

Not interesting lectures

*Luke: There is this Mr. ξξξ who doesn't teach learners but*

*himself. He enters the class, faces the blackboard and starts talking until the end of the class. Meanwhile, some students are sleeping or simply get bored and their interest in the subject is lost.*

*Gilt:* *I agree with Luke. But I want to add also that lecturers should be practical. They should try all their best to make the subject interesting by giving practical examples and encouraging the learners to study hard by giving them interesting, yet challenging problems to solve. As an example: It is much better to let them do a student registration system than finding the lowest common multiple of two numbers.*

*Kamati:* *Do you now want to tell me that the problems they give are not challenging, and if no, then why do students fail them?*

*Guilt:* *It is because they are boring, No one is interested in doing such a project. Give things that can benefit and have meaning to everybody, not only to the mathematician or the statistician.*

*Kamati:* *Which modules did you find most difficult and why?*

Disorientation

*Luke:* *Introduction to computing – maybe because it was the introduction and I didn't quite know where to start and where to end. When reading other books for references, I did not know how far to go. The subject/module was just too complicated for me that I did not even have any question to ask.*

*Guilt:* *Don't forget that second module in the second year: Complexity Theory- is really tough. I failed it. But I didn't break the record, since about 50% of the people usually fail it. It is quite hell. It is easy in class, but when you get out, you don't know where to start.*

*Kamati:* *You know, I failed it also. First time by 1%. But I still failed it you know. First I thought the lecturer hated me, for which reasons I didn't know. But I knew that I was not that serious with my studies and it needed special attention.*

*Guilt:* *It is the same with me. I just wanted to pass it.*

This conversation expresses a couple of points I raised earlier in the chapter and it also demonstrates that some students never got interested in the subject as they were not sufficiently motivated by the style of lecturing. The lectures were presented in a meaningless way and the students seemed to be disoriented.

## 4.9 Conclusion

### 4.9.1 Current learning system

The Computing Department of the University of Namibia faces similar problems as in other Southern African universities, with a great percentage of disadvantaged students failing or dropping out of the course. Knowing that the students' background, foreground and learning habits determine the learning success of individual students, I believe the major drawbacks of the curren learning system are that the subject presentation ignores the influence of the lecturer, the values associated with the subject and is based on assumptions about incoming students.

The gap between the practical and slowly changing indigenous lifestyle of most of the students and the highly abstract and rapidly evolving nature of Computer Science is problematic. The students need more time to familiarise themselves with concepts like abstraction and efficiency. Due to the apartheid system, disadvantaged students lacked scientific education. The learners were trained to memorise, not question, and therefore not to deduce anything on their own. Hence the students have a very weak mathematical background and lack the ability to analyse and structure problems. Furthermore, the system suppressed freedom of speech and criticism which disfavours innovative thinking. Moreover, the students' foreground does not increase the students' motivation to learn Computer Science beyond computer literacy level. It results in students with a low self-confidence and a general lack of initiative. Besides, the informal learning strategies of African students do not coincide with the implanted formal western tertiary education system.

After reading this chapter, one Namibian friend asked me:

> *"But did you not find anything positive about Namibians? I mean could you not identify any characteristics that favour the learning of Computer Science?"*

This was an excellent question reflecting the overemphasis of problems in an analysis like this one. A holistic solution has to be found in such a way as to minimise the obstacles and emphasis those elements which favour the knowledge assimilation process. I would therefore recommend further explorations which characteristics of Namibian computing students favour the computer concept acquisition process. Some possibilities may be:

- the individualistic style of learning coinciding with Information Technology;
- the habit of information-hiding, which relates to object-oriented programming;
- the multi-linguality of most students demonstrating the ability to learn languages, (including programming languages?) easily.

However, as I mentioned earlier, the learning system does not consist of the student only and an analysis of assimilation difficulties is not supposed to be seen as justification for the failure of the system. Nevertheless lecturers who blame the students for their failure rather than criticising their own presentation of the subject aggravate the situation. Many lecturers in Southern Africa operate on assumptions about students and make use of oppressive teaching methods,

treating the computing student, or more specifically the so-called 'previousl disadvantaged students' as being incapable of assimilating computing concepts. I is about time we recognise that we as lecturers, as so-called experts have failed to teach the subject in a learner oriented manner. As Hengari [Hen95], my colleague from the education department remarks,

> "The challenge is to make the school [or University] capitalise and build on skills, values and knowledge that the children bring with them from home if we are to make it a place of harmony as opposed to a place of alienation."

### 4.9.2 From 'educacao bancaria' to 'educacao problematizadora' featuring Freire

This is where Freire [Fre73] sees the need for a revolutionary education, to free the people rather then oppressing them. However many revolutions, as well as political and educational plans have failed because their leaders/authors onl planned out of their own view of the world without considering the affected people. Freire therefore develops his educational program in co-operation with the learners. Always comparing the education to revolution, the leader/teacher has the responsibility to co-ordinate the action. It has to be understood that culture as a superstructure can preserve elements from the past in the substructure during the revolutionary period. I believe, that it is unavoidable for Computing students to internalise certain technological values in order to assimilate IT concepts fully and that this can be done whilst still preserving indigenous values. Seemingly contradictory theories like science and Christianity can cohabit in many modern westernised minds.

Freire redefines the aim of learning as the perception of one's own life condition as a problem and the solution in the form of reflection and action rather than the absorption of foreign knowledge. He calls his approach " educaca problematizadora" (conscious education). The teacher does not remain the solel "knowing" part of the interaction. A mutual learning process oriented on the life condition of the student and the content of the teaching material takes place. Norman and Spohrer [NoSp96] express similarly,

> "The goal is active exploration, construction, and learning rather than the passivity of lecture attendance and textbook reading. The major theme is one of focusing education around a set of realistic intrinsically motivating problems."

Eden et Al. [EdEtAl96] emphasis that

> "Learning situations should not be geared solely to train skills at high speed, but should allow learners to develop a true passion for their subjec resulting from the solution of self-selected problems. It is this kind of passion that is responsible for producing motivated and effective lifelong learners."

### 4.9.3 Towards an intuitive and technical solution

At the University of Namibia, the course materials, like books and application programs, are mostly developed in countries with a different culture and are

therefore inadequate for the local context. The study material has to be redesigned to consider the students' background, foreground and learning habits. The material has to emphasis the training of skills which are indispensable to understanding of Computer Science, like abstraction, efficiency, analysing, and deducing, etc.. Teaching methods should be adapted to the students' preferences, for example "more touchable" and practical, learning from successful indigenous techniques. It is hoped that with the use of a computer system the motivation of the students can be increased through the different representation of the subjec and the interactive approach The student may have less interaction fears, as for example the student may ask the system the same question over and over again without being judged as uncomprehensive.

Towards computer assisted teaching

Applying Freire's approach of a revolutionary education co-ordinated by the lecturer in co-operation with the students, I believed the development of a computerised tutorial system is more suitable than developing conventiona course material for several reasons:

- The majority of the Namibian computer students thought that computer assisted teaching would help to overcome the assimilation problems and were therefore eager to participate.
- As most learning habits are implicit and therefore difficult to verbalise, the co-operative development of a computerised learning system as part of the computing studies gives the opportunity to experiment and discover the students' learning methods.
- One can explore the possibilities of representing information on a computer, like animated algorithms to facilitate the conceptualisation process of the students.
- By developing a prototype, the first step towards a tutorial system is completed.
- I am a computer scientist (and therefore by default believe in technical solutions [ironical])

I am not saying that a computerised tutorial system is the answer to the students' learning problems or that the system should replace conventional course materia or the lecturer. However through the development of a tutorial system – presented in the next chapter- the students and myself learned a lot about the students' learning strategies. This is important for developing a holistic and valid solution. Yet I believe that the inclusion of such a system in the current learning syste improves the learning success.

# 5 Attempts at a technical solution

Having studied the socio-cultural background of students and being familiar with the domain of application - the teaching context as presented in the previous chapter - I began with the development of an instructional system. Based on participatory system design principles, I implemented a prototype in co-operation with the students. The prototype was tested and evaluated for two successive years in an actual teaching context. After being confronted with an unexpected poor and unrealistic outcome of the evaluation, I started questioning the universality of system design methodologies and their cultural validity in different settings.

## 5.1 Design of an instructional system

Numerous authors attempt to introduce standards for the design of learning systems. Yet listed principles of, for example, Cates [Cat92] or Schaefermeyer [Sch90], for the design of more effective instructional systems or courseware can only be taken as guidelines. Any system design setting is unique in that methods and issues of concern differ.

### 5.1.1 Design methodology

Case-based prototyping

In the first instance, I acquainted myself with the teaching/learning context, the students, and the course content itself by using quantitative and qualitative methods as delineated in the previous chapter. Based on participatory system design principles, I began to develop an instructional system in co-operation with students. Case-based co-operative prototyping [BlEtAl96] appeared to be the most appropriate method in the given setting. It includes iterative development as a means of eliciting user input during the entire development cycle. Changes to the prototype are made in direct response to feedback that users provide during prototyping sessions. Based on prototype-evaluation cycles, a satisfying, sustainable solution ought to be achieved.

In the first prototype cycle, each final-year computer science student registered at the University of Namibia in 1996 was asked to implement an instructional prototype. The students were given a minimal set of requirements and asked to complete it with their own creative ideas. The purpose of this exercise was to capture different design ideas from students. The second-year students and myself then evaluated the three conceptually different prototypes. An example is given in Appendix B.

Based on the results, I worked out a requirement specification and drafted a system specification for the next prototype. The final design and implementati of the interface with a translation into one of the local language, the databases and the algorithms were done jointly with one of the computers science graduates (who previously implemented a prototype). The same students who evaluated the first set of prototypes then evaluated the prototype. Suggested changes were made before the system underwent its pilot study within an actual teaching context.

Evaluation

The prototype was tested in an actual teaching context in 1997 and 1998. In 1997, the second-year class was split into two groups, one attending a lecture and the

other learning via the system. The following year, the second-year students all had lectures and additional access to the prototype. A comparative evaluation was done, gauging the students' performance against the usual assignments and tests. No significant difference in scores was recorded.

Schulmeister [Sch97] elaborates on the so-called null-hypothesis of many reported experiments with instructional systems leading to non-significant results. Like many other authors, he criticises comparative evaluations as such. Schulmeister points out the lack of consideration of the Hawthorne (novelty) effect and the difficulty of appropriate test settings. Oliver [Oli99] further questions traditional methods of quantifying learning success and thus demands an expanded view of evaluation criteria. He presents four different facets of evaluation models:

- Documentation Evaluation: What actually occurred
- Formative Evaluation: How can it be improved
- Objective Evaluation: Did it accomplish its objectives
- Impact Evaluation: What impact did it have?

In the evaluation cycles that followed, the focus was on formative evaluation in an attempt to improve the prototype, combined with objective evaluation. To achieve this, user satisfaction and the usefulness of systems were rated wit questionnaires, interviews and logs.

Yet the evaluation results did not meet the expected outcome, it was lacking innovative ideas, further possible developments or changes and even identification of shortcomings of the system. Analysing the evaluation process led me to determine the correlation between the methods and cultural factors. Did I not previously state that most Namibian students are not yet accustomed to freely expressing their opinions or to criticise? Beside the past oppressive colonial system, the authoritarian hierarchical social order contributes a great deal to their submissive attitude. Young people are not expected to contradict elders or persons of higher rank in their traditional hierarchy system. So when requested to comment on the prototype, the students indicated satisfaction and expressed littl criticism. The necessity for a different evaluation methodology became apparent.

Alternative evaluation

I therefore experimented with different methods. In order to overcome the authoritarian gap, a peer-to-peer evaluation method was tried. The by then third-year students, familiar with the prototype, were now assigned to be requirement engineers responsible for evaluating the prototype with the next generation of second-year students. The third-year students were grouped according to their choice of four evaluation methods, namely questionnaires, interviews, in-situ observation or Future Workshop. Significant differences between the success o the various methods themselves as well as with the evaluation of the previous year were recorded.

Moreover, the system was presented and demonstrated at three different conferences involving an audience of Southern African Computer Lecturers [Win97a], peer computer PhD students [Win97b], and educationalists [Win99a].

### 5.1.2 Design decisions

The primary objective of the system was to facilitate the students' assimilation o abstract computer concepts by presenting the information in the conceptual categories of target groups.

Target audience, Course content and Curriculum role

The target audience consisted of second-year computer science students of the University of Namibia who studied the topic "recursion". At this point in time, the database was loaded with information on this topic by transcribing all available resources of the local library. "Recursion" was chosen because students had most assimilation difficulties with it. Although the databases are independent of the interface and the functionality of the system, it was not the intention to implement a generic instructional system. The system can be applied in a teaching context as an additional information-and-training resource. The students are able to spend as much time as they need with the system seeing that it has been installed on every computer in lab and library.

Course presentation: Examples

Mostly, students of the University of Namibia feel more secure on the detail level, and they require a large number of examples. Their approach to learning is more of what is called atomistic [Ram92], the building up of factual details step by step until an overall picture is formed. Therefore, more than 30 examples are included and categorised according to perspectives of theoretical, practical, applied or additional information in order to support individual preferences. To explain abstract computer concepts, images, concepts and activities very familiar to students' experiences should be used. For instance, the concept of a *queue* is quite familiar in modern day living, implying that the one who comes first also will be served first. A *linked list* may readily be understood in terms of threading beads to form a necklace or other equivalents, and some properties o *trees* can be illustrated via their natural biological counterpart. An *integer array* is well exemplified by means of the playing board of a well-known African game which contains rows of holes into which a certain number of stones may be put, etc.

Course presentation: Animation

The most important algorithms have been visualised and animated. The intention was to explore further and, if possible, quantify the extent to which appropriat graphic and animated interfaces assist in the learning process of students as compared to conventional textual and diagrammatic instruction as seen in most student textbooks. It is thought likely that the use of suitable graphics in the learning interface may have an appreciable effect on the quality and speed o concept acquisition. Furthermore, interest and motivation of students is increased by animated examples.

Learning theory and resulting approach: explorative versus instructional

The concept of the system is based on ideas of cognitive psychology and constructivism rather than behaviourism. Constructivists emphasise learners' intentions and cognitive strategies. Learners construct new cognitive structures based on their previous knowledge [Ree99]. This process can be facilitated b implementing alternative learning environments that learners can explore according to their intention and knowledge. Following an explorative approach, the students can improve their individual study skills. An instructional (didactic/)sequential approach I judged to be counter-productive as I felt the students should not yet be directed through material in a designer-conceptua approach and that they should explore for themselves.

System control versus Learner control

This leads to a further point of discussion, namely the choice between user control versus system control. The control can be at different levels, e.g. navigation, content, and display. Research has been conducted aimed at system control for the implementation of so-called Intelligent Tutorial Systems (ITS). They generally consist of a domain model (declarative and procedural knowledge), a student model (subset or deviation of the domain model), tutor model (educational strategies) and an interface (dialogue, coaching, learning by doing, learning while doing). One of the major problems in ITS is the student model which implies a simplistic learning strategy. Learner models are no always considered to be favourable.

> "The requirement that the instructional dialogue should be driven by an explicit model of the student's state of knowledge places extreme constraints on the freedom that the learner can enjoy" (Hammond 1989 in [Sch97]).

Yet 30 years later, the breakthrough of those systems is still outstanding. Presen implementations are characterised by insufficient research in cognitive sciences and too much technological emphasis dominating over educational goals. Clancey (1992 in [Sch97]) concludes,

> "I have spent most of the past four years reconsidering the assumptions tha directed my AI research. I have concluded that the exclusively individualistic view of cognition as something that occurs inside the individual brains is a useful, but a narrow conception of knowledge […] I have concluded, that as a computer scientist interested in applications programming, I must turn my work upside-down. I must start with the user-environment, not computer science ideas. Rather than developing systems inside a computer lab and delivering to users, I must develop within the context of use. The idea that I could demonstrate a medical instructional program to teachers in computer science office now seems ludicrous to me."

Compromising between system and learner control, I implemented differen levels of system answers which depend on the assumed learner's familiarity with the subject. Yet the learner can change the level manually at any time in order to adjust the system answers to his requirements.

Interface language

Based on the observation that students would explain the subject to each other in their mother tongue - and the mentioned[34] difficulties with the terminology o commercial English software - motivated me to implement the system in English and partially in Oshiwambo, which is the mother tongue of the majority of Namibian computing students. It might be controversial with regard to the curren language policy of the country, but I wanted to verify if mother-tongue usage facilitated the knowledge acquisition process.

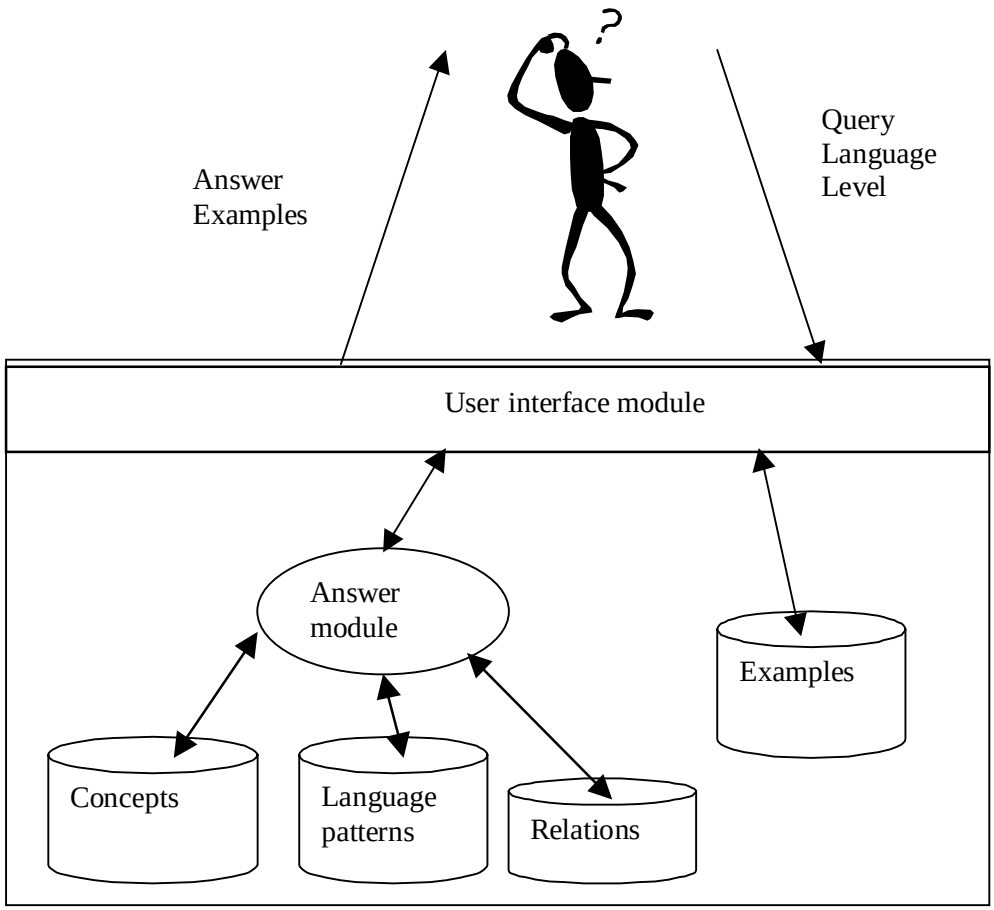
The designed prototype, called UDITS (User-Dependent Interactive Tutoria System) can be described as an instructional system supporting an explorative learning approach, allowing flexible user-level-dependent access to information. Detailed design decisions will be explained together with the system features.

[34] In the quantitative research conducted in 1995

## 5.2 UDITS version 1.0

The system has been implemented in Visual C++. It consists of a user interface module, an answer module as well as four distinct databases containing language patterns and the subject information grouped in objects of three distinct classes, namely concepts, relations and examples. The students have different options of retrieving information: after choosing a topic, they can select a pre-formulated question (like What is 'recursion'?, How does 'recursion' work? etc.), enquire about the relationship between two concepts, or look at diverse examples. Depending on the student's level and language, the system generates an answer: The answer module retrieves the relevant information from the database, depending on the user level. Then the answer is formulated by combining the retrieved data with the patterns from the language module. The constructed answer will then be displayed to the user. Examples can be retrieved independently according to distinguished criteria. Some of the examples are fro students' everyday lives or graphical, animated algorithms.

Figure 5-1 System architecture



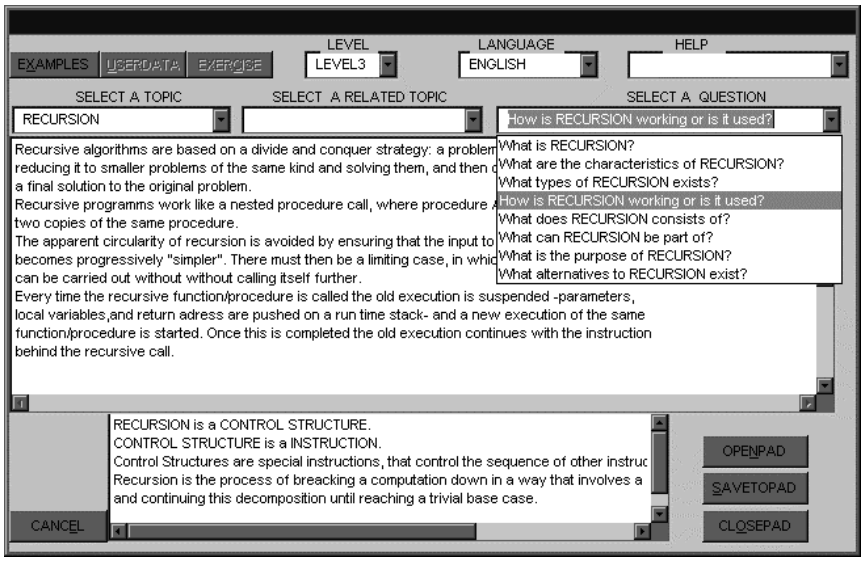

In the following subchapters, the system's interface and functionality is described according to the three different possibilities according to which the user can retrieve information. The user's choice of language and level has been determined in a previous dialogue window, yet it can be changed at any time.

### 5.2.1 Pre-formulated question

First the user selects a topic of choice [Select a topic] from a given list.
Then the user selects a question of choice [Select a question] out of a list of pre-formulated questions, like 'What is...?', 'What are the characteristics of…?'.
For example, if the user chose 'RECURSION' as topic, the list of questions is accordingly:

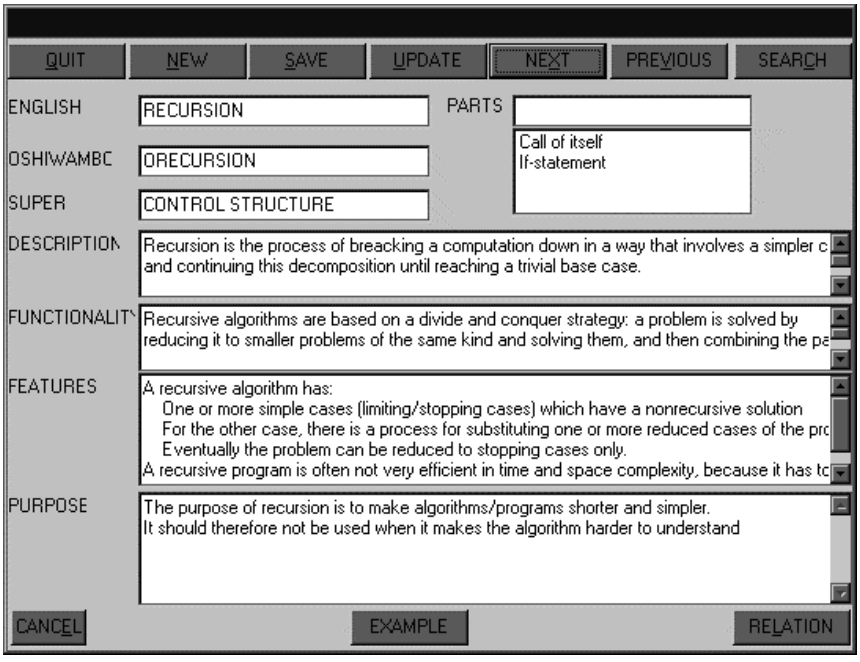
'What is RECURSION?'
'What are the characteristics of RECURSION?'…
Etc

Figure 5-2 Main user interface



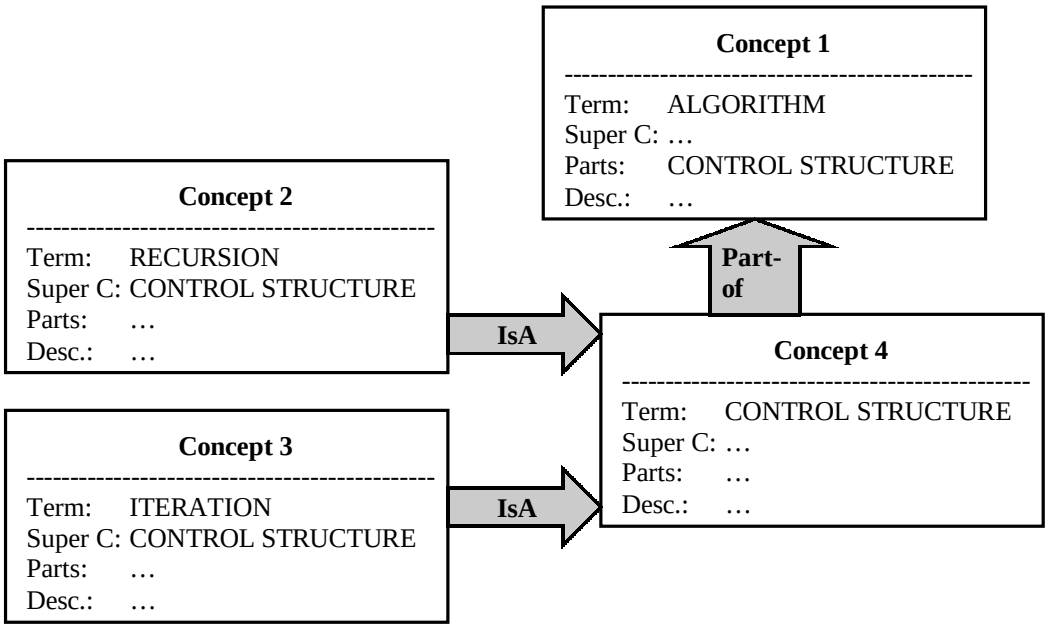

In order to understand the way the answer is generated, the underlying data structure has to be explicated. The subject information retrievable through the pre-formulated questions is categorised in objects of the class concept. Each object contains data, e.g. English term Oshiwambo term, super concept, part concept, description, functionality, features and purpose. The data are entered b the teacher via the following form:

Figure 5-3 Concept entry form



The objects within the database are interrelated through two distinct relationships. A concept and its super concept are related through a so-called 'isA' relationship. A concept and its parts are related through a so-called ' part_of' relationship. The following graph represents a selection of the relational network.

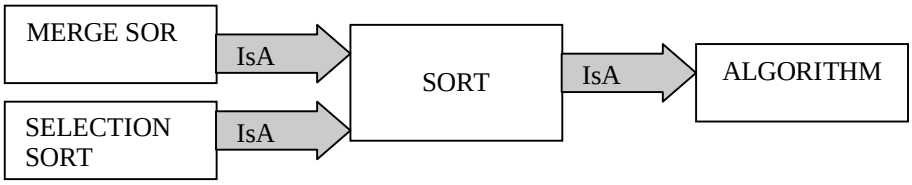
Figure 5-4 Relational network




With this kind of structure, the answer module can derive information that has not explicitly been stored, e.g. 'ITERATION can be part of an ALGORITHM'. Further attributes of related concepts can be added to the answer - e.g. the description of the CONTROL STRUCTURE can be added to the answer for a RECURSION question - if the student choose a high level (very extended) answer.

Once question (type of question and topic/concept), level and language details are sent to the answer module, the concept is looked up in the database. For each question, three different algorithms - corresponding with the level - are implemented to construct the answer. Depending on the question, specific data are retrieved. Depending on the level, more or less data of the surrounding relational concepts are retrieved.
For example, with the question 'What is a SORT?' the database has the following information:

Figure 5-6 Database extract sample




The answer is constructed in the following way:
First, SORT is searched for in the concept database, and the respective term of the super concept is retrieved. The language pattern 'is an' is retrieved from the language pattern database and the following sentence is displayed:

'SORT is an ALGORITHM.'

If the level is 2 or 3, the equivalent sentence is constructed for the super concept (if the super concept is different from Omega), 'ALGORITHM is a …"

Second, the description attribute of SORT is displayed, 'Sorting is putting data in order….'

If the level is 3, SORT will be looked up in the concept database, and all concepts with an 'isA' relation to SORT are retrieved. Complemented with the language patterns, the following sentence is constructed:

'Examples of SORT are MERGE SORT, and SELECTION SORT.'

Correspondingly, if the language is chosen to be Oshiwambo, the answer i generated in Oshiwambo. And, as displayed in the following screen print, the answer is short as the level is low. A further feature of the system is that the student can take notes on a notepad that is part of the interface (at the bottom), which can be closed if not required.

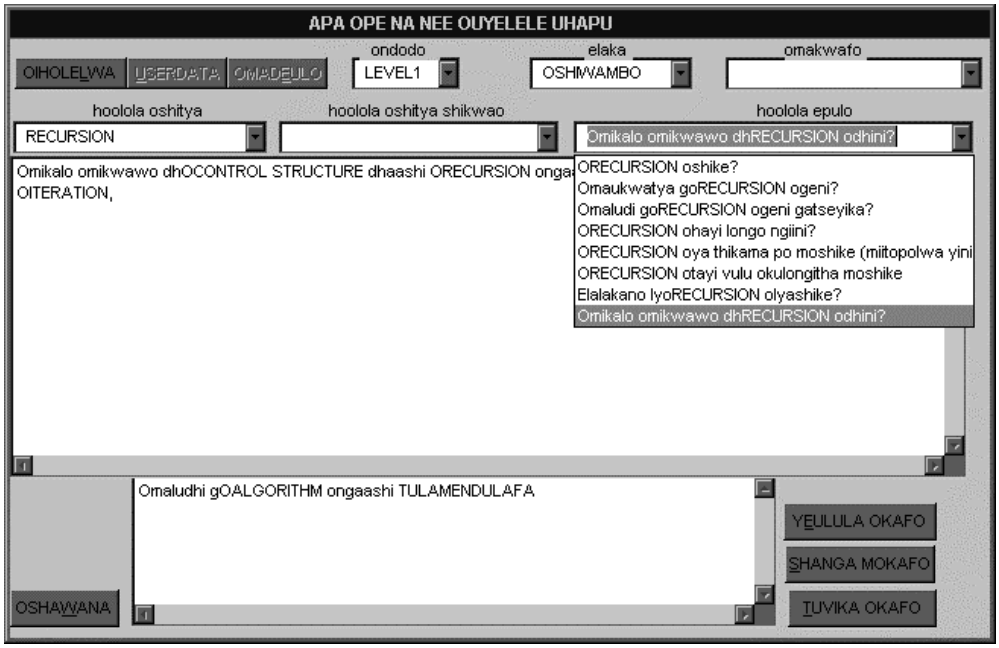


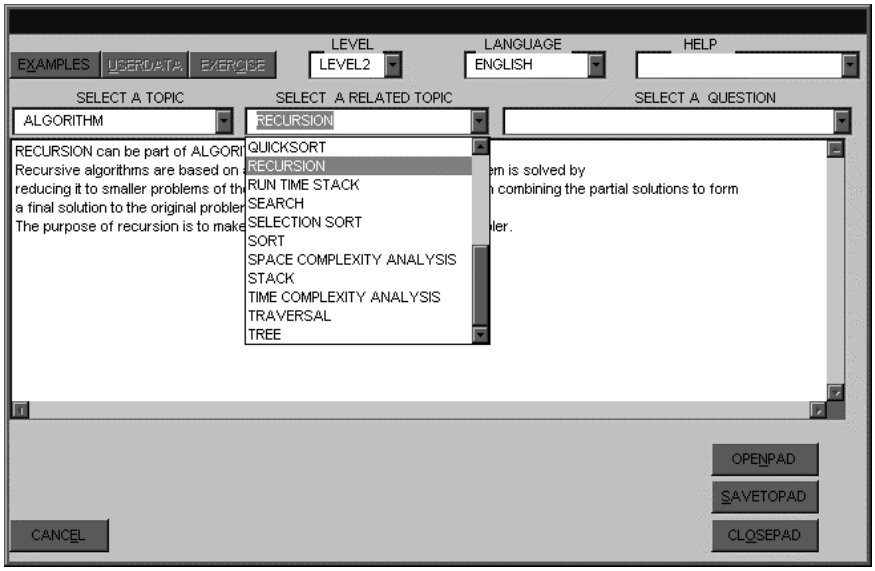

Figure 5-7 Main user interface (Oshiwambo)

The set of questions was determined with the help of a student who was given the task to read a couple of different types of books on the same topic and write down the questions coming to his mind. It was further complemented by questions the students would usually ask during the course. The most frequent questions were chosen to be implemented in order to structure the topic according to the students' conceptual understanding of a subject. The answer algorithms were worked out with a graduate involved in the interface implementation. The various levels, meaning the varying detail of answers, serve individual requirements.

### 5.2.2 Relationship between two terms

The user chooses one topic [SELECT A TOPIC] and a second topic [SELECT A RELATED TOPIC] to display the relationship to the topic.

Figure 5-8
Term
relation
interface




The answer to relation between TERM A and TERM B is constructed in the following manner:
First, it is verified whether a direct "part_of" relation in either direction exists, e.g.

"CONTROL STRUCTURE can be part of ALGORITHM."

Second, it will be verified whether a direct or indirect (following the isA branches) "isA" relation exist, e.g.

"MERGE SORT is an ALGORITHM."

Third, it will be verified whether a "part_of" relation exists within an " isA" relation hierarchy. For example, it can be deduced tha

"RECURSION can be part of ALGORITHM"

because RECURSION is a CONTROL STRUCTURE and CONTROL STRUCTURE is part of ALGORITHM.

Fourth, it will be verified whether TERM A (or TERM B) appears in the description texts of TERM B (or TERM A) - combined with it within the scope o one sentence[35].

And last but not least, for some topics the teacher may have entered an explicit relationship (in form of a text) into the relation database that, if present, is displayed.

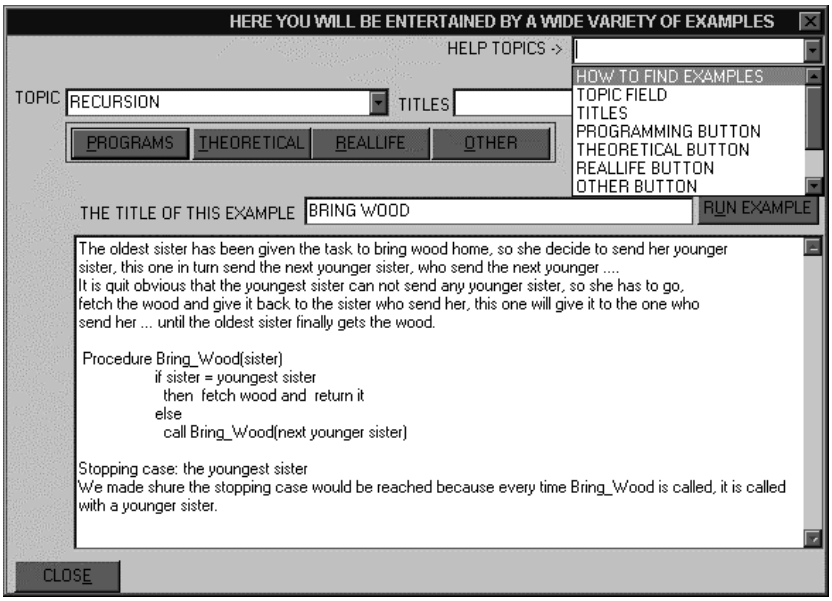
The intention of this feature was to explicate inferences, as students usually struggle to relate the diverse concepts to a complete view of the topic.

[35]This algorithm still has to be improved as eventual sentences are retrieved which need th pre/proceding sentence to be meaningfull.

### 5.2.3 Examples

After clicking on the button [EXAMPLE], a separate window is opened in which the user can look at diverse examples. The user can select by title or by type of the example, e.g. programming, theory, real life or other.

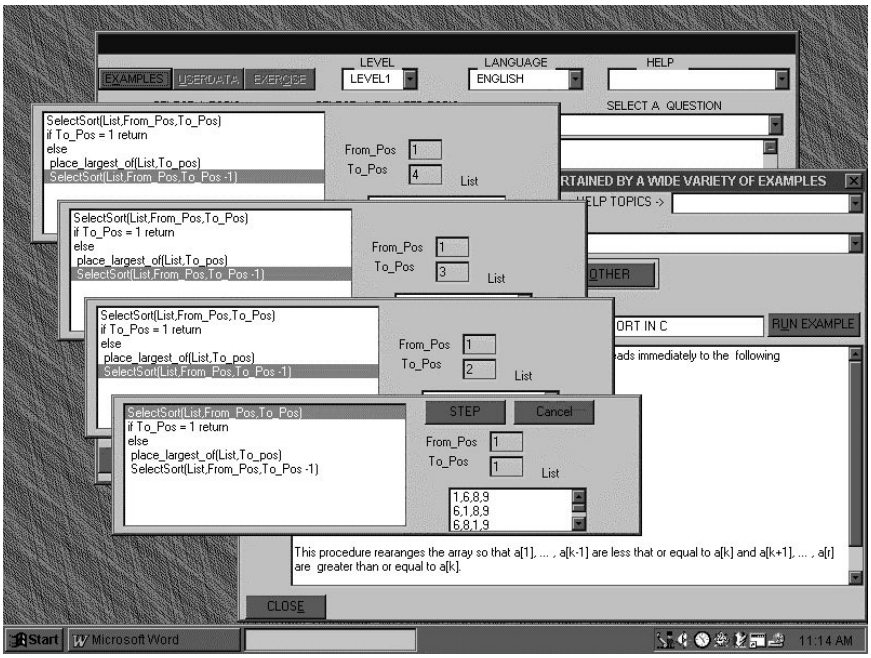
Figure 5-9 Example interface




If the user selects “PROGRAMS”, a programme - usually in C or Pascal - i displayed, “THEORETICAL” displays the algorithm or the theory of the topic, “REAL LIFE” is an application of the topic in a real life context, and “OTHER” gives supplementary information like historical background.

Once the user selected an example, an animation can be run for certain algorithms. As in the following Selection Sort, the recursive calls are displayed at the pace of the student clicking step buttons.

Figure 5-10 Selection sort interface



Various techniques have been explored to display animated algorithms. The "Towers of Hanoi" algorithm, for example, is demonstrated together with its graphical presentation.

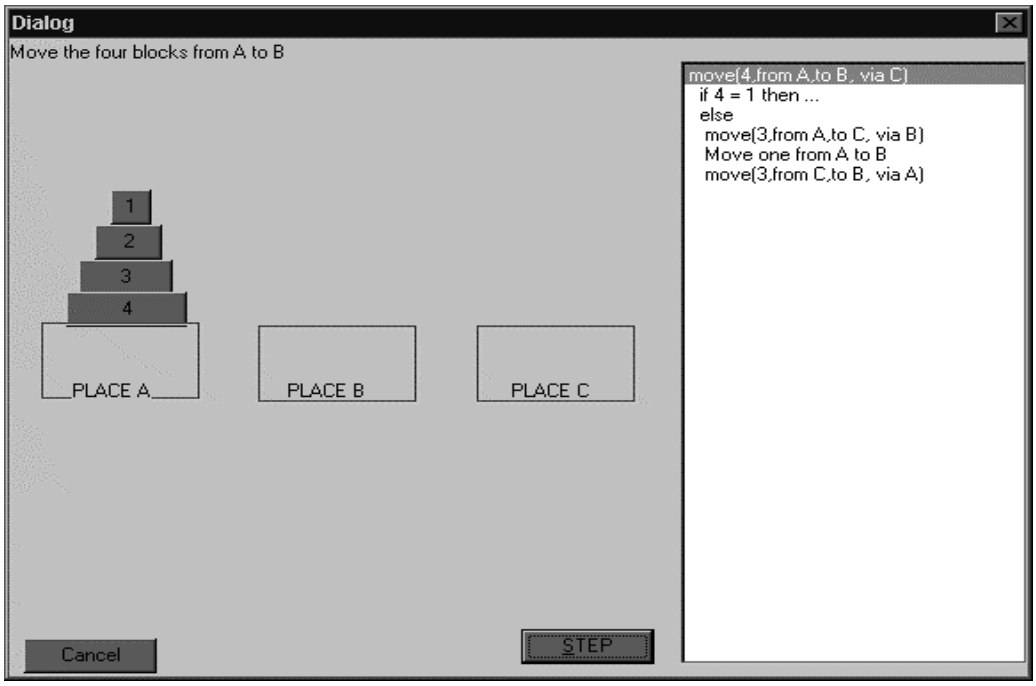



Figure 5-11 Towers of Hanoi interface

The Merge Sort demonstrates in which way the elements are compared, swapped and merged.

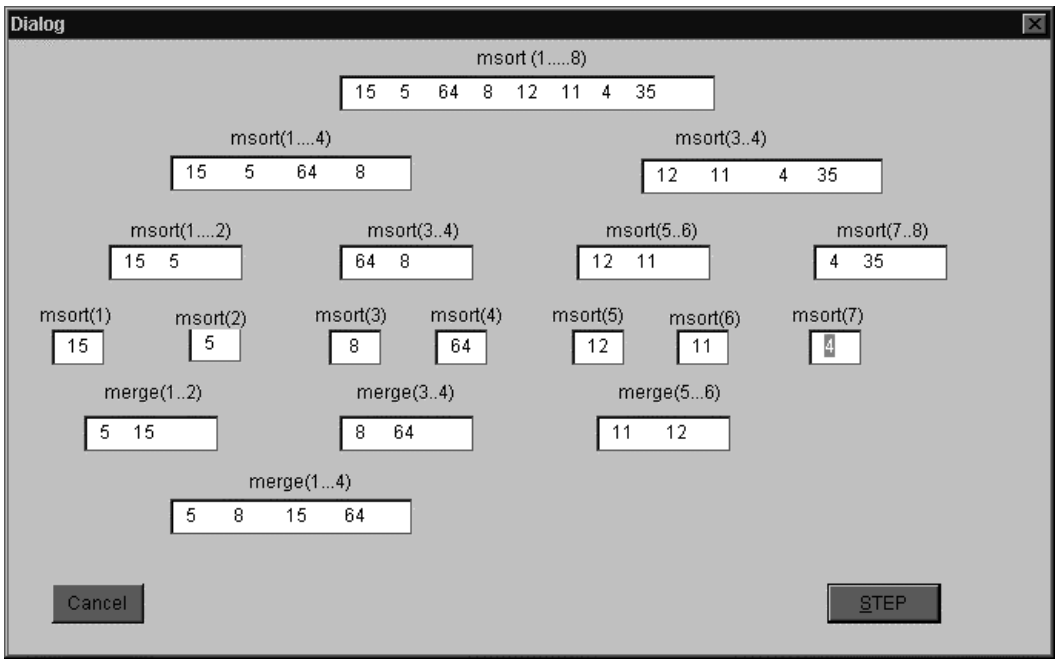



Figure 5-12 Merge Sort interface

Many other algorithms have been implemented in various ways.

## 5.3 Evaluation of UDITS

In order to evaluate the prototype, two different types of evaluation were conducted. A comparative evaluation was done to test the performance of the students, and a formative evaluation tests user satisfaction and the system's usability with the aim to identify changes, further requirements and shortcomings of the current prototype.

### 5.3.1 First evaluation cycle

Performance

In order to evaluate the prototype, a group of students was given access to the system while their classmates were following a lecture on the same topic. The groups were equally distributed, considering course repeaters, sex and ethnical affiliation. Afterwards, exercises and a test were given to the students for verifification of their performance.

In order to judge whether the students understood the concepts, various criteri were set up by various authors. Sanders and Mokuku in [SaEtAl97] summarise i as follows: "

- know and be able to recognise the name and definition of a concept
- be able to define the concept in their own words
- be able to recognise instances (not previously encountered) of the concep
- be able to distinguish between and classify instances and non-instances of the concept (not previously encountered)
- be able to apply the concept to new situations".

Exercises and tests

Accordingly, the exercises in test and assignment were categorised (see Appendix C.1:

- Pure repetition or recal
- Definition of concept in own words
- Application (differentiation of instances from non-instances, tracing of recursive functions)
- Construction of recursive functions

The exercises were set up in such a way that 80% of the information would be available on the system, but not accessible or not expressed in the same way as the question in the exercise. The results were evaluated per category, to differentiate in which categories the system could be of more assistance.

Considering the performance, the students attending the lecture graded better, on average with a factor of 1,2 only. In general, the students who had access to the system could better remember definitions and explanation. The system provided animated visualisation of tracing programmes and, as expected, the students who used the system could better trace and determine what programmes are doing than the ones who attended the lecture. On the other hand, the students who attended the lecture were more competent in constructing recursive programmes.

The following year, all second-year students had a lecture on recursion and additional access to the prototype. The same assignments and tests were given as in the previous year to analyse performance. Yet the students with lecture and

system scored 20% better than those of the previous year in the assignment and also the test.

Comparing the performance of "good" students showed that those student performed well once more, no matter whether they attended a lecture or studied with the system. The weak students unfortunately stayed weak. Much more research should be done on the reasons of failures of those students and how to support them. Yet, as has since been analysed by numerous authors, comparative studies often record no significant differences in results, and therefore no conclusion could be drawn.

Satisfaction

As part of the formative evaluation, the grade of satisfaction was attempted to be determined through informal interviews conducted with the students and a questionnaire handed to them.

In general, the students were satisfied[36] with the way the topic was presented and they preferred it to a text presentation in books. No student appeared to have difficulties in using the system. Nobody used the help facility, but most of the students were asking for more assistance. Only a few changes were suggested b the students, e.g. shorter explanations, bigger font, more and clearer examples, give overview of possibilities, show how to start, include multimedia (pictures and sound), explain "relation", exercises, working programs, type the word and get information, index, references and a menu. The following table displays the quantified answers of the students' questionnaire. The symbols stand for:

Table 5-1 User satisfaction

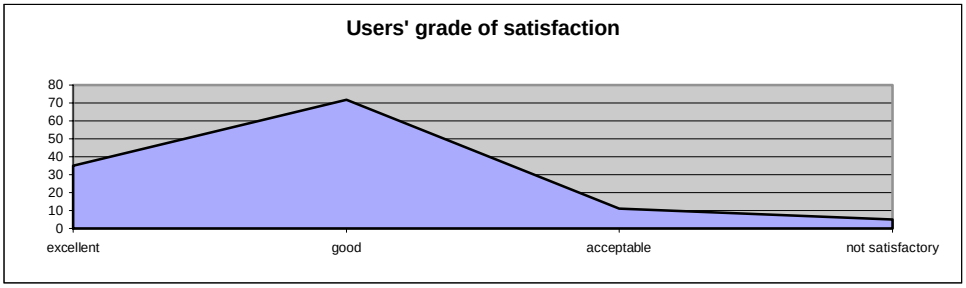
A: very easy, good, yes
B: manageable, good, more or less
C: difficult, acceptable, and not sure
D: impossible, not satisfactory, no

| A | B | C | D | Question |
|---|---|---|---|---|
| 1 | 5 | | | How easy was it to start working with the system? |
| | 7 | | | The user interface itself of the system is |
| 3 | 4 | | | The use of the user interface of the system is |
| | 6 | | | The features of the system are |
| 2 | 5 | | | The use of the system is |
| 1 | 6 | | | The organisation of the user interface is |
| 4 | 2 | 1 | | The choice of the interface language (English) is |
| | 2 | 1 | 1 | The choice of the interface language (Oshiwambo) is |
| 2 | 5 | | | How easy was it to find the information you were looking fo |
| 1 | 4 | 2 | | The structuring of information retrieval in Relations, Questions and Examples |
| 2 | 3 | 1 | | Is the information retrieval the way you would like to approach a new topic? |
| 2 | 4 | 1 | | Do you prefer this representation to a compact text representation? |
| 4 | | | 3 | Did you enjoy being able to find your own way through the subject |
| 2 | 5 | | | Did the pre-formulated questions correspond with what you wanted to ask? |
| 3 | 3 | 1 | | Were the questions answered to your satisfaction? |
| 2 | 1 | 2 | 1 | How is the presentation of the examples? |
| 2 | 3 | 1 | | How is the retrieval of the examples? |
| 1 | 4 | | | How did you like the option of getting a relation between two words? |
| 3 | 3 | 1 | | The given information/help is |

[36] General comments were like, "well designed", "straightforward to use" and "We want lectures and the system combined".

Figure 5-13 User satisfaction

Summarising the answers illustrates that the students were mostly satisfied.




Usabilit

The usability of the system was evaluated through the analysis of records tracing students' interactions with the system. It demonstrated a clear tendency of favouring examples, as most students spend 2/3 of the session looking through examples. It further showed that students do not take advantage of a selective, intentional information retrieval but follow a sequential process, asking all questions in sequence. Moreover students liked to come back to the same poin regularly, I assume to reinforce their comprehension. Another repetition clearly demonstrated the misunderstanding of the purpose of enquiring the relation between two topics. Students asked for a relation between two similar terms, e.g. "Recursion-Recursion" getting the simple answer of "Recursion is a Recursion", yet students would repeat the same for other concepts. The traces also showed that all Oshiwambo students were interested in the Oshiwambo interface, yet as i has not been completely implemented the students eventually switched to the English interface during sessions.

### 5.3.2 Reconsideration of design decisions

Analysing the evaluations, a few design decisions have to be reviewed.

Instructional versus explorative

Although explorative learning has received a lot of resonance in modern teaching, it has to be recognised that it is not universally successful. Only after implementation of the prototype came I across a study conducted b Heller (1990 in [Sch97 describing the limitations of the success of explorative learning. Heller discovers that learners from higher socio-economic background and from towns profit from explorative learning approaches as well as self-confident and competent learners as opposed to students scared to fail who rather profit fro instructional learning. Looking at the Namibian students' attitude (as described earlier), then obviously an instructional approach should be chosen. Hsu et al. (1993 in [Sch97]) found in their survey that the experimental subjects explored the learning environment in a methodical manner rather than creatively. These results are similar to my findings according to which students in Namibia are constantly looking for guidance, expecting instructions, and they were given an explorative prototype still sequentially processed. The next prototype should definitely have an instructional mode with a step-by-step guidance into exploration.

Animations

Although students were asking for more graphics and animations, it did not considerably facilitate the abstraction process. Instead, students memorise animations or examples without conceptualising. Animations with exemplary function seem problematic and still unexplored within the learning process. Algorithmic tracing skills can certainly be taught with the help of animated and

graphical representation. We could consider a code-view facility to visually illustrate the running of a programme: perhaps an animated runner following the execution path of code, or messages being exchanged between objects in an object-oriented program. Yet possibilities to improve constructive skills still need to be researched.

Language

The students showed a lot of interest in the development of different languages. Unfortunately, time did not allow a full implementation of Oshiwambo, yet i should certainly be included in the next prototype.

### 5.3.3 Revue on the design methods

The result of the evaluation did not correspond with the expected feedback and lacked major suggestions for further development. The reason for this is indicated by analysing the co-relation between the methods and cultural factors.

Participatory design

Namibian students have hardly any motivation to participate in extra-curricular activities. The students required for evaluation are exactly those who will not profit from the improvements, as by that time they would be in the next course. One student explained why he gave so little input

> *"Then we were only interested in passing and so we were sort of unconcerned about any change that would occur after us."*

Prototype

Having taken prototyping as universal method to get feedback and constructive criticism from users, I failed to consider the Namibian culture of non-criticism Considering it to be impolite, the students would not criticise my work in front of me. Furthermore, the students did not belief the prototype to be modifiable or even to be discarded yet as a final product. Many Namibians have a tendency to accept anything given or presented to them (as long as it appears to be an improvement to a current situation). In all likelihood, most students could not think of any means of improving the system because they are not used to offering suggestions. A further constraint on the students' freedom of criticism is the culturally established authoritarian hierarchy. As a lecturer – and to them therefore a superior - conducting the interviews, I would therefore not receive any serious complaints.

Questionnaires

The evaluation of questionnaire data demonstrated its unreliability. For example, comparing the indicated time spent on the system with the actual time[37] shows large discrepancies. None of the students indicated the correct time; mostly, more was indicated. More students were recorded to have attended lectures or to work with the system than indicated on questionnaires. Students feel pressurised into filling in the questionnaire and thus do not bother about the truthfulness or correctness of the answers. One student explained:

> *"In questionnaires, people were only given options, and they have to select one among the given, even though they are not aware of them. Sometimes they might not have understood the questions provided to them, but even though they don't understand, they have to select one for the sake of completing the questionnaire, so that it can be fully completed."*

[37] verified with the trace files

Questionnaires are highly designer-dependent because the evaluation is structured in concepts of the designer, and participants usually do not give more input than the answers to the questions.

In the development of instructional systems, the value of student feedback is generally questionable since the learning process itself is tacit. Especiall Namibian students did not have a chance to experiment with different learning approaches and to reflect upon their own learning process.

## 5.4 Method experiments

Looking at the students' cultural backgrounds and at the method suggests a verification of their compatibility. Methods have to be identified which trigger criticism, motivate participation and guarantee honesty and commitment of the students. I therefore experimented by using varying methods.

### 5.4.1 Co-operative Experimental System Development

Grønbæk, Kyng and Mogensen [GrEtAl97] introduced Co-operative Experimental System Development (CESD) to overcome a number of limitations in existing participatory design approaches. CESD is characterised by its focus on active user involvement throughout the entire development process using prototype experiments closely coupled to work situations. CESD differs from participatory design as it applies both co-operative and experimental as well as intervening techniques in those parts of the projects where the main concerns are technical design and implementation. Grønbæk et al. point out that the technical implementation requires an understanding of design vision in addition to programming competency. They suggest an overlap between members of the analysis and design groups as well as the implementation group for the success o any development project, since it is impossible to convey all the information needed for implementation through the artefacts and descriptions ( Dreyfus 1986, Naur 1985). The analyst as well as the user investigates curren practices which are approached with very diverse competencies, perspectives and backgrounds, and different groups lead to different results. Co-operative analysis suggests analysing constraints and potentials for change in current practices by experimenting with alternatives, using dilemma games [38] and prototypes. Users and software experts with different competencies actively contribute to the development process using workshop techniques similar to those of participator design.

### 5.4.2 Experimental evaluation

In order to overcome the authoritarian gap, a peer-to-peer evaluation was worked out. Through involving the students in the evaluation process itself, better results were to be expected, and the motivation of the students to be evaluated was assumed to increase. Third-year students familiar with the prototype were assigned to be requirement engineers and, as such, responsible for further design. They had to evaluate the prototype by establishing the requirements for system changes from the users (second-year students). Based on the outcome and their own ideas, new visions had to be developed, either in form of improvements and

[38] Participants act out scenarios that expose dilemmas.

changes of the current prototype, or a new implementation. The third-year students were grouped according to their selection of analysis methods, which consisted of either questionnaires, interviews, in-situ observation or Future Workshop. The intention of the experimental evaluation was to test the following:

- To compare the outcome of using different methods;
- To compare the outcome of using different data collectors: the students themselves instead of me;
- To compare the input given from the same students, once from the perspective of a user, and once from the perspective of a system developer.

Comparing methods

The questionnaire group designed a questionnaire and distributed it to all second-year students. Two interview groups interviewed four students with differing approaches. The following questions were used as a guideline for the first group:

1. Do you understand how the system works?
2. Did the system help you to solve your exercise?
3. Is there sufficient information on the system to enable you to solve your exercise?
4. Is it necessary to use two languages on the system, i.e. English & Oshiwambo?
5. Do you think it is useful to have 'Open pad' on the system?
6. Were you satisfied with the answers provided to you by the system
7. What ambiguities/vagueness can you identify on the system?
8. What changes should be made to the system?

According to the interview protocol, students concentrated on working out solutions with the interviewees.

The second group chose to use a more provocative approach with the following questions:

1. What would you pay for this system
2. If nothing, why?
3. Would you use it as an aid to study for your tests? Explain.
4. General comments.
5. Over all what would you sum it up to
6. How did you find the UDITS system
7. What changes would you make?

The in-situ observation group observed four users successively while using the system in order to complete their homework and interviewed them afterwards. One student was recording with a video camera, another was taking notes, and a third was the contact person. Every user interaction was traced in a log during the session.

The Future Workshop group invited a few second-year students. The facilitators opened the workshop with a fifteen-minute demonstration of the system, highlighting special features like the animated examples, the different levels, and language choices. A phase of encountered complaints and difficulties followed, then a phase of constructive criticism succeeded by a wish-list phase. All in all, this took three hours.

The outcome of the peer-to-peer evaluation was drastically different from the evaluation of the previous year as quantified in the following tables:

P: Previous evaluation, S-Q: Students Questionnaire, Ob: Observation, I: Interview, W: Workshop, S-D: Student Developers

Table 5-2 Interaction problems

| Interaction problems discovered | P | S-Q | Ob | I | W | S-D |
|---|---|---|---|---|---|---|
| Concept of related topic unclear | x | | x | | x | |
| Not enough questions | | x | | | x | |
| Input not enough user defined | | | | | x | |
| Help not helpful | | | | | x | |
| Navigation is poor | | | | x | x | |
| Overuse of combo-boxes | | | | | x | |
| Difficulties in finding the needed information | | x | | | | |
| Students rash to fast to the animations/graphics without knowing the algorithm | | | x | | | |
| System still crash | | | x | | | |
| Bottom buttons not on the screen | | | | | | x |
| Problems in understanding meaning of caption | | | | x | | |

Table 5-3 Content problems

| Content problems | P | S-Q | Ob | I | W | |
|---|---|---|---|---|---|---|
| Explanations too long | x | | | | | |
| Examples are unclear | x | | | x | | |
| Not enough information | | x | x | x | x | |
| Vocabulary used not common/answers vague | | | x | | x | |
| Explanations with same words not recursive enough: *Quicksort is a sort* | | | | | x | |
| Errors | | | x | | | |

Table 5-4 Design suggestions

| Suggestions on Interaction Design | P | S-Q | Ob | I | W | S-D |
|---|---|---|---|---|---|---|
| Give overview of possibilities | x | | | | | |
| Show how to start/provide tutorial/guidance | x | | x | x | x | x |
| Include exercises | x | | | | | |
| Type word and get info | x | | | | x | x |
| Index | x | | | | | |
| References | x | | | | | |
| Menu | x | | | x | | |
| Touch screen | x | | | | | |
| Include commercial view and research vie | | | | | x | |
| Printing, saving and formatting facilities required | | | | | | |
| Ask own questions | | | | x | x | |
| Undo facility (In running examples) | | | | | x | |
| More languages but fully implemented (interface + answers) | | | | x | x | |
| Navigation facilities with back and forward butto | | | | x | x | x |
| Include compiler to test own programs | | | | | x | |
| Integrate system with library system or link with Internet sides about th same topic. | | | | | x | |
| Icons and maximising options | | | | x | | x |
| Interactive examples | | | | x | | x |
| List of topic and choice for definition, example | | | | x | | |
| Button "more information" | | | x | | | |
| Filter out questions with no examples | | | x | | | |
| Mapping device that show the user where he is if he wants to go back | | | x | | | |
| No cascading window | | | | x | | x |
| Help should be in a menu | | | | x | | |
| Table of contents | | | | x | | |
| Search engine | | | | x | | |

Table 5-5 Design suggestions

| Suggestions for Interface Design | P | S-Q | Ob | I | W | S-D |
|---|---|---|---|---|---|---|
| Bigger font | x | | | | | |
| Use of multimedia: pictures and sound | x | | | x | x | |
| Common captions should be used | | | | x | x | |
| Instructions must be better visible | | | | x | | |
| Communication boxes should be smaller | | | | | | x |
| Common MS interface, what they are used to | | | | x | | |
| Separate user screens for questions, answers and examples | | | | | | x |
| More colours | | | | x | | |

Table 5-6 Content suggestions

| Suggestions on Content | P | S-Q | Ob | I | W | S-D |
|---|---|---|---|---|---|---|
| More examples | x | | | | | |
| Working programs in examples | x | | | | | |
| More different programming language examples | x | | | x | | |
| Information about programming, compiling running programs | | | | | x | |

Table 5-7 Fantasy Requirements

| **Fantasy requirements** | **P** | **S-Q** | **Ob** | **I** | **W** | **S-D** |
|---|---|---|---|---|---|---|
| Integrate system with meal booking system | | | | | x | |
| System talks back giving the answers | | | | | x | |
| E-mail facility for communication about the topic | | | | | x | |

Table 5-8 Remarks

| **Any criticising remarks** | **P** | **S-Q** | **Ob** | **I** | **W** | **S-D** |
|---|---|---|---|---|---|---|
| Its not PhD quality | | | | | x | |
| System was not ready for testing | | | | | x | |
| Design is unattractive | | | | x | x | |
| Graphics are old-fashioned | | | | | x | |
| Interface not comparable with commercial packages | | | | | x | |
| Too much security with password | | | | x | x | |
| Doubt the purpose of the student number | | | | | x | |
| Too many formalities before starting | | | | | x | |
| Too much ambiguities | | | | | x | |

Comparing methods, it demonstrated that the Future Workshop was the best forum for criticism and problems of students. It showed that the students felt free to say what they desired to say. The Future Workshop method therefore generated many more creative requirements, like "integrate system with meal-booking system".

With the observation method, hidden problems could be discovered, e.g. "students rush too fast to the animations/graphics without knowing the algorithms".

Looking at users' suggestions for alterations in the Interaction and Interface Design, the interview method was the most constructive method in developing directl implementable changes. Yet criticism could also be invoked through provocative questions. The interviewer reported

> *"If money is involved, they are bound to be more critical and look deeper into requirements."*

Then this is what he gets:

> *"The interface is boring, the colours are boring. The system is not user-friendly because it mocks the user with long remarks, e.g. no example exists, maybe tomorrow" and "If it was a web page I would leave as fast as I could".*

The students underestimated the complexity of questionnaire design, and consequently the results were poor.

To obtain the most valid results, methods should be combined. In this case, observation and workshops can be used as initial methods to discover problem areas. From there, an interview guideline can be written. In single or group interviews, the users can work out solutions to their best knowledge. At a later stage, the software expert summarises the requirements, presents the summary to the user again and again - eventually in form of a questionnaire to quantify the data - for confirmation. From there, a new prototype can be developed and the same procedure of evaluation can take place.

Comparing views

Of ten software-engineering students, five students were evaluating the syste the previous year - from the perspective of a user. As the general outcome of the evaluation done by the students was better, I expected individuals to have more ideas when they were in the role of developers than when they were in the role of users. Yet looking at the analysis proved me wrong, those individuals did not make more suggestions.

Comparing collectors

The fact, that the second-years students were approached by their own colleagues - and not by a lecturer, who at the end of the day still has the power to punish them for being too critical (that is what they thought), changed their attitude towards answering drastically.

Furthermore, especially the interview method was highly interviewee-dependent as could be seen comparing the results of the two groups. One group was trying t find the shortcomings of the system and work out practical solutions in the interview, whereas the other group was already biased against the system which influenced interviewees to voice ambiguous criticism.

Students proved to be valuable collectors of data. A similar experiment was repeated the following year: this particular class consisted of a large number o students who were previously trained in communication techniques like interviewing and workshops within the social science department. This is where a huge difference in the quality of the results appeared. It confirmed that the students conducting the survey in the previous year were not sufficiently trained in communication techniques. In 2000, a psychological module was introduced in the software-engineering course, comprising an intercultural communication workshop and interview and workshop training modules especially designed for system analysts.

### 5.4.3 Lessons learned

Although following principles of participatory or co-operative design, chosen methods did not lead to the expected collective design process. Methods well known for effective user feedback, like prototyping, did not seem to trigger constructive criticism. However, the results seem so obvious when looking at the user study conducted previously. Namibian students are not used to express themselves freely, nor to criticise or be innovative. So how could they possibly have given feedback to a prototype that seemed complete to them? In search for

valid methods, I experimented with different methods. This I should have done from the start. The methods were applied in such a manner as to eliminate discovered problems. This is where I realised that for a selection of design methods, one has to consider the characteristics of the users. The success of design methods is in direct relation to the users' attitudes. Usually, a user-study precedes the design specification, yet the results are only considered for the specification of the software product, not for the software development process. This is where I see a major deficit of current system design methodologies. In order to obtain valid data, valid methods of information exchange - depending on the cultural setting - have to be identified.

Many students of the Computing Department at the University of Namibia experience difficulties in assimilating abstract computing concepts. Thus, a supporting instructional prototype was developed, in co-operation with the students. It has been tested and evaluated in an actual teaching context. Valuable experience was accumulated and previously underestimated problem areas were identified. Additional research on animation and inter-activity is planned, although the issue of including graphics and animation with an explicit exemplary function is problematic. The students tend to memorise the animated example rather than the concepts of algorithms. Certain design decisions were found not to be desirable and need to be changed. For instance, the students disliked the implementation of flexible informational retrieval that takes into account their different tastes and levels. They are rather looking for step-by-step-guided navigation through information space. Moreover, students' individuality as well as their cultural background have to be considered within the system design process itself. Accordingly, evaluation and participation-based design methods have to be revised.

# 6 Understanding the cultural variable in system design

System Design can no longer be seen as a single phase within software development processes, but as a pervasive activity in software development. System design involves the establishment and validation of requirements to be co-operatively constructed by stakeholders concerned. Furthermore, system design can only be meaningful if the embedding environment is understood. Some models acknowledge the importance of the environment of users by including an analysis - and eventually a modelling process - of the current users' reality. However, post-modern and post-structural theories recognise that accounts of reality can never be observer-independent, and therefore software cannot be based on models that represent reality precisely. An approximation of reality may be obtained through merging the various viewpoints of stakeholders involved, presented in so-called viewpoint-oriented system-engineering methods. However, in multicultural system design settings[39], the formation of viewpoints as a cross-cultural judgement faces inherent difficulties leading to misperceptions which affect design decisions. Diverse disciplines plead for a dialogical approach to resolve or rather minimise those misperceptions within a co-operative task. However, a dialogue requires autonomous participants able to communicate their perspectives. Yet cross-cultural communication is predestined for misunderstandings due to distinct cultural determinants. Differences in the organisation of discourses and expression of intention have to be considered in the selection of means of communication. Although the importance of communication in system design has generally been recognised and multiple methods have been devised to facilitate communication user and system engineer, their validity in a multicultural context has not sufficiently been researched. It is then pertaining to system engineers' competency to determine stakeholders' intention and communication competency and to accordingly develop and apply culturally valid communication techniques to overcome communication difficulties.

## 6.1 System Design as a co-operative process

Within the field of computer science, the terms of software development, system design and requirement engineering are not explicitly defined. I therefore briefly elaborate my understanding of the concepts to clarify the underlying assumptions of the following discussion.

### 6.1.1 The continuity of requirement engineering within the system design of software development

Software development as production

In many cases, software development is still understood to be the manufacturing of a product - a software system - that fulfils specifications based on requirements determined by developer teams. Software engineers usually see themselves as technologists who provide technical solutions to defined problems. The reasoning is purely instrumental: starting with a problem to be solved, the problem is not questioned, but the most demonstrably efficient means of solving it is sought

> "To be a computer person is to possess a certain repertoire of specialised hammers and to be constantly looking out for nails to hit" [Agr97].

[39] This includes any system design setting which involves stakeholders from a different cultural background, which is possibly an increasing situation in the age of globalisation.

This view is realised in the models of traditional software development through defined sequential phases based on one another, interfacing with formal documents. In those models, system design is considered as a phase between requirement definition and implementation, leading to system specifications. However, shortcomings inherent in 'sequential' models have been recognised for some years now. They result from inflexibility and excessive formality, and the lack evaluation cycles encountering user-acceptance problems and other difficulties at later stages. This is where Floyd [FlEtAl89] sees the need for a change of view on software development processes:

Software development as design

> "On the basis of practical work in projects as well as in developing and evaluating methods, I have been led to believe that viewing software development as production, and thereby focussing our attention primarily on the product software, is misleading. Instead, I consider processes of software development as the primary area of concern; I regard the product software as emerging from these processes and the use of software intertwined with its development. As a result, I have come to view software development as design rather than as production."

Within this context, system design can no longer be seen as a phase within the software development process,

> "but [as] pervasive in all development activities. […] In software development, design pertains to the establishment of requirements and their connection to software functions and architecture, to the realisation o programs, to the anticipation of software use and the adaptation of software for creating computer-based milieus in different settings, and of course, to the development process itself" [FlEtAl89].

Furthermore, system design - and requirement engineering as well - can no longer be considered as distinct processes. According to Kotonya and Sommerville [KoSo98]:

> "Some people (Jackson 1995) suggest that they are quite separate activities; requirements are mostly concerned with the problem to be solved; design is concerned with the solution to the problem. That is, requirements engineering is about what has to be done; design is about how it should be done.
>
> We do not agree with this separation. It would be nice if it were true and would certainly make life easier for both the specifiers and the designers of systems. However, in reality, requirements engineering and design are interlaced activities."

The reasoning becomes obvious as the authors define requirement as a specification of what should be implemented, which has been the output of the system design phase within traditional software development.

> "Requirements are defined during the early stages of a system developmen as a specification of what should be implemented. They are descriptions o how the system should behave, application domain information, constraints on the system's operation, or specifications of a system property or attribute" [KoSo98].

Although I agree that requirement engineering and system design are intertwined activities reinforcing each other, I do not agree that requirements are defined during the early stages of system development. Requirement definition has to be considered as a continuously re-evaluative activity of the largest part of the development process. Once requirements have been recorded, they have to be analysed and validated throughout the entire system-design process. The validation is responsible for checking whether "actual" requirements are listed.

### 6.1.2 Whose requirements are embraced?

Macaulay [Mac96] points out the difficulty of deciding whose requirements are validated in software development.

> "A requirement could be defined as something which a customer needs. However, from a designer's point of view, it could also be defined as something which needs to be designed. These may or may not be the sam as each other."

The IEEE (Institute of Electrical and Electronics Engineers) Standard 610 (1990) clearly takes the stand of users' requirements described as:

1. A condition or capacity needed by a user to solve a problem or achieve an objective.
2. A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed documents.
3. A documented representation of a condition or capability as in 1 or 2.

However, Woolgar [Woo94] believes that requirements rather are a producer's fiction. Difficulties

> "centre on problems of negotiation and translation, as the producer/professional attempts to force the experience, beliefs, discourse o the customer/client into the conceptual and technical categories which makes sense to the sphere of the professional/producer" [Woo94].

This contradiction of views is equally reflected in activities related to requirements grouped under the term requirement engineering:

> "Requirement engineering is a relatively new term which has been invented to cover all the activities involved in discovering, documenting and maintaining a set of requirements for a computer-based system. The use of the term engineering implies that systematic and repeatable techniques should be used to ensure that system requirements are complete, consistent relevant, etc.. Process activities include requirements elicitation, analysis and negotiation, and validation" [KoSo98].

An ongoing debate in requirement engineering is the decision on whether we are talking of requirement capturing, specification, elicitation, or construction. [JiGo94]:

> "Capturing requirements suggests that although they may be elusive, they are out there somewhere, while specifying requirements may suggest that a straightforward engineering job needs to be done, in which the issues involved are largely technical. Alternatively, 'eliciting' requirement suggests that requirements are to be found among people - the users,

managers, etc. Finally, constructing requirements suggests that requirements may not be out there, but instead are a somewhat arbitrary product of the requirements engineering process."

According to Woolgar [Woo94], they are certainly actively constructed and he therefore demands that the

> "pursuit of requirements should not centre around the application o disembodied formal rules - premised on the mistaken belief that actual requirements exist independently of local organisational preconceptions about users" [Woo94].

Floyd et al. [FlEtAl89] suggest a gradual establishment of requirements, which

> "takes place in an interplay o anticipative, constructive and evaluative steps to be carried out by the developers and users in interaction".

Requirements are of different nature; within a specific software developmen setting, the need for requirement capturing, specification, elicitation and/or construction may occur. The stakeholders might have concrete requirements before the system design begins, but new requirements arise and change with the progression of the system design process. Methodological provision has to be made for those different activities between software expert and user. In short:

> "The requirements process is a human endeavour, so the requirements method or tool needs to be able to support the need for people to communicate their ideas and obtain feedback" [KoSo98].

Who should be involved?

The next question arises: Who are the people to communicate with each other

> "Because system design involves organisational changes, the peopl affected by the changes should have a say in the design process. All changes may challenge current power structures, and thus a democratic change process should include a fair representation of users and management." [BrSt97]

This statement originated within a democratic setting. But what if system design takes place in non-democratic organisations? Can we really enforce democracy as the only proper form of co-operation? Should methods of co-operation not depend on socio-political context? For example, while debating the concept of participatory design with some Namibian friends, they demonstrated thei common understanding of a hierarchical system in which subordinates are not included in design decisions; even contact persons at any management level are incapable of providing detailed requirements from those considered of lower rank. It is believed that the expert is the one who should know. This paradigm is reflected in traditional system design as criticised b Lyytinen (as quoted in [KeMa91]):

> "System goals motivate mainly system analysts and management and not the end-users. The result of this is that the development process seldom solves the "right" user-problems, because these are insufficient incentives for the user to participate and contribute his know-how."

Given the setting of foreign software experts communicating with management only, it becomes obvious that the actual problem is not solved - since it could not be identified. Korpela et al. [KoEtAl96], based on seven years experience in Nigeria, suggest the necessity of user participation in developing countries

"for a sustained and societally justified application of informatics".

Bearing in mind that the foreign expert is seldom capable of interpreting and understanding local contexts without assistance from local people, Muller [Mul97] suggest the inclusion of users in the system design process:

> "Users as co-interpreters and co-investigators bring a firsthand knowledge of the wok directly into the translation and can thus provide clarifications and corrections that would be unavailable if users were considered to be outside the analytical work."

Users provide their domain knowledge as the basis for system designing and they provide feedback in analysing, modelling and evaluating activities [LiZu96].

> "One way of developing systems that, in part, aim to avoid premature imposition of a particular technology on a setting and the pre-specification of the set of tasks a system should perform, is by enlisting users to participate in the design process. Such participative approaches are also seen as a way of coping with the possibility of conflicting and ambiguous definitions of the 'non-functional requirements' of users, customers and various other stakeholders" [LuEtAl93].

However, a global implementation of participatory approaches is obstructed by varying socio-political systems.

> "In development, there is regular talk about empowering people and creating projects that are participatory. Unfortunately, this is easier said than done" [Lum96].

A community worker of a rural area in the north of Namibian identified the disregard of the existing community structure as the main reason for the failure o one of her grassroots projects. A group of women had been selected without involving the headman in the decision process. When the project was handed over for self-management, it fell apart. The participating women did not fully understand the long-term benefits and were only interested in immediate gains. Sustainability was not obtained as the project was not integrated in the existing structure which could have supported it. A Namibian system designer described how she usually approaches stakeholders within a project:

> "Depending on the size of the system and the number of people, I focus on the main session with the main people initiating the system. I also contac the sponsors involved to determine the amount of money they are willing to spend and the main people I should see in the organisation." [40]

For any participatory co-operation, the community including its communicative rules are to be considered. Software must be developed with understanding and insight, from within the context of the society. [And95]

## 6.2 Perceptions and perspectives

"Representation of the world,
like the world itself,
is the work of men;
they describe it from their own point of view,

[40] Interviewed by Mulala Mwansa, one of the Computer Science students of the University of Namibia in 2000.

which they confuse with the absolute truth"
Simone de Beauvoir
(quoted in [SuJo97])

### 6.2.1 Reality-modelling construction in system design

> "Bateson (1979) helped us see that 'nothing has meaning except it be seen as in some context'; context brings meaning to words and actions, and context is the pattern that connects. Cultures provide the context that brings meaning to the rituals of life (Cohen 1991)" [Weh95].

System design is only meaningful in a context of users' cultures. The importance of studying the embedding environment has been recognised by software designers; as Kotonya and Sommerville [KoSo98] point out,

> "If the environment is not well understood, it is unlikely that the requirements as specified will reflect the actual needs the component mus fulfil."

The perception of the environment from within which the system design originates is therefore a central issue as it aims to define the problem to be solved.

> "The requirements model is incomplete unless the environment with which the component interacts is modelled" [KoSo98].

Rational software development - as indicated by Floyd - [Flo92c] depends on the assumption that there exists a given reality "out there", and that software is based on models which represent reality precisely. The task of a software engineer is to start from the problem defined in that reality and to find a solution by way of a programme system. This implies that the developers' responsibility covers only the construction of the product in accordance with the system specification, and that the development is independent of the individuals responsible for it

> "The software developer's task is to analyse, to abstract and to elaborate a correct model that can be manipulated by the computer. While this may be difficult to do, the task itself - discovering the correct description - is supposed to be clearly defined and independent of the software developer as an individual. Also, his or her responsibility in carrying out this task is restricted to matching the real world in the model with the greatest possible care" [Flo92b].

> "Although various requirements methods provide ways of organising and abstracting from the representations of activities produced by an analysis, the means by which the gathered material is assembled into representations is generally assumed to be unproblematic" [LuEtAl93].

However, modelling is a complex social process, which is recognised in practice but has no objective validity.

> "Essential aspects of the socially organised character of the domain concerned are obscured or, worse, misrepresented. More specifically, the analytical deconstruction of work activities into ever more finely grained components removes the essential 'real world' features which make them practices within a socially organised setting" [Com94].

Floyd [Flo97] reasons that modelling uses decontextualisation followed by embedding as recontextualisation, but in a different context. Therefore

operational reconstruction implies a reduction: For a specific purpose, important is divided from non-important (abstraction), the important operational represented (modelled), and the model implemented. The result of modelling represents a subjective artificial world which is dependent on the judgement of the modeller of what is to be considered as important. Basic postulates in science state that the properties of the observer should not enter into what is observed. However a new understanding in science has gained an awareness of how the observer constructs reality by the act of observation and interpretation and how the questions asked can influence the answers [Flo92b].

> "From a post-modern and post structuralist point of view, observation always happens from a specific position which includes the class and gender of the observer. This is different to saying that class and gender 'influence' the nature of the observations. […] There is no 'detached' observer who, provided that she employs the 'correct' method, has direct access to the research material and can observe it unmediated. Instead, the observer is involved in creating what she observes. An aspect of this creating is that the researcher must make choices in terms of where to look and what to look for. Furthermore, even if the researcher is fully committed to understanding and describing the way in which the research participant construct the world, the very process of describing serves to construct a world through devices such a typification (Smith, 1993)" [Kob97].

In other words, even if software developers endeavour to model reality objectively, they would fail as their view is focused through their individual personal experiences, knowledge, interests, intentions and emotional interrelations with reality. As opposed to rational thinking, the key of constructivist reasoning is the idea of what we deem to be real, the way we see reality, and the invention of a suitable description for it. In this paradigm, modelling is no longer regarded as objective representation of reality but rather as a reality-construction process.

> "In applied epistemology, reality construction refers to cognitive processes, in which we bring forth what we perceive and know" [Flo92b].

The perception of reality depends on the perspective - which is embedded in socio-cultural contexts - of individuals. According to findings in developmental psychology, the development of individual perception systems requires cultura contexts. What is perceived as disgusting, as smelling or tasting awful or as sounding irritating is culture-dependent [41]. Perceiving involves registering a sensory stimulus, the evaluation of it based on conditioning and perception codes, and the integration of it into existing concepts of reality [Hol97]. Perception may be seen as an active interpretation process [Mue91]. Bateson [Bat72] introduced the concept of ways of punctuating events in which certain modes of structuring of experience, perception of reality and processing of experiences is addressed. The way of punctuating is dependent habits which structure sensual perceptions. Habits are behaviour-stabilising assumptions or premises; once established, they become subconscious but develop a rigid steering potential (Marotzki in [Nes91]). It is a habit to punctuate the stream of experiences so that it is coherent with social conditions. Accordingly, software experts' perception of

[41] excluding extreme disturbances like a high pitched pure sinus which is irritating to all human kind

a particular situation is (sub-) consciously influenced by their experiences, interests, values and backgrounds. Bratteteig and Stoltermann [BrSt97] introduce the concept of designers' vision[42] which is

> "a way to restrict the range of possibilities in the design process, a means of handling and navigating the enormous amount of information and number of possibilities normally present in a design situation".

Of major consequence is their quote of Stolterman (1991) and Ferguson (1993) according to which an experienced designer uses this vision as heuristic tool in the choice of what and how to think about particular situations. This is a clear statement on designers' judgement of situations depending on their background and intentions.

Considering the individual bias of reality models, the original assumption of rational software development - where software is based on models representing reality precisely - can no longer hold, seeing they that are observer-independent, and the validity of those models has to be questioned.

> "Our perception of the world as a whole, including the values we hold, is elaborated from our perspective, against our background" [Flo92a].

If the ideas of constructivist thinking are applied, then problems are views or descriptions of reality constructed by people involved.

> "Thus in software development, we construct the problem as well as the solution" [Flo96].

In a multicultural system-design environment, the way problems are conceptualised may diverge remarkably. What is considered to be a problem in one culture may not be considered a problem in another. How a 'problem' is perceived and solved is highly perspective-dependent and therefore culture-related. Lumpkin [Lum94] demonstrates this diversity with an example of the diagnosis of illness:

> "An acupuncturist may diagnose an ill person as having too much fire. An allopathic, biomedical physician may diagnose that same person as having high blood pressure. A Namibian diviner-herbalist may diagnose that person as having made a transgression against his/her ancestors. Meanwhile, a Western-trained psychologist might diagnose the person as having an anxiety disorder… All of the former diagnoses are valid[43], yet all perceive the patient's illness within different physical, social, psychological, and spiritual paradigms. Furthermore, in each case, treatment will be different, because each practitioner has diagnosed the patient according to a specific health care modality based on differen cultural reality constructs."

Goehring [Goe80] understands culture as a set of recipes to solve problems, an outline for the contact with people, things, thoughts, feelings and for the organisation of perception. A problem-solving design guides the action. Action is understood to include inner actions like perception, thinking and feeling. In a culturally different context, new problem-solving designs are not necessarily

[42] a distant visual or conceptual idea of a possible design.

[43] Not all diagnoses might be valid however as long as a healing of the patient can be achieved the diagnosis becomes irrelevant.

successfully applicable. Instead, the designers encounter failures although they acted to the best of their knowledge and with good intention.

> "First, customers and designers must develop a shared understanding of the work problems" [HoEtAl95].

System requirements are related to the defined problem and originate from the viewpoints of different stakeholders involved. Requirements are therefore dependent on personal priorities and values. System design in a multi-cultural environment involves the merging of points of view of stakeholders with different socio-cultural perceptions and perspectives in order to gain a common understanding of the problem. Out of the diverse recipes for solving problems, a common concept has to be designed. System design is therefore considered to be a constructive process with different point of views involved. The need for new techniques in software design arises.

> "The techniques must address interpersonal dynamics and idiosyncratic differences that can get in the way of developing a complete, accurate understanding of the customer's problem and potential solutions" [HoEtAl95];

> "While traditional approaches tend to advocate the early construction o comprehensive and quasi-objective models relying largely on forma techniques to be used in defining documents, the emphasis here is on recurring to perspective-based evaluation as the supreme guide both in building models and in interpreting constructed models in the context of meaningful human activities" [FlEtAl89].

Often there is no single user perspective, but a plurality of perspectives related to the different functional roles of users, to collective interests and of course to individual tastes and priorities. To obtain a satisfactory model, the perspectives o all stakeholder involved have to be considered. This paradigm has been implemented in the so-called viewpoint-oriented methods.

> "A viewpoint is a collection of information about a system or a related problem, environment or domain which is collected from a particular perspective. These perspectives can include end-users of the system, other systems, engineers involved in the development of the system, any system stakeholders, etc." [KoSo98].

Implicit viewpoints were first introduced in the SADT (Structured Analysis and Design Technique) method. CORE (Controlled requirement expression), developed for British Aerospace, is explicitly based on viewpoints - entities that interact or affect the intended system in one or the other way. Improving on shortcomings of these two methods, VOSE (Viewpoint-oriented System Engineering) and VORD (Viewpoint-oriented Requirements Definition) were developed in the early 1990's. VORD is based on viewpoints focussing on user issues and organisational concerns whereas requirements are defined as services.

> "The objective of all viewpoint-oriented methods is to strike a balance between preservation of multiple perspectives during system development and the demands for consistency" [KoSo98].

In a multicultural context, a software expert encounters users and other involved stakeholders from a different cultural background. It is therefore essential to stud

the manifold factors involved in cross-cultural perceptions and their consequences on the formation of viewpoints.

### 6.2.2 Establishing viewpoints across cultures

> "The cultural pattern of the approached group is to the stranger not a shelter but a field of adventure, not a matter of course but a questionable topic of investigation, not an instrument for disentangling problematic situations but a problematic situation itself and one hard to master" ( Schuet 1944) in [Gue91].

In an intra-cultural system design context, the software expert is classified to be from a different culture than the users due to the difference in profession. In a multicultural system design environment, software experts are furthermore classified as being part of a different cultural group than the user due to their personal background. Either way, the software expert is categorised as to be par of a different group. This leads us straight into the debate of the categorisation problem and the perspectives of people involved as well as their judgements on other groups.

#### 6.2.2.1 The categorisation problematic

Debates about the objectivity of ethnical grouping or the validity of scientific discussions concerning cultural identity have been going on for decades. In the days of colonisation, grouping according to race, by distinguishing physica characteristics - e.g. colour of skin, colour and type of hair, shape of eyes and nose (Negroid, Caucasian, Mongolian, etc.) - was predominant. The way of distinguishing between physical characteristics was entirely dependent on colonialists who wanted to differentiate themselves from the indigenous populations of conquered countries. Beside a proven genetically invalidity of a racial differentiation according to the selected criteria, the discourse of race is interwoven with practises and justifications of exploitation and inequality, colonialism and racism. As a response, a substitution of race by culture succeeded.

> "The shift from race to culture reflects discursive shifts in Western democracies more generally and the development in social science, during the 1950s, of new theories of identity and sociological analyses of discontent" [WePo92].

Nevertheless the grouping of people according to race and/or culture remains ambiguous. According to the psychologis Weheley [Weh95],

> "An ethnic culture or ethnic group is a group set apart others because of its national origin or distinctive cultural patterns" (Schaefer, 1990,p.27);
>
> "Each of us is socialised into an ethnic culture (or ethnic cultures if our natural parents are of differing ethnic heritages). This occurs whether we are raised by our natural parent(s) or by someone else. It is in this ethnic culture (or cultures) of socialisation that we take on ethnic group values, beliefs, and behaviours.
>
> Each of us is also born into (or socialised into) a family with one or more racial heritages" [Weh95].

The author attempts a separation of the concepts by extracting race from the ethnical categorisation. However, the interwoveness is present in everyda discussions. Kober's [Kob97] research on the Namibian identity and articulati of difference demonstrates the absurdity and complexity of cultural and racia grouping within a multi-ethnical[44] and post-apartheid[45] society.

> "The norm originators depict the lives of Namibians as inevitably permeated by racial awareness because of the history of the country; it is a matter of fact. On the one hand, the preponderance of a racial discourse is spoken of with a sense of resignation and this can be articulated as follows: 'the history of racism is imprinted in me, on my skin and I cannot escape it, but I must live with it, however uncomfortably'. On the other hand, race and racial divisions are spoken of ironically, playfully and humorously. The humour is closely connected with how people fall between racial categories" [Kob97].

This can be illustrated b Kober's recorded discussions of norm originators:

> *P.03 [to understand the significance of this excerpt it should be kept in mind that P's skin colour is dark] As I see one's being how should I say, one's being is actually characterised by one's identity and the identity is formed by the way you grow up. Let's say for instance, somebody looks like for instance V's son, he is light in colour, I don't know is he the way, I grew up with them hmm, I regarded myself just as just like they would, I mean the mentality and everything. I don't know, maybe he changed I don't know.*
>
> *V.37 You can tell he's not white.*
>
> *P.04 Ja, okay, not white, okay somebody everybody else here would say he is a Coloured or something.*
>
> *... Ja, okay let's say if he is together with some Coloured guys the skin is the same but I would not say the mentality.*
>
> *V.39 No the mentality, this is something that I mentioned earlier. I don't know whether you were here that it depends how you were brought up when I was talking about Coloureds, you know Basters.*
>
> *J.23 I can't see if you were brought up in Europe.*
>
> *V.40 No but the Coloureds and the Whites, I can tell around this area [points to the eyes]. It is like the Chinese and the Japanese. They can differentiate and say he is Japanese, and not Chinese. But you can't because you are not from Asia ja, you are not familiar with that so you cannot tell who is Japanese and who is Asian and who is Korean....*

---

44 Social scientists have identified 5 indigenous ethnical groups, the Herero, the Nama, the Damara, the Owambo, and the Saan people [Ved91] and 5 migrated or evolved ethnical groups, the Kavangos, the Whites, Caprivians, Basters, and Tswanas.

45 Remembering that in pre-independence Namibia, under apartheid practices, Namibians have been distinguished by ethnical affiliation recorded in the assigned identity number

*Now with blacks, Nama, Damara, Owambo or Herero and so on. You know at times I can't distinguish who is Herero, who is Oshiwambo, but if I speak to the person and ask for a name, I know exactly this one comes from Okavango, or Katima or Herero or he's Oshiwambo … because the surname.*

*A.14 younger generation now. It's very difficult to see which one is. But I think somewhere there one could still tell this is pure Nama person that one is pure name or that one is a mix or something that he was saying a mix of Nama or Damara, but I think the young generation, it's now difficult to tell because there are a lot of intermarriages and inter-relationships.*

*V.68 You know years ago I would know a Herero man from a distance because he will be wearing a hat.*

Kober [Kob97] comments:

> "The discourse of difference is articulated in terms of language and cultura as well as ethnic and racial distinctions. These distinctions tend to become mixed up in the sense of being used interchangeably at times.
>
> Namibia is constituted as being unique because people are so highly differentiated in terms of cultural and ethnic affiliation."[46]

Kober's record further demonstrates an issue raised in the ethnical discourse, namely the concern about the perception and definition of an ethnical group by group members themselves or by outsiders. In other words: who is considered to be a stranger and who not? "Strange" is a relational category, as strangers are not strange as such but only strange to us, as much as we are strange to them. Furthermore, strangeness is not a static but a dynamic category that varies depending on the point of view. As an example, Bredella [Bre97] states that if Germans try to understand the French, then the French are strangers, but if Europeans try to understand Africans, then the French are part of the own group. Auernheimer [Aue90], with reference to the sociologist Max Weber, argues that ethnical grouping is projected to a subjective belief in commonness by its own members. He states that a group of people with similar external habits and traditions or both - or with identical memory of colonisation and migration - which entertains a subjective belief in common origin can be called an ethnica group. Ethnicity has to be seen as a social construct that has historical character, is development-dependent and evolving, and certainly not naturally given.

> "Social categorisation is the process by which people organise their social environment by categorising themselves and others into groups (Wilder, 1986)" [ZiEtAl93].

This phenomenon common to all human beings is explained in social cognitive science as one of the limitations of human cognition:

[46] Even the author ends up entangled with the terms by saying, 'ethnic and racial' and 'cultural and ethnical'.

> "We simply do not have the cognitive space for paying attention to all the richness, diversity and individual differences. According to Hamilton and Trolier, if we did try to perceive every individual we met as a unique individual, then, as with the hard disk on abused personal computers, the available processing capacity would become quickly over-loaded. Socia interaction and the perception of others have to be organised, ordered and simplified, principally around a set of cognitive categories." [WePo92]

Recognising this limitation, however, this categorisation has a major impact on the perception of individuals towards groups or individuals we categorise to be of the same or a different group, i.e.:

> "the perception of similarity of those within one's group and dissimilarity of those in the outgroup;
>
> a failure to distinguish among individuals in the outgroup;
>
> a reduced influence of outgroup members on the ingroup;
>
> and hostile attitudes toward and beliefs in the inferiority of the outgroup (Tajfel, 1982; Tajfel & Billig, 1974)" [ZiEtAl93].

Bredella [Bre97] further argues that the ontology of the strange is not only problematic from an epistemological point of view, but also from political and educational perspectives. When differences are emphasised, the understanding process often ignores intra-cultural differences as well as the intercultura similarities, even though it is the only basis for differentiating.

Within system design, the differing perspectives have to be acknowledged and processed. Considering that the software expert categorises the user to be from a different group, based on an ethnical and a professional basis, the listed shortcomings in the perception of the other group's members affect the processing of viewpoints. The failure to distinguish individual stakeholders leads the software expert to work with assumptions that are stereotypical and prejudice-based. A thorough study of the user's cultural identity, as well as the software expert's stereotyping, prejudicial attitudes and ethnocentric behaviour is thus necessary.

#### 6.2.2.2 Cultural identity

As discussed above, individuals affiliate themselves or are affiliated by others to certain groups. Often in the discourse of cultural identity, the individual is no longer distinguished from a group. This results from the failure to distinguish among individuals of a different group, as mostly the cultural identity of others - like indigenous Africans or Americans - is discussed rather than 'my cultura identity'. Albert [Alb91] states that individual development takes place in a cultural context, and therefore individual identity and cultural identity are not distinguishable on a factual basis. This is moderated by Hoare (1991 as quoted in [Weh95]) who outlines the powerful role that culture plays in shaping one's identity, but taking into account the influence of personality as well:

> "Identity is constructed from within the person and culture in which it is forged."

Although of immense influence, culture does not determine the behaviour of a human being but determines the scope for his/her self-realisation [Bre97].

> "Cultural identity is built up on the basis of the place occupied in space and the individual, family or community history. […] Culture is the result of the creative attitude of individuals towards reality." Report from the European commission (DECS/EGT 1986) in [Aue90].

Goehring [Goe80] created the term Idioculture[47] to describe the sum of problem-solving designs individuals choose from cultural offers in their context, and which they have modified for their specific needs and integrated to varying degrees. Weheley [Weh95] has pointed out the individual distinctiveness within each cultural group:

> "Even though an individual operates within the context of a cultural group, it is important to recognise that each individual will interpret and act out the culture in a slightly different way."

Considering that any cultural group consists of individuals, Das and Littrell (1989, as quoted in [Weh95]) address the importance of understanding the difference between culture as a construct and culture as it is manifested in the lives of people:

> "In their view, culture as a construct includes modal practices of a group's way of live that are held in common. Culture as it is manifested in the lives of people will show much individual difference, with no individual exemplifying all the group's modal practices" [Weh95].

#### 6.2.2.3 Stereotyping and prejudices

Within the own cultural group, people usually differentiate personal and individual characteristics, whereas individuals categorised to be from another culture are firstly perceived as stereotypical representatives of their group. This means that the group is pictured in a simplified way with fixed ideas about characteristics of that group, which hinders perception of individual characteristics and also readjustments of perception - even when contradictor experiences are made. Unexpected problems in intercultural encounters can easil lead to stereotypical attitudes, which have a bad impact on the professional and personal abilities of the people involved. In system design, stereotyping leads t unverified hypotheses:

> "Every system incorporates certain assumptions about the users and about the larger network of human activities within which the system will be used [...] This trend can lead to misguided decisions about which activities to automate and to poorly designed systems that do not stand up to the complexities and variations of the actual tasks" [Agr97].

In psychology, stereotyping is explained as a deficit of information-processing ability, which is an exception of categorisation implemented to reduce complexity, in other words - an overgeneralization [Aue90]. Through equating individuals with their cultural group, prejudices towards individuals encountered

[47] In analogy to "idiolect", in linguistic meaning the linguistic competence and performance of a speaker

are implicit. Prejudices are usually associated with negative affects and beliefs affecting the encounter. A prejudice is characterised as

> "dislike or distrust of a person, group, custom, etc. that is based on fear or false information rather than on reason or experience, and that influences one's attitude and behaviour towards them" [Oxf95].

I, however, understand prejudice in the pure sense of the word as any pre-judgement (premature judgement), no matter whether associated with negative or positive affects.

> "Prejudices are often formed on the basis of limited or false information, they are typically unwarranted and irrational" [ZiEtAl93].

Allowing prejudices to be part of the modelling leads to an invalid point of departure for the design of the future system. As prejudices have been seen to be destructive in social interactions, research into them has always been high on the agenda of social psychology. It is believed that:

> "Understanding its complexity and persistence enables the development of strategies to change prejudicial attitudes" [ZiEtAl93].

However the prejudice problem as discussed by Wetherell and Potter [WePo92] identifies unresolved sources of tension between the particular and the universal and between facts and values.

> "The psychodynamic strand in socio-psychological analysis of prejudice emphasizes the distinctive character weakness of the prejudiced – their rigidity, emotional needs, reluctance to respond to new information, and pattern of vindictive gratification" [WePo92].

This is in opposition to the perspective in social cognition which argues that

> "the prejudiced are not necessarily different from other individuals. We can all be guilty of pre-judgement. […] we cannot help it because life is short and our minds are limited. People are built this way for perfectly sensible reasons […] and so constantly judge in advance of the facts" [WePo92].

This leads to the classic dilemma of positivism of facts versus values.

> "The difficulty is this: what counts as a rational judgement? When is a description merely factual and when is it an interested account? If prejudice is 'thinking ill of others without sufficient warrant' ( Allport, 1954,. p.6), then what is an adequate warrant?" [WePo92]

Remembering our discussion on the invalidity of descriptions, the impossibilit of any human being to describe reality precisely, then the problem of prejudice cannot be untangled. There are no criteria to determine when a view is a 'pre-judice' (judgement in advance or ignorance of facts) or a verified and rational judgement.

Cultural or racial prejudices however can be avoided by acknowledging that, although being products of our cultural heritage,

> "we cannot predict the behaviour of an individual on the basis of that person's cultural background because so many factors within each culture mediate the culture's influence on the individual Das and Litrell (1989) also remind us that many people of colour are socialised to live not only in

> their own culture but also in the White culture. Negotiating more than one culture on a regular basis influences when and how cultural behaviours will be exhibited"[Weh95].

Only when the software expert can differentiate individual stakeholders, cultura prejudices can be excluded.

#### 6.2.2.4 Ethnocentrism

Besides failing to differentiate individuals from another group, people usuall make judgements about others using standards of their own group.

> "Ethnocentrism is seen as one outcome of group membership. It is seen as a consequence of perceiving social reality in group terms and as a phenomenon produced through aligning oneself to a group or being aligned in this way by others" [WePo92].

Common to all cultures is, as Jouhy (1985 quoted in [Alb91]) expresses, that a conscious perception and valuation is done. All cultures define what is wrong and what is right, truth and untruth, bad and good. The universality is that man, nature and technology are valued in all cultures. Looking at a situation within another culture, observers still evaluate according to their own cultural system. Alber [Alb91] states that ethnocentrism as such is present in any culture, and that it is not problematic. However, ethnocentrism is not constructive when the two value systems are not compatible or one considered to be superior to the other, since this has a major impact on the attitudes of the interacting parties.

For example, the European ethnocentric perspective is one of foreigner being deficient. It has its historical roots from the time of missionaries and colonia education. The indigenous attitude was made responsible for the stagnating development in the so-called developing countries. Blacks were considered as children, savages or pagans, who had to be educated to become adults, civilised, or Christians. The dominating, calculating rational discourse in linear or European culture hides its historical multicultural background in order to enforce their superiority over circular cultural societies believing in differentiating, complex problem solving and palaver rituals. In the Sixties, the hypothesis of deficiency led to compensatory education without reflection on the right for cultural identity. In that movement, "black children" were brought to former white schools to equalise rights [Aue90]. These deficiency-orientated and compensatory educational approaches have been criticised and reviewed, and they are now moving from a deficiency-orientated to a differentiating approach, regarding other cultures not as minor but as different [Mer91][Nes91].

Nevertheless, in the IT-oriented world of today, attitudes of valuing non-IT communities as minor or under-developed is omnipresent.

> "Technology has exploded. We are in it, shaped by it, entrenched by it, dependent on it. It influences the way we perceive the world, constitute our social lives and make our basic human choices"[Flo92a].

The software expert will always evaluate the environment from his or her technological perspective and may easily follow an ethnocentric approach within the design situation.

> "The bonds of culture are often invisible, and its walls are glass. We may think we are free. We cannot leave the trap until we know we are in it." Marilyn Ferguson (1985, in Aquarian Conspiracy quoted in [Weh95]).

Software expert unconsciously project their own values on the users' culture under study and therefore obtain a distorted perception. Furthermore, the people being studied react to the researcher according to their own experiences. It is therefore important for researchers to be aware of their position within the stud [Aue90]. However, reviewing the work of scholars in psychology and human development,

> "Hoare points out that individuals can never completely escape the realit of their own culturally influenced identity and be totally objective in understanding the cultural reality of another person's identity" [Weh95].

Even with rationality and objectivity as structural characteristic of each culture, the possibilities of overlapping cultural comprehension is limited. Without the specific content in which they were formulated they are not understandable. [Alb91] This has serious consequences for the potential - and limitations - of cross-cultural modelling and the comprehension of viewpoints. Cross-cultura understanding is more than a change of perspective; it requires the perception of the own cultural bounds and limitations and, based on this, the determination for an equal exchange. Each crossing of cultural border aims to sensitise the self-perception, to recognising one's own subjectivity with regard to one's view of reality. [Hol97] In an inter-cultural encounter, my culturally self-evident syste confronts another self-confident cultural system, and if I allow it, mine may lose its self-evidence [Nes91]. Ways must be identified to facilitate the process through which the influence of prejudices, stereotyping, and ethnocentric judgement of the software expert toward the stakeholders involved can be minimised.

### 6.2.3 Attempts at understanding viewpoints despite different perceptions and perspectives

An important feature of inter-cultural interaction is the process of role distribution, empathy and the acquisition of perspectives. In cross-cultura psychology, a process called contextual identification is pursued. In terms o cultural grouping we differentiate an emic perspective, as the view from within a culture, and the etic perspective, as the view from outside a group.

> "Counsellors working with someone from a different cultural background need to learn, as much as possible, the client's emic perspective of her or his culture.
>
> Hoare encourages counsellors to learn the symbols and messages of their client's cultures, to recognise, that clients are the experts on their own cultures, and to work to transpose themselves into the unique worlds o clients. This may involve reading and studying about the client's culture, listening carefully to what the client has to say, and asking many culturall sensitive questions to understand the client's emic view"[Weh95].

Related thoughts are found in the literature of system design which differentiat the software experts' culture from the domain experts' (user) culture.

> "Mutual understanding is brought about by formulating one's own ideas and by trying to understand the ideas of others. It is important that all participants try to see the world as if they were one of the other participants, trying to grasp the essence of important aspects of the other perspectives. The point is not to learn a new profession, but to recognise the basic values other professionals have. In this way, the value basis for evaluating an idea or a product expands to include aspects of perspectives and professions involved. A shared understanding may be based on different interpretations of the same (boundary) object" [BrSt97].

However, the system designer who attempts to interpret and translate information into systems supporting an efficient implementation of a system which is intended to meet the needs of users runs the risk of appropriation[48]. As Muller [Mul97] points out

> "The translated material becomes a newly constructed text, and may take on a life of its own that has a more powerful impact than either the original text or any statements made by its source constituency. The originating culture may lose control of the translated material, and may find that the material is being used in ways that are alien or even hostile to the originating culture."

At this point, ethnocriticism, a hybrid child of anthropology and literary criticism, has posed an extremely relevant question to the software design context:

> **HOW COULD A PRIVILEGED, POWERFUL CULTURE PERFORM CRITICAL ACTS WITH REGARD TO CULTURAL PRODUCTS OF AN UNDERPRIVILEGED, DISEMPOWERED CULTURE?**

Muller [Mul97] elaborates on the relevance o ethnocriticism on Human Computer Interaction (HCI) as the focus of attention on differences in culture between interpreters of a system of thought (the HCI professionals) and the people who live within that system of thought (the users). HCI is rooted in so-called modernism[49], which gives privilege to rationality and efficiency over qualitative issues. The narrowness of a modernist view may have severe impacts in cross-cultural communications in that different cultures may have differen interpretations of modernist values, or may have different values entirely. In HCI, the act of analysing often includes the act of evaluating by the software exper rather than working out an interpretation through discussion [Mul97].

> "Some schools of translation insist that the originating culture maintain control of the applications to which its translated materials are put. Other translation approaches emphasise the need for a translation or interpretation to be verified by members of the culture that is being represented in the translated materials […] In this way, the new text that has been formed through the act(s) of translation may become an arena for negotiating the shared understanding of the multicultural participants"[Mul97].

As Bratteteig and Stolterman [BrSt97] point out,

> "Group discussion should lead to a changed perspective on the design by

[48] Taking ownership of another culture's stories, concepts, or artifacts. More generally, translating or (re)interpreting someone else's words to make a point not intended by that person.

[49] Its enlightenment history encourages rule making by experts rather than interpretative contributions to shared decision making.

each member of the group as a whole. The design proposal, the operative image, should be intelligible by all members, since their knowledge was part of the basis of the proposal, and since their priorities were part of the design process."

The development of a system is considered to be a process of communication and learning, where different people (developer, analyst, user, …) work together to develop and use a series of system versions [Flo94]. Participatory design may claim to equally consider all members by involving the user through selected communication strategies. However, as Floyd et al. [FlEtAl89] point out, the term "participation" already suggest a lopsided arrangement because users may have a participatory role, yet the developers still are responsible for the design and have the power for decisions.

"Opportunities of participation need not provide for opportunities of exerting influence […] Participation in decision processes need not automatically lead to power equalization. Often those with most influence tend to become more influential within the participation structure" [Brå73].

Bråten [Brå83] elaborates on an asymmetry of communication in which the perspective of one partner is swallowed by the other communication partner due to the latter holding a "model monopoly".

"It is generated by the predefinition of some universe of discourse in such a manner that only one of the participant actors finds himself rich in relevant concepts and symbolic representations that reflect his own premises and perspective, while the other is without independent symbolic resources. I call the former a MODEL-STRONG actor and the latter a MODEL-WEA actor, always defined relative to each other and relative to a given universe of domain of discourse."

This means that the system designer, being a model-strong actor in the discourse of technological development - even though he transmits a certain amount o information to the user through communication remains – remains in a position of power. However, this monolithic view is in no way acceptable within the syste design context as discussed above.

"Symmetric dialogue in terms of rival perspectives is to be desired and indeed required by any conscious and sensitive system"[Brå83].

Cross-cultural psychology as well as ethnocriticism recognise the potential of dialogue between cultures to develop new concepts. Thomas [Tho93] presents Adler's (1980) cultural synerg process which - after a thorough analysis of the situation and the culture – is followed by a process of cultural creativity. In a dialogue, new codes of conduct and order evolve out of the potential of both cultures in order to develop culture-adequate problem-solving strategies. Ethnocriticism considers the particular context which originates when cultures meet (the frontier) and the asymmetric, complementary contributions of each culture to the understanding emerging at the frontier.

"The emergent, shared meaning is an asymptotic approach to a fuller understanding. From the perspective of a critic, researcher, or analyst, the meaning discovered at the intercultural frontier contains insights that are unavailable within each culture…. If meaning is developed through dialogue, then action and policy should also be developed through a process

that explicitly recognises different voices and perspectives, and the different stakes held by each of the diverse constituencies"[Mul97].

Floyd [Flo92c] introduces the concept of dialogical system design which comprises constructive criticism, exploration of consequences of proposed design decisions, the multi-perspective evaluation of results and a joint revision until a stable solution emerges that is endorsed by all parties. Ramos [Ram96] emphasises the difference between communication and dialogue:

> "Dialogue is an intercommunication communication that generates criticism and problems once it is possible for both partners to ask: "why?" […] It is a horizontal relation, contrary to the anti-dialogue born from the vertical relations where one talks and the other hears."

Therefore the prerequisite for a symmetric dialogue is at least two autonomous partners with distinct perspectives, able to communicate with each other.

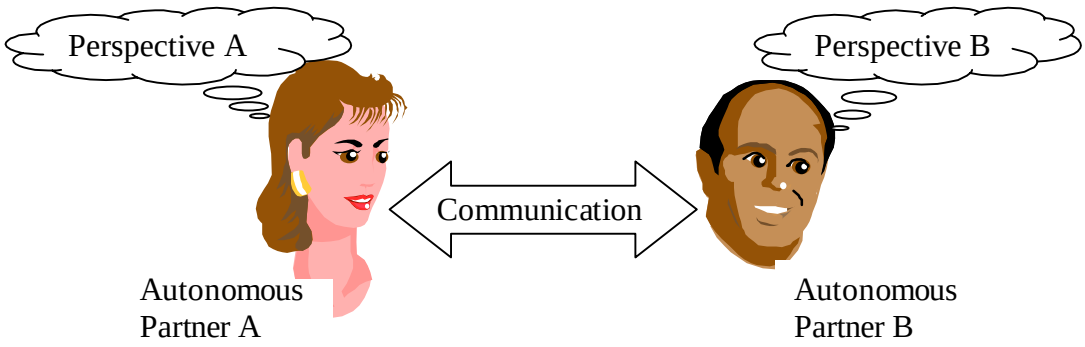



Figure 6-1 Symmetric dialogue

Having sufficiently discussed the distinct perspectives, the focus of the following discussion is on communication, more specifically on cross-cultura communication as imperative for cross-cultural dialogue in system designing.

## 6.3 Cross-cultural communication

"Cross-cultural communication is like
trying to follow a route
on which someone has turned the signposts around.
The familiar signposts are there,
but when you follow them,
they take you in the wrong direction."
(Tannen 1979 in [Gue91])

Mueller [Mue91] points out that it has been realised that in international long-term development projects, the malfunctioning of intercultural communication has a negative impact in such a way that economical advantages of internationa co-operations is drastically reduced. It is therefore important to identify the origins of this malfunctioning to ensure successful cross-cultural communication for people involved in system design.

> "What is interesting as 'cultural' in linguistic analyses of intercultura communication are those properties of the shared knowledge of a social group which, because of their distinctiveness, cause or may cause trouble in interaction with members of another group"(Knapp/Knapp-Potthoff) in [ReEtAl91].

### 6.3.1 Cross-cultural communication failures

Many failures have been reported in cross-cultural communication.

> "Cross-cultural communication is fraught with many possible barriers, blunders, or errors that can limit two-way interaction or cause the communication to break down completely"[Weh95].

Identifying the causes of communication failures is considered to be a step towards breaking cultural barriers of understanding and avoiding miscommunication.

Streek (as quoted in [ReEtAl91]) differentiates three theories of failures in cross-cultural communication:
1) Irrelevance of ethnicity (Erickson/Schultz)
2) Theory of ethnical borders (Barth, McDermott)
3) Theory of communication codes (Gumperz)

The first theory claims that failures are not due to different codes or communication tactics, but rather to individual social conflicts related to gender, age, profession, etc., as is equally encountered in intra-cultural communication. Findings in psychology research demonstrate the influence of this value system on internal models of individual perception and action. Thomas [Tho83] states that most problems in interpersonal encounters are due to psychological reasons. Inappropriate action often is the result of frustrated expectations. Unexpected reactions in social interaction affect the confidence in actions, and therefore action goals are not realised in the usual manner.

However, value systems are culture-dependent, and communication partners from different countries are shaped by their socio-cultural background, experiences and habits in such a way that they systematically include those they are communicating with in form of explicit or implicit orientation systems [Mue91].

> "Basically, intercultural communication deals in the complex realm o perceptual constructs, that is how people perceive the world around them. Perception colours everyone's lives, but perception is particularly relevant, when persons (or cultures) with different reality-constructs are attempting to communicate with each other"[Lum96].

Mueller [Mue91] believes that misunderstandings and "wrong" reactions between people of different cultures are caused by the cultural determinant influencing individual action for the following reasons:
- Cultural factors influence the internal model of individual perception and interpretation of the physical and social environment
- They influence the process of identification of action goals and objects
- They bias the anticipation and realisation of the course and results of action
- The determine the interpretation of results of action and the anticipation of the sequence of action
- They influence the development of individual self-concepts and self-esteem in relation to future actions and design of the social environment

Considering the influence of the cultural determinant on the communication act, the theory of the irrelevance of ethnicity in communication failures cannot hold

any longer. The second and the third theory coincide with regard to thei recognition of communication failures due to cultural differences.

The theory of ethnical borders maintains that communication differences have to be understood as interactive mechanisms of the reproduction process of an ethnically stratified social system, not only as sources, but also as a result o miscommunication. Consequently, the authors believe that the understanding of communication failures cannot contribute to a better cross-cultural encounter as the underlying problem is of a political and ethnical nature. It reflects the existing power structure in which software experts might abuse their power in order to avoid resolving any misunderstandings.

The theory of communication codes is based on the opinion that a better cross-cultural understanding may be obtained through an analysis of cultural differences in communication. It came up with useful socio-linguistical and communication-analytical research and a description instrument identifying sources and mechanisms of communication failures [ReEtAl91]. Numerous authors have disproved the universality of conversation principles. Ethnographic and socio-linguistic analyses demonstrate cultural differences in, for example, the length of silences (Enninger 1987), the change of speakers ( Tannen 1984, Albert 1988), politeness and directness/indirectness (Naotsukaa/Sakamoto 1983, Keena 1988) or the organisation of discourse ( Gumperz 1982). The ethnologist Hall has been working out the importance of intonation, facial expression, clothing, etc., which are indications containing hidden information necessary for mutua orientation of the communication partners [Aue90]. It is often those unconscious (but transferable to consciousness) behaviour subtleties, like intonation, gesticulation and procemic phenomena, directness, formality, etc., which lead to failures in intercultural communication [Kot91].

> "It is especially difficult to discuss verbal and non-verbal behaviour as separate entities. In interpreting communication, it is important to understand both verbal and non-verbal cues within the context of the culture"[Weh95].

According to Kim (1986, in [Aue90]), the following is of importance within intercultural communication: culture specific modes of contact, sending and receiving, the interpretation of verbal and non-verbal messages, the differences o background experience based on cultural, religious, linguistic, historical and biological variance.

Those criteria of communication have been studied with different foci in the various related theories.

### 6.3.2 Communicative Competency

Holzbrecher [Hol97] looks at communication from two aspects:

1) what is the intention of the speaker?
2) what is the competency of speakers to express themselves in such a way tha recipients understand the message as it was meant?

### 6.3.2.1 Speakers' intentions

The speech-act theory considers lingual expressions as acts accompanied b intentions. Different intentions are, for example, requests for information, or an order. Speakers have to express themselves in such a way that listeners can reac according to the speakers' intention. Oksaar [Oks91] sees one of the problems in communication in the expression o coherence which the partners need for the understanding of the message. As an example she gives the following dialogue between a mother and her son:

*Son:* *Where are my jeans?*

*Mother:* *Today is Sunday.*

*Son:* *Ok.*

The son understood the wish of the mother not to put his jeans on because it is not considered adequate on a Sunday. She expressed this not by answering his original question, but by reminding him which day it is. The complexion occurs because of context deviated meaning of statements which follows implicit cultural rules rather than explicit lingual rules For example an interrogative sentence is not necessarily a question in a given context. Oksaar states that the interpretation of the heard and seen follows cultural, social and psychologica rules of a society. In a communication act situation specific norms are applied. As inter-subjective understanding is not possible without coherence, but coherence systems are culture-dependent. The understanding becomes problematic for the foreigner who is unfamiliar with those implicit rules.

A developer team engaged in a project in which technology had to be introduced to rural health care in India experienced great difficulties with the culturally dependent coherence system. As they reported,

> "It was difficult to filter translator biases in some cases, and we observed some cultural subtleties, such as the difficulty of assessing when yes means no, and no means yes"[TsEtAl96].

In many languages 'yes' indicates agreement with the speaker, even in reply to a negative question, when the reply would be 'no' in English. The Indian speakers certainly have a high competency to express their intention within the Indian context however across a cultural boundary their message may be misinterpreted. The misunderstandings can be described to be due to a weak intercultural competency of the Indian speaker but it could also be due to the lacking interpretation or understanding competency of the developer team. Holzbrecher's categorisation of speaker's intention and speaker's expression competency is insufficient for intercultural communication. The model is too focused on the action of the speaker omitting the relevance of an active interpretation of the message. Therefore the competency of any communication partner comprises the expression as well as the understanding capability.

### 6.3.22 Communication competency

Communicational competence is acquired simultaneously with language and culture; in this respect, language cannot be separated from culture. Pillsburt and Ho (1972) as quoted in [Gue91] understand language in a broader sense as

> "a complex living tool evolved for the purpose of communication within a particular society and embodying the rules of social behaviour necessary for survival in that society. To divorce language from such social rules is virtually impossible. The Westerner hoping to slip behind the fabled mask of Chinese inscrutability must therefore do more than memorise vocabulary lists. He must learn Chinese in its social context. And he must appreciate the differences between Chinese and Western socio-linguistic behaviour."

In most cross-cultural interactions, at least one of the participants does not speak the language communicated in as her or his mother tongue. However, to master the syntactical and grammatical part of a language is not sufficient to guarantee successful communication.

> "There is no doubt that a good command of [English] grammar, lexis and phonology are helpful in effective cross-cultural communication. What is not so commonly realised is that it is not enough […] Recognition is needed that concepts such as places of silence, appropriate topics of conversation, forms of address, and expressions of speech-acts (e.g. apologies, requests, agreement, disagreement, etc.) are usually not the same across cultures and that they are perhaps more important to effective cross-cultura communication than grammar, lexis or phonology" (Smith1987) in [ReEtAl91].

discourse analysis

Implicit conventions exist on, for example, how to start conversations, when to have a change of speakers and how to terminate the conversation, depending on context and type of dialogue. These conventions are stored in so-called scripts which

> "are simply large-scale action descriptions representing a typical course of action that might be described in a story or conversation" [All87].

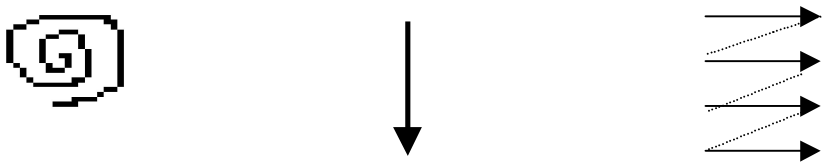
The communication scripts are culture-specific and culture-dependent; they are acquired in socialisation processes. For example, it is important how to start a conversation; in a Namibian context, for example, an excessive greeting precedes any conversation. Those scripts drive expectations and actions of speakers. In case of a deviation - or rule violation - from the norm, the communication flow is disturbed or even terminated. [Aue90] Mueller [Mue91] explains tha conversation involves to express verbally and/or through gestures to mimic one's intention, and also one's interpretation of the opponent's intentions. A community is created by giving mutual feedback. In intercultural conversations, irritation arises when there is no feedback or an unexpected feedback, or one that cannot be interpreted. In non-western cultures the feedback is often more subtle and indirect.

Wildner-Bassett [Wil91] states that in communication theory literature it is believed that every culture developed its own schemata. They can be described as plans or strategies to understand events, generally to act upon them. Those schemata are culturally based on general experiences with previous events and serve to organise perceptions, memory performance, and the reconstruction of new events. A more or less static relation exists between culture-dependent schemata, a specific situation and a statement. Within schemata, so-called safety islands may be found which are places of refuge while engaged in more creative and cognitive processing and planning. Wildner-Bassett [Wil91] lists eigh different functions of safety islands:

1. during contact: creation of a social relation, securing mutual agreement of co-operation
2. increase of behaviour safety
3. situative obligation
4. conventionalit
5. discourse control
6. evaluation
7. meta-communication and meta-linguistic domain
8. delay and relief for speaker.

Culture influences the way we think and consequently the way we organise discourse. Kaplan (1989 quoted in [Weh95]) states that rhetoric is not universal but evolves from the language and culture in which they are used. He differentiates English thought patterns[50] - linear thinking - from other languages' thought patterns. According to Kaplan, the Arabic language - and most Semitic languages - employs a complex series of parallel constructions to develop a paragraph. Oriental thought is marked by indirection, i.e. looking at topics from variety of views, discussing the subject in terms of what it is not, never addressing the topic directly.

Oriental Englis Semitic

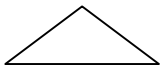


Although evidence in this regard was lacking, Kaplan's hypotheses initiated research in rhetoric conventions of different cultures as part of intercultura communication [Gue91].

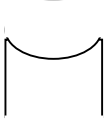
Galtung (1985), a philosopher (quoted in [Mue91]), describes four culturally different ways of thought influencing the organisation of discourses.

**a) Anglo-Saxon**
How do you "operationalise" it?
[small theory pyramids on empirical fundament}

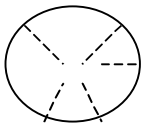
**b) Teutonic**
Wie koennen Sie das zurueckfuehren/ableiten?
How can you deduce this
[giant theory pyramid covering a large area]



**c) Gaelic**
Peut-on dire cela en bon francais?
Can one express it in good French?
[dialectical arc of tension]



**d) Nippon**
Donatano monka desuka?
Where is your master?
[vague trail to link data, derived from Buddhist wheel].



[50] "The English language and its related thought patterns have evolved out of the Anglo-European cultural pattern…[which] descended from the philosophers of ancient Greece and [was] shaped subsequently by Roman, medieval European, and later Western thinkers" (Kaplan 1989 quoted in [Weh95]

The success of intercultural communication depends on intercultural competence of the partners involved. Communication could be asymmetric in the sense tha one communication partner is familiar with the other one's communication script, but not vice versa. In this case, the partner is using the other one's script, and the outcome depends on that person's competency. The other frequent situation is with two communication partners both following different culture-dependent discourse patterns since they are not familiar with the one of the partner.

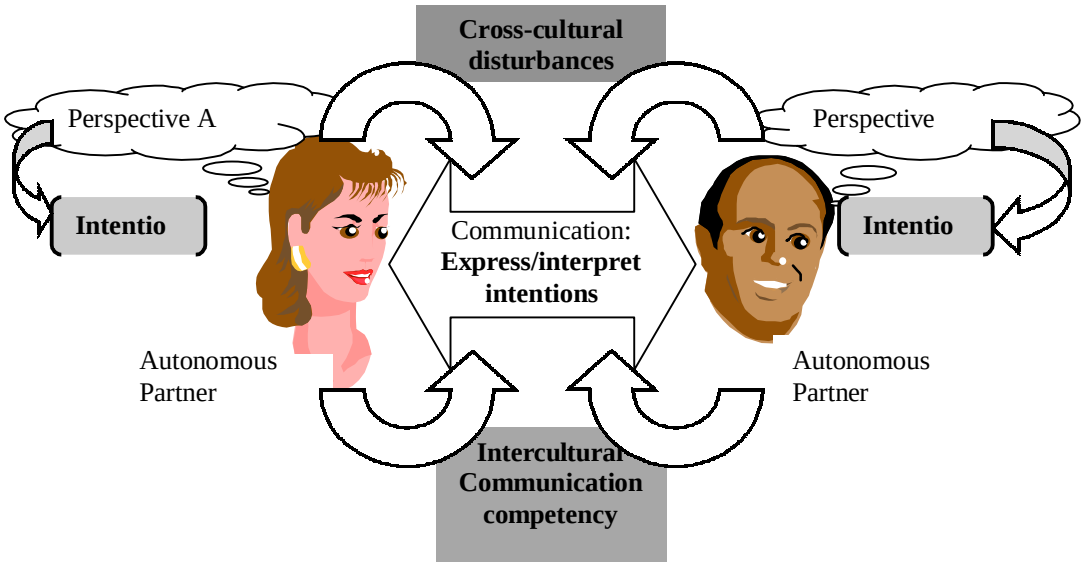



Figure 6-2 Cross-cultural dialogue

The most frequently mentioned features of intercultural communicational competency are flexibility in handling situative factors, the ability to deal with the unknown and with differences, knowledge of the language used as medium of communication, empathy, role distance, tolerance of ambiguity to initialise utilisation of unused interpretation patterns, conflict-resolution ability, judgement of alternative formulations and behaviours and finding forms of ascertaining understanding, but also a lot of patience, enthusiasm, commitment and respect.

## 6.4 Communication methods in system design

Envisioning a dialogical design within a multicultural setting, the assumption is that the system designers' main intention should be the anticipation of symmetric dialogue, in the sense of communicating with autonomous users expressing their perspectives and their intentions. However, an integral symmetric dialogue within system design cannot be envisioned as the software expert and the user are playing different roles. The software engineer finds himself in the position of a facilitator responsible for the success of the dialogue. To be a facilitator implies being skilled in a set of methods to moderate the communication process.

### 6.4.1 Contextual choice of communication methods

> "Methods are massively heterogeneous as manifested in their origins and presupposition, the problems they address, the extent to which they focus on detail, which phases of the design process they emphasise, the community the method is intended to serve, and more" [Com94].

Many communication gaps between system engineers and user have been reported. Methods therefore have to cater for different cases as listed by Woolgar [Woo94]:

- The users do not know what their requirements are (not well enough informed)
- The users cannot articulate their requirements
- The users cannot talk about what they see/do
- The users change their minds
- Individual users say different things to different people

However, Naur [Nau85] argues that there can be no correct method for theory building as each process unfolds in a unique way.

> "Design of information systems is a social process aimed at creating a conscious organisational change by means of a computer-based system […] The creative and social sides of the system design suggest that parts o the process cannot be predicted or prescribed – an open attitude toward the situated nature of design is needed […] To be innovative, design must leave room for re-definitions of a given problem so that new and unexpected solutions can be suggested" [BrSt97].

As stated earlier by Floyd [Flo92c], designers have to admit errors, accep constructive criticism, abandon erroneous goals and recognise changing concerns in the development process. Consequently decisions that have been taken can be revised on the basis of their evaluation. Floyd concludes that there are no methods per se, but that methods are constructed to suit the situation at hand. The concern within software design is therefore the process of situative method development and application.

> "Software developers do not receive much guidance with regard to an easier understanding of the users' situation (the perspective from which people are carrying out their work with the aid of the computer). Therefore they have no basis for evaluating whether the results of their design appear felicitous there. An adequate consideration of the embedding of computer programs in the human world does indeed require us to go scientifically beyond the formal and mathematical methods provided for in traditional Computer Science, and to open ourselves to approaches from the humanities. [...] However, these approaches mostly have been developed with no specific concern for computing. Therefore, we face the task o selecting suitable approaches and tailoring them to the needs of our discipline" [Flo92b].

Although a set of methods has evolved in system design to cater for specific phenomena, their cultural validity has not been considered. Looking at a few examples of methods applied I will illustrate the interdependence between the cultural setting and the method development and hence a new requirement for the competency of system engineers.

### 6.4.2 Cultural validity of communication methods

Taciturn users

Robert Jungk [JuMu87] reports about his first attempts in the middle Sixties t prompt young Viennese factory and office workers to talk about their wishes for tomorrow's world.

> "To get people who have been suppressed, intimidated and dragooned into mere consumers to open up requires a great deal of patience and empathy... When I finally lost my patience and complained about their 'mulishness', one of them retorted: 'Why don't you tell us what future would be best for us? After all, you're the future researcher. It's your job, not ours.' [...] I had been expecting too much without realising that it takes quite some time for buried thoughts and hopes to emerge from the layers of suspicion and thwarted self-confidence, built up through years of deference to others."

The setting is comparable to southern African post-apartheid countries. Beside a pre-independent oppressive system, the present authoritarian hierarchical order contributes a great deal to a remaining submissive attitude. People are culturally not supposed to object to elders or those of higher rank. People are not (yet) used to freely express their opinion or even have an opinion. Most previousl disadvantaged people have no self-confidence and are still of the opinion tha whoever comes from abroad knows better.

Jungk [JuMu87], after failing to get the workers to talk about the future, discussed the workers' childhood and their experience of oppression. It helped to free them from their reservation to talk. Jungk and Muellert conclude that:

> "to get taciturn people talking about the future, first you must talk about the way they relate to the past and present. Memories and past experience often provide the springboard into the unknown."

Two contrary suggestions where made by Namibian computer experts on how to approach the user and motivate their co-operation:

Solidarit strategy

> *"I start with questionnaires before I meet with the individuals/groups. I establish common ground with the individual(s) e.g. if a woman has children, I pick up conversation from there. I also make them aware that they know something. After all this, I then draw up the first agenda of the workshop. Workshops will differ from project to project and I would advise one to use the methodology they are familiar with."*

Oppression strategy

> *"I start at the person with the highest position and being introduced to the next subordinate person by this ones' superior, participation can be enforced."*

Future Workshop

Finn Kensing [KeMa91] was the first to propose to use Future Workshops - the technique developed by Junk and Muellert - in system development. It intends to shed light on a common problematic situation - to generate visions about the future - and to discuss how these visions can be realised through a critical phase, followed by a fantasy phase that is succeeded by an implementation phase. Future Workshops can be categorised as more user-driven than conventional methods, even though facilitated by the designer. The aim is to support users playing an active role in the design process.

Western discourse strategy

However the phasing of Future Workshops is organised according to a western discourse structure with criticism on the presence followed by future visions and ending with means of implementation. In an African context, for example,

planning is more pragmatic: inventory rather than criticism ; usage of existing items rather than future visions (which seems utopian in any way).

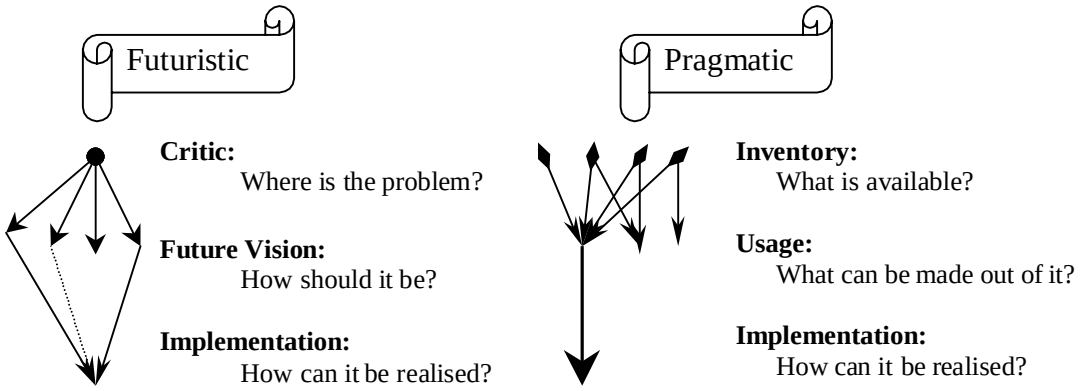



Figure 6-3 Futuristic versus pragmatic approach

To be fruitful, the Future Workshop, as structured currently, would have to be reorganised within differing cultural settings such as the African one. Moreover, the phases themselves have to be redesigned to fit cultural contexts.

Critic phase

Not in all settings people are used to be free to criticise their current situation without having to fear negative consequences. For example, a survey conducted by Bodley and Warren [BoWa92] about usability problems that Third Worl workers experienced with their computer user-interface showed that users with lower levels of education tend to be more easily satisfied – as is the case with previously disadvantaged Namibians, for example. Different explanations can be given for this frequently encountered result:

- The trained fear of criticism of formerly disadvantaged workers.
- Their acceptance of any situation, no matter how bad, believing that they can't change anything in any way.
- The lack of knowledge that it can be technically made more user-friendly.

Therefore, before conducting a successful critical phase, the autonomy of participants is to be enhanced as it allows the forming of independen perspectives. Besides, one should clearly distinguish between criticism and personal attacks.

Future Visions

Furthermore, discussing future visions is highly abstract for people who are used to debate current practical issues of concern. The developer has to compromise on the abstraction or formality of the outcome as it still has to be understood and approved by the user. Tschudy et al. [TsEtAl96], a developer team for a health care system in rural India attempted to assess data classified by seasonal activities:

> "We knew that during the summer, the participants must collect census material; in the monsoon season, they have to manage malaria outbreaks; and in the winter they must deal with influenza and family planning quotas. This turned out to be too abstract a concept to start with and as a result the team abandoned this seasonal distinction."

The system designers' conceptual categorisation has to asymptote with the users' one.

> "Dialogical Design calls for the conscious development of a project language, linking the relevant domains of reality in a way that everyone is able to follow" [Flo92c].

Software experts translating data into a system specification - which in the worst case is totally incomprehensible to users, e.g. formal specification Z, predicate logic, etc., even Data Flow diagrams as used by some companies in Namibia - do not include users in any further planning. Specifications in form of text or graphic cannot considered to be appropriate because users struggle to visualise the resulting software product. Prototyping has become a favoured approach to demonstrate requirements that the user does not fully understand [KoSo98].

> "Prototypes are tangible objects for anticipating future situations both from use-related and technical perspectives [...] By discussing a prototype with the user, the developer is able to see how a prototype is used and to gain hints about its usefulness" [LiZu96].

However, if users do not know what part to play in the process of modification or development of prototypes, they will not participate they way they should. In other words, if users do not understand in which way the implemented versi can be changed, they will not be able to criticise fruitfully. This is especially important in the non-information-technological-versed societies, as they lack the experience of what is possible.

In one of my student projects, a student successfully conducted a workshop wit the users to gather initial requirements from where she developed a prototype. However demonstrating the prototype to the workshop participants they all said:

> *"Yah, it is just fine like that."*

Only one computer-literate student requested:

> *"When I click on this image I want it to be enlarged on the screen".*

Once more, to be creative is different from evaluating or criticising. The success of an evaluation depends on autonomy, self-confidence and eventually on technological understanding of participants. Even when prototypes are less abstract, users still get intimidated. The use of prototypes contains the danger of strengthening model-monopoly. Bådker and Grånbaeck (1991 in [Mac96]) present the approach of co-operative prototyping where users are not only involved in the evaluation process. It is considered to be a mutual learning process that, if time and money resources allow, could be considered as mos favourable.

Alternatively more non-abstractive culture-imminent methods could be used, e.g. association.

> "In associative information processing, people use all clues (verbal and non-verbal), plus the context in which communication is taking place, to understand and interpret a message. This type of thinking has also served as a survival mechanism for people who have been oppressed. Triandis [a psychologist] cautions that the minority client who relies on associative information processing may have difficulty communicating with a therapis who uses an abstractive pragmatic style. The abstractive-pragmatic style of

communication relies almost entirely on the spoken word and focuses on verbalisation directly related to the topic under discussion." [Weh95]

Numerous authors discussed the relevance and usefulness of metaphors in the area of design.

"Metaphors can be used as a tool for reflection as well as for action" [KeMa91].

However, metaphors in a cross-cultural context are prone to misinterpretation as they are highly culture dependent. The user of metaphors has to be competent in the target culture. In a setting in which the chosen project language is not the native language of the users, metaphors cannot be considered appropriate.

Other frequently used associative methods in system design are scenarios.

"Scenarios describing the current work situation, the everyday tasks and the objects and means of work. Scenarios are written by developers based on interviews with users and the other various groups involved"[LiZu96].

If written by the developers it leads back to reflecting an etic perspective. As much user involvement as possible is required to avoid misinterpretations. Ramos suggests the representation of working relations through street theatres conducted by participants to facilitate a reflection process as well as an enlightenmen process for the developers. PictureCARD[51] - a Storytelling Tool for Task Analysis - was developed by a team [TsEtAl96] for a cross-cultural context to provide a voice for user-participation. The technique is highly visual and interactive and does not depend on capturing information textually, or on ethnographic investigatory techniques. To keep in line with cultural norms, detailed line drawings were used, based on photo extraction rather than text. PictureCARD provides

"an excellent tool to conduct and facilitate cross-cultural interviews in order to reach a shared understanding of the participants tasks and activities. [...] PictureCARD as a method is effective in providing a consistent and broad basis for analysis of context."

In a multi-cultural setting, methods familiar to the system developer may not be valid any longer, like Future Workshop for tacit users or prototypes to receive feedback. The system designer therefore has to possess an intercultura competency to identify culturally appropriate techniques to motivate the user to co-operate and to discuss future situations.

### 6.4.3 Requirements for cross-cultural dialogical system design

Normalised knowledge

There is knowledge that does not seem to be important to be mentioned by the user because it is "normal" within the target culture but of major relevance for the system development as the developer is not aware of this. For example, one Namibia software company reported that they would implement big buttons and fonts for the user interface as they were aware of the reading difficulties of their semi-illiterate users. For this, we need to adapt research methods that allow the investigator to become part of the community in order to understand what is not usually made explicit [Jor96]. There is no way to gather this kind of information

[51] developed PictureCARD on the basis of the participatory method CARD (Tudor et al.,1993a,b) in [TsEtAl96

with conventional methods of communication. The interviewee would never think of asking about it as he is not even aware of its existence. Reuter et al. [ReEtAl91] believe that a successful intercultural communication depends essentially on the knowledge about the foreigners. Therefore methods have to be identified to inform the developer about the users and their environment.

Say/mean problem

In many instances, target users may not be used to be involved in creative, communicative decision processes and therefore are unable to participate. Further, what the users say and what they mean might be two different things. In communication-theoretical terms it would be summarised as the users having a weak communication competency since they cannot verbally express their wishes and anxieties. The chosen method therefore has to secure the enhancement of users' communication competency.

In some cases, users are intimidated or distrust the foreign system developer and therefore behave non co-operatively and intentionally hide information. The autonomy of the users therefore has to be developed for them to be in a position not to be frightened by foreign system developers. The latter has to show respect and empathy for the user to build up trust and a co-operative relationship. The chosen methods have to support the users' autonomy.

The success of a symmetric dialogue with autonomous users and system developers communicating their perspectives is mainly dependent on the intercultural competency of the system developer to facilitate cross-cultura communication. The system developer has to find techniques to evaluate the users' intentions and competency in order to develop and apply culturally valid methods for the system design process.

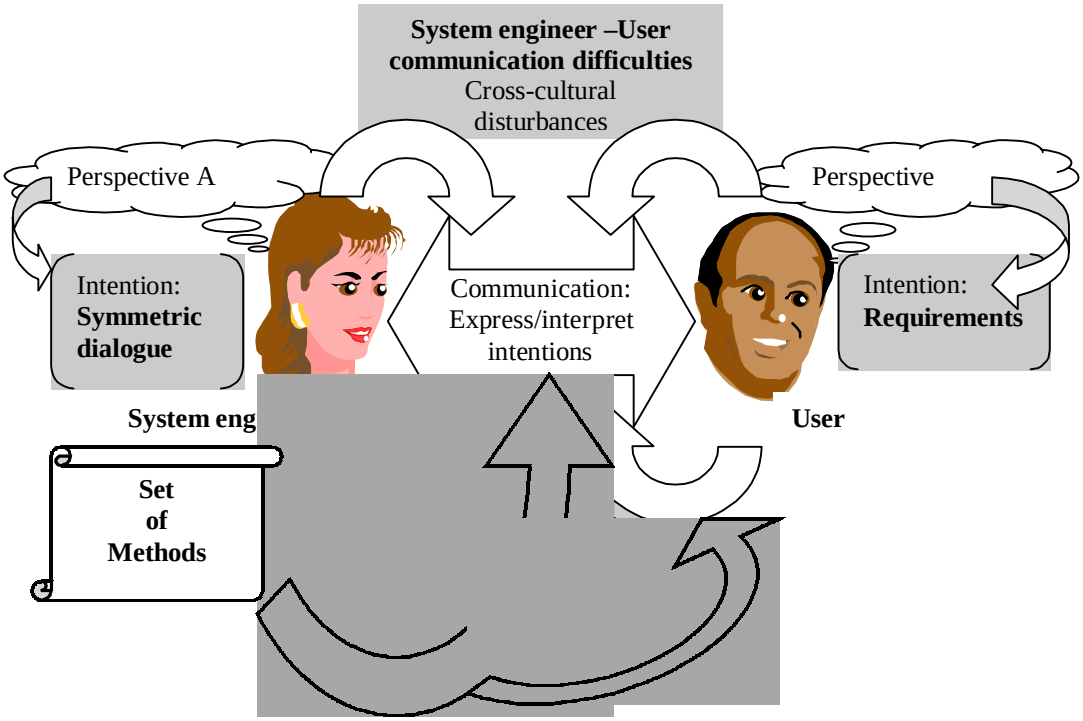



Figure 6-4 Cross-cultural System engineer-User dialogue

Therefore the answer to cross-cultural system design is system engineers with skills and behaviours indispensable for mastering cross-cultural interaction and a set of culturally appropriate methods to facilitate successful dialogue.

This chapter illuminated the influence of culture on system design and the resulting requirements for successful system design in a multicultural context. Communication plays a central role all along the system design process and does not end after the establishment of an agreed-on problem to be solved. As much as a shared understanding of the problem has to be established, a mutua understanding of the solution has to be guaranteed. Therefore a symmetric dialogue with autonomous partners being able to communicate is envisioned. However for a cross-cultural communication to be operative, intercultura communication competency is required from the partners involved. Within system design, many methods have been developed to bridge the user-system developer communication gap. Thus their cultural validity has not been considered. The success of the dialogue depends mainly on the system engineer's intercultural communication competency in assessing the users' intention and competency to chose culturally appropriate methods. The then required skills of system engineers are emphasised by diverse intercultural training programmes as presented in the next chapter. Furthermore, ethnographic methods are presented, as they are to reinforce a culture-sensitive method development.

# 7 Promoting cross-cultural learning of system engineers

System engineers working in a multicultural system design context need to be equipped for the challenges of an intercultural dialogue. Based on cross-cultural sciences, psychological and educational theories, cross-cultural education and training programmes promote knowledge, behavioural strategies and affective aptness for intercultural encounters. Yet certain culture-specific knowledge of users cannot be formally taught but has to be explored locally. In this regard, ethnography seems to be a promising approach to inform system analysts about users and their environment. Ethnography - as applied in current system design processes - has only been considered to inspire system design with regard to the domain of application, yet never to inform the design process itself, i.e. to decide in advance the means of interaction and the choice of design methods in a specific design situation. This is a new challenge: the integration of ethnographical studies into system design.

## 7.1 Cross-cultural training and education

An intercultural co-operation without prejudices, recognising and considering the culture-specific influence in social interactions and, step by step, being able to understand the others in their culture requires an intercultural learning process [Tho83]. With contributions from psychology, ethnology and pedagogy, cross-cultural educational training programmes are constantly evolving to support intercultural learning effectively. System engineers working in a multicultura context can be equipped for the challenges of intercultural dialogue through cross-cultural education or training.

### 7.1.1 Intercultural learning

The different sub-fields of psychology have delivered distinct explanations for the intercultural learning processes of people involved in intercultural encounters. It is generally understood that intercultural learning includes - besides comprehension of other cultural orientation systems - the reflection on the own cultural orientation system

Integrative process

Thomas (1988, quoted in [Aue90]) describes intercultural learning as an integrative process, and the learner as a person who endeavours to

- understand the others' specific orientation system of perception, thinking, judging, and acting
- integrate the others' orientation system into his/her own
- apply it to his/her thinking and acting within the alien cultural field of action.

Cultural choc

Goehring [Goe80] looks at the emotional stages a person goes through. A well-known phenomenon often described is the so-called cultural shock, the discovery that one's set of problem solving approaches is not valid with a resulting decreases in self-confidence. Goehring introduces Adler's (1975) phase model of:

1) contact
2) disintegration
3) reintegration

4) autonomy, development of intercultural sensitivity, flexibility and the ability to communicate and act in the target-cultural contex
5) independence, where the individual can accept and appreciate cultura differences and similarities.

Ethnocentric to polycentric

Holzbrecher [Hol97] looks at the learning process from a cognitive psychologica view. The metamorphoses of the world perception within an intercultural encounter can be compared to Piaget's (1991) concept of decentralisation of the infant's self-perception. The infant's I detaches itself from its centric position in its perception of the world to become a subject in a wider context, like a group or a society. Much the same counts for the conception of the world which evolves from an ethnocentric to a polycentric structure. Holzbrecher argues that the societal organisation develops out of self-confident design of dialogical structures with the aim to form a net of interconnected, different - yet equal - subjects. The perception as well as the active formation of this situation implies the necessity for dialogical and relational skills. Further he argues that only in dialogue, self-knowledge and subject development can take place. Holzbrecher refers to psychological findings of adolescent self-perception and world-conceptualisation to inform methodologies of intercultural learning. The endeavour for validation is considered to be an interaction of perception, reflection (reflexive processing) and (ways of) expression. Through a reflexive processing of intercultural encounters, required competencies may be acquired, such as,

- To direct the intellectual and emotional concentration on the dialogical situation
- Anticipating possible behaviour and reactions of the other
- Objectify/ express one's own form of perception
- Actively listening
- Process the effect of the different experience through self-reflection (resonance perception).

Holzbrecher further describes the process of understanding as an oscillation, based on Erdheim's (1990) idea of oscillation between cultures as decisive instrument of understanding in ethnopsychoanalysis. The intention is to allow an oscillation between consciousness and unconsciousness, linear and non-linear thinking, synthesising perception and analytical thinking in order to facilitate intercultural learning leading to a change of world conception. Yet to achieve intercultural learning through a dialogical and conscious oscillation between the other and oneself -

1) The image of the other must be open to changes
2) The wish to understand the other, knowing that one can never entirely understand the other.
3) Develop a sensitivity of the dynamic at the border of contact.

Ethnocentric to ethnorelative

Paige [Pai96] elaborates on the stages of development of a person within an intercultural learning process. A number of developmental models have been presented, yet Bennett's (1993) developmental model can be considered as the most conceptually sophisticated. He represents intercultural learning as a process that moves from ethnocentric stages of denial, defence and minimisation to ethnorelative stages of acceptance, adaptation, and integration. Accordingly, he

suggests an education and training programme which supports the development through those stages.

> "Intercultural sensitivity is not natural. It is not part of our primate past, nor has it characterized most of humanity history […] Education and training in intercultural communication is an approach to changing our "natural" behaviour. With the concepts and skills developed in this field, we ask learners to transcend traditional ethnocentrism and to explore new relationships across cultural boundaries." M. Bennett, 1993, p.21 [Pai96].

System engineers in multicultural system-design contexts require going through a conscious intercultural learning process. They have to endeavour to understand the users' orientation system. Therefore they have to reflect on their ethnocentric perspective, on their problem solving strategies and on the intercultural encounter itself. Through dialogue, the system engineer can acquire the necessary skills for a successful intercultural communication and a polycentric or ethnorelative view. This will enable the system engineer to understand, accept and integrate the different views of users into the system-development process. This intercultura learning can be formally supported and anticipated through multicultura education and cross-cultural training programmes.

Many general goals of training and education are similar, like increasing awareness, knowledge and acceptance of cultural differences, confrontation wit prejudices and ethnocentrism, challenging stereotypes, coverage of behaviours and emotions, such as cultural shock. However, Paige [Pai96] warns that intercultural education is intrinsically transformative as it is preparing learners for major transitions in their lives which therefore poses serious risks. He appeals that competent trainers - able to recognise those risks and assess and sequence learning activities accordingly - should carry out the training. A major difference between education and training is the length of the programme, and that training is usually for a specific purpose whereas education is meant to be more pervasive and far-reaching. Furthermore, looking at the nature of publications, intercultura training literature comprises many empirical studies, whereas multicultura education draws heavily from descriptive and goal-oriented debates [BrHo97]. A brief elaboration on both will be given in the following.

### 7.1.2 Multi-, Inter- or Trans-cultural education. Only a terminology problem?

The field of multicultural pedagogy is very young, dating back from the Seventies only, stemming from the time since debates have started about the terminology, about the normative or descriptive meaning of multicultural and intercultura education. Brislin and Horvarth [BrHo97] identified four specific uses of the term: diversity (minority) education, global (international) education, non-western education, and intercultural education.

Diversity education (ethnic education) addresses issues concerning minorities (immigrants or natives); it promotes the development of cultural pride and behaviour necessary for economical and political success of minorities. In Germany, controversial debates are held about inhowfar the cultural dimension is used as a legitimisation of the exclusion of minorities [Nie99].

Global education focuses on international trade relations and often provides specific information mostly on business.

Non-western education aims to educate western countries about non-western cultures. Different non-western education emerged, like in the German literature the so-called Paedagogik der Dritten Welt" (Third-World pedagogy) which focuses on cultural identity. The research of leading authors, e.g. Nestvogel, Dias, Schoefthaler and Schmidt, operates under the motive of "learning from the Third World" to overcome the monocultural eurocentric theories of pedagogy. The intention is to consider culture specific cognitive styles, social habits and communication codes in order to synthesise field-dependent and field-independent thinking. Often it is also called transcultural education or culture-general education. Schmidt (1987) has presented an exceptional general educational programme comprising a curriculum based on multicultura education. [Aue90]

Intercultural education refers to diversity in classrooms. Intercultural education has been criticised under different aspects like ideology, constitutional law and philosophical normative, the elaboration of which would lead too far. However, to be mentioned is the sensitiveness of the topic within post-apartheid countries, e.g. South Africa and Namibia, where the distinction of ethnical groups was misused to justify a separatist and unequal education. Culture within intercultural or multicultural education cannot be used as a neutral concept. However, overemphasising commonalties cannot be the answer to equalise education. Real respect for the other, the stranger, is not only demonstrated through focus on similarities, but also in the honour of differences [Nes94]. The Namibian Ministry of Education and Culture [MEC93] therefore explicitly formulated in its educational policy document:

> "We must explore our diversity to become familiar with how we are alike and how we differ. … We must make the transition from viewing culture as the object of study to understanding ourselves as the subjects of culture. W must be part of our cross-cultural dialogue, not simply its observers. We must recognise our differences not as curiosities but as the foundation of our unity. Only by valuing those differences can we replace the cultura superiority of the few with the cultural confidence of the many."

In German literature, intercultural education is said to be the pedagogic answer to a multicultural society, a flexible action concept that perceives social changes and initiates innovation processes. It is seen as a contribution to peace education through conflict resolution. It is based on child-centred pedagogy, understood as life-related, as active learning, spontaneous, and as considering individua differences. Most supporters of intercultural education consider empathy [52], solidarity, tolerance, co-operation and conflict competence as ke issues which are part of social learning. [Aue90]

Yet the fruits of these highly ambitious pedagogies are still to be awaited. Lacking are further discussions about the implicit cultural variable of the subjec

[52] Empathy means to understand the other person, to be able to put oneself in his/her position, to see the world through his/her eyes. Like sympathy but emotionally detached.

itself. Only few fields like ethnomathematics raise concerns with regard to integration in the curriculum [Sch94]. Furthermore, an explicit analyses o cultural differences between teacher and learner is important as has been pointed out by Hofstede [Hof86]:

> "As teacher/student interaction is such an archetypal human phenomenon, and so deeply rooted in the culture of a society, cross-cultural learning situations are fundamentally problematic for both parties."

It would be expedient to integrate multicultural education in the computer science curriculum at University level. International education could easily be integrated as it can be taught as independent module since it can be found in some Universities in the United States. However, beyond this it seems that for the time being we have to be content with training programmes as their implementation is much more progressive.

### 7.1.3 Overview of cross-cultural training

Much the same as multicultural education, cross-cultural training is related to a variety of labels like intercultural training, diversity training, cultural diversity training, cultural diversity awareness training, multicultural training or intercultural communication training. Although there is some overlapping of contents, there may also be some distinctions among them. Common to those programmes is that they are short-term programs with a very specific focus like training of a group of business people about to be assigned to China, or people about to live in another country, or individuals who interact with members of diverse cultures [BrHo97].

Training focuses on the transfer of relevant knowledge, skills, and attitudes aiming to change the participants' thinking, feelings and behaviour.

Benefit

Accordingly, Landis and Bhagat [LaBh96] praise the positive effects of cross-cultural training:

- Changes in people's thinking: better understanding of hosts, decrease of negative stereotypes and oversimplifications and increase of world-mindedness and knowledge about own culture
- Changes in people's affective reactions (feelings): anxiety reduction and enjoyment and good working relation with hosts.
- Changes in people's behaviour: better interpersonal relationships in multicultural groups, better adjustment to everyday stress and better job performance, increased interaction ease, and assistance of people achieving their own goals.

Training design issues centre around the following topics:

- Organisational and learner need assessmen
- Determine goals and objectives
- Determine content (culture specific/ culture general)
- Determine approach (Didactic/Experiential)
- Techniques (cultural simulators, role plays, lectures…)
- Programme implementation
- Programme evaluation

Need assessment

Gudykunst et al. [GuEtAl96] suggest that the programme should not be based on need assessment only, but that it still has to be theory-based. The need assessmen is considered to be essential for an understanding of the trainees' perceptions of their needs, and this will have to be addressed, otherwise the other material presented might be rejected.

Goals and objectives

Many approaches have been described in the literature with different objectives. Like the Brislin Yoshida's Approach (1994) in [GuEtAl96], which addresses awareness and knowledge about culture and its influence on behaviour, the emotional challenges individuals face when communicating with members o other cultures, and the skills trainees need for effective intercultura communication in another culture. Another approach presented b Gudykunst et al. [GuEtAl96] is the anxiety/uncertainty management (AUM) which is based on the assumption that managing uncertainty and anxiety is necessary for effective intergroup communication and intercultural adjustment.

Mueller [Mue91] lists the following goals for training courses:

1. openness for new experiences
2. empathy for people from other cultures
3. detailed perception of differences and similarities between the own and the other culture
4. ability to describe non-understandable attitudes rather than to judge them as bad, useless or insignificant
5. relative distance of observation of the own and the other's attitude
6. ability not only to enter into superficial relationships with representatives o the guest country
7. less ethnocentric behaviour (first understand the other within his or her own culture).

Content

Depending on the needs, the contents of the training programme are determined. Two major streams can be pursued - a culture-general programme or a culture-specific programme. The culture-general programme covers issues like awareness/sensitivity about cultural influence on behaviour, ethnocentrism, stereotypes, prejudices, and cultural variables like individualistic vs. collectivis cultures. The culture-specific programmes pertain to interaction guidelines and information about specific cultures.

Approach

Two different pedagogic approaches can be distinguished: the didactic (cognitive) approach based on cognitive understanding versus the experimental (affective) approac based on the assumption of learning best from own experience. Usually they are intermingled within one workshop to satisfy the different learning styles of participants.

Techniques

A few different training materials have been published which describe techniques like cross-cultural mini-dramas ( Seeley), cultural assimilators (Albert, Triandis), culture capsules (Miller/Bishop), role-game simulations, or diverse percepti exercises to sensitise for different cultural standards. Mostly, those methods comprise critica incidents which are cultural intersections/typica misunderstandings. They can be fact-oriented or central cultural patterns. Mueller [Mue91] criticises fact-oriented material as it might often be contradictory and the course participants might apply it mechanically and unreflected. He therefore

suggests a broader view through transmitting a general cultural sensitivity. The training material comprises interpretation exercises on the foreigners' attitudes as well as a reflection on how one's own behaviour appears to the stranger. In simulation and planning exercises, preferably representatives of the target culture are actively involved.

Gudykunst, Guzley and Hammer [GuEtAl96] present a typology of intercultura training techniques depending on approaches and content

Table 7-1 Intercultural training techniques [GuEtAl96]

| Content / Approaches | Culture general | Culture specific |
|---|---|---|
| **Didactic** | • Lecture/Discussion<br>• Video tapes (illustrate intercultural communication process<br>• Culture general assimilators (critical incidents) | • Area orientation briefing<br>• Language training<br>• Culture specific assimilators<br>• Culture specific reading |
| **Experimental** | • Intercultural communication workshop (discussion/role plays)<br>• Culture general simulations<br>• Self-assessments (questionnaires) | • Bicultural communication workshops<br>• Culture specific simulations<br>• Culture specific role plays |

Implementation

The trainer or the training institution has to design an appropriate training programme in accordance with the determined goals and objectives. For example, Bennett - who supports the transition from ethnocentric to ethnorelative - starts off with cultural awareness activities, then more and more intense and experiential activities, and in the last phase activities focused on developing a system of ethics to guide behaviour.

Evaluation

The issue of an evaluation of training is complicated as the success cannot be measured at the end of the course and the result can only be perceived once the trainee is in a specific intercultural interaction.

More details are beyond the scope of this work but can be found in numerous publications, e.g. the Handbook of Intercultural Training edited by Landis and Bhagat [LaBh96], or the Handbook of Cross-cultural Psychology edited by Berry et al. [BrHo97]. The concern of these authors is to provide essential theoretical foundations for designing effective intercultural training programmes.

Flechsig [Fle99] suggests that culture-specific training programs should be complemented by supporting measures of encounters with real representatives o the host country as well as factual knowledge of country-specific as well as general research results in cross-cultural social sciences. Those ideas have been implemented by diverse organisations specialised in sending people abroad. For example, people recruited with CIM undergo a three-month training consisting of an intercultural communication workshop, a language programme, survival workshops, organisational and country-specific information, preferably with people of the host country involved as trainers.

### 7.1.4 Anticipation of cross-cultural training for system engineers

The specific training needs depend on whether an individual system engineer is sent abroad, or the organisation is having a cross-cultural joint venture or the system engineer is part of an international development team. Yet, the goal of the training should focus on awareness of ethnocentrism, on affective reactions due to unsuccessful problem solving strategies and general knowledge on change o perspectives. Depending on the context, the culture-general content should be completed with a culture-specific part. In either case, it is desirable to have a se of culture assimilators and role-plays tailored to the system-design context. Furthermore, the communication competency has to be promoted with eventually culture-specific knowledge, like language and discourse strategies and other interaction forms. The software expert who has to design a system has to have knowledge about:

- the historical, cultural, political, and economic realities of users
- power (dominance and subordination), oppression, socio-economic inequalities, and marginality
- time orientation of the users' culture
- activities (working, religious, leisure)
- social relation of the users culture (linear, collateral, or individualistic)
- perception of the world and self.

> "These psychometric paradigms are then used to help different cultura groups understand how their perceptual reality-constructs differ and how they misperceive the constructs of other cultures. This offers a subsequen point of departure for improving dialogue and reaching conflict resolution" [Lum96].

Factual knowledge (economy, politics…) is usually excluded from training programmes as the trainees themselves are expected to retrieve this information from other sources. Furthermore, the greatest care has to be taken with regard to biased culture-specific information even if supplied by representatives of the country. According to Mueller [Mue91], intercultural training should demonstrate how verbal indicators for different cultural attitudes and interpretations can be understood in order to differentiate cultural from personal attitudes. I believe tha certain culture-specific and, more precisely, user-specific information or context sensitive knowledge is best obtained locally.

## 7.2 Ethnography, towards a better understanding of the user

> "A distinguishing feature of ethnographic work is that it is concerned wit understanding what the world looks like from the point of view of participants. How do they describe and make sense of their world and their activities; how do they talk about what is going on; what is important and significant to them and what is not; what resources in their environment do they use; what categories, models and representations are relevant and meaningful to them for solving problems and carrying out their work [Jor96].

The concern of ethnography as mentioned by Jordan matches precisely with what is essential to cross-cultural dialogical system design. Ethnography therefore

seems a valuable method for a multicultural system design context. However, a successful integration in system design has not been accomplished. Yet I see the challenge of ethnography to shape the design process itself rather than the system requirements, as opposed to diverse attempts in system design. I will therefore present a distinct integrated approach in the next chapter.

### 7.2.1 Ethnographic Principles

Ethnography is unlike other social sciences in a number of ways. The most obvious difference is that it keeps a distinctive attitude to what it regards as premature theorising, which means that it cannot set up analytical frameworks prior to inquiry [Com94]. The ethnographer starts his research with as few assumptions as possible as opposed to the traditional hypothesis-testing social scientists.

> "If objective information is replaced by situated information, then the orthodox approach of formulating and then testing hypotheses objectively, for example through statistical sampling, will not be valid, because the random events observed can no longer be assumed to be statistically independent. However, statistical methods are the foundation for much of traditional sociology, for example, the design and evaluation of questionnaires. I do not suggest that statistics and questionnaires are never useful, only that they are not always valid, and in particular, that they should not be used in situations where context plays a significant role" [Gog94].

Initial learning

In ethnography, emphasis lies on the initial learning process within a natura setting. Ethnographic fieldwork involves an iterative approach to understanding. Early formulations are continuously revised as new observations challenge the old, and adjustments in research strategy are made as more is learned about the particular situation at hand (Blomberg et al. 1993 in [Jor96]).

Holistic perspective

Ethnographic studies aim to gain a holistic perspective, through which isolated observations can only be understood in relation to other aspects of the situation.

> "An ethnographer learns something new, and then tries to connect how it connects with other aspects of the situation in which the new learning occurred. [...] He then tries to see if it connects with other things he has learned [...] like parts of the belief system, or the history of the group, or the wealth of the informant"[Aga80].

Personal long term involvement

Furthermore, the direct personal involvement in the community is important in order to associate with people over an extensive period of time in a variety of contexts like at home, at the work place, in religious ceremonies, in recreationa activities, etc. The ethnographer thus builds up a relationship of trust. Fischer [Fis92] suggests that the ethnographer should live among a "closed" community for a longer period, at least one-year, participate in its activities, take on a "role" in their system and learn to act "correctly". The period of one year relates to experiencing a full cycle of the four seasons. Jordan [Jor96] is talking of the "surprise index", whereby one can be certain to have made enough observations when there are no more surprises, e.g. the events that happen are predictable and familiar to the researcher the same way they are to the people.

Ethnographic account

Ethnography is a post-hoc representation or account of what has been seen, heard and found in the field. Ethnography does not consist of just writing down field notes but also of their interpretation and analysis [And96]. Nestvogel (1987) in [Aue90] suggests that cultural phenomena should be explained within their social context and should only be interpreted in a following step under consideration of value criteria. The goal is to transfer observations into accounts that according to group members are possible interpretations of what is going on. Ethnography also insists on the fact that the native - the participant - is not necessarily the best judge. Of course they have to be asked, but their answers have to be corroborated by many other forms of evidence. The ethnographer learns how informants interpret the world through which they move [Aga80]. The ethnographer therefore learns language and culture in order to become intimately familiar to obtain the subjective understanding necessary to integrate and correlate the various types of data obtained, like [And96]:

- synoptic charts which lay out the relationships between various kinds of institutions, customs and activities with information provided by native informants and observation of events
- description of day-to-day life and activities
- Collection of stories, narratives, myths, magical formulae and the like, through which the society represents itself and the world around it.

Results

Within ethnographic studies, different results can be anticipated like [Fis92]:

- A theory can be confirmed, proven wrong or be completed
- Problems can be found or stated more precisel
- An outline of the culture can be made
- A summary of the history can be given
- Information about possibilities or errors of certain methods

### 7.2.2 Ethnographic methods

> "The ethnographer is a human instrument. […]
>
> Relying on all its senses, thoughts, and feelings, the human instrument is a most sensitive and perceptive data-gathering tool. Yet the information this tool gathers can be subjective and misleading. Fieldworkers may lose their bearings in the maze of unfamiliar behaviors and situations. Ethnographic methods and techniques help to guide the ethnographer through the wilderness of personal observation and to identify and classify accurately the bewildering variety of events and actions that form a social situation" [Fet89].

Triangulation

Shipman (in [Hen95]) pointed out that each social researcher is likely to concentrate on different aspects of a 'confused reality', which is too complex to study in its entirety. A partial solution to understanding this complex reality is triangulation of methodology, which means using several methods to study the same object. If only one method would be used, the result is a 'one dimensional snapshot of a very wide and deep social scene'. The core of ethnography is observation combined with interviews. Depending on the researcher, more emphasis is given to the one or the other. For example, Agar [Aga80] considers

informal interviews as the heart of ethnography, with observation in a supplementary role.

Participant observation

> "Using a highly structured randomised design without a basic understanding of the people under study may cause the researcher to narro the focus prematurely, thus eliminating perhaps the very people or subjects relevant to the study. Such a misdirection study may yield high reliability but extremely low validity, undermining an entire research study. The best way to learn how to ask the right questions - beyond the literature search and proposal ideas - is to go into the field and find out what people do da to day" [Fet89].

Participant observation is therefore a very important method in the initial learning period. The ethnographer should be open for unknown and unexpected situations. Observation enables the researcher to gather data that cannot be collected with other methods, especially normalised and tacit knowledge. It may seem unsystematic, yet it sets the stage for more focused research and refined techniques in a later stage of the study. Another important concern has been raised by Jordan [Jor96]:

> "What people think and say they do and what they actually do are two different things […] Failure to pay attention to the say/do distinction is common and rarely questioned, but is likely to produce data that are invalid in the technical sense, i.e. data that do not measure what we intended to measure."

Agar [Aga80] explains that a difference between reports and behaviours is a normal part in human interaction, whether it is labelled as problem of reliability, error, or lying, as long as the methodology includes procedures to deal with. Observation can thus be used to verify interview data without relying on second-hand information.

Interviews

The ethnographer should be part of the flow of community life, observing and talking with people, to learn which questions to ask and how to ask them. In the beginning, the ethnographer does not know enough to ask the right questions. In a long-term relationship, there is a lot of time to ask questions that have been missed earlier [Aga80]. The more one knows, the more specific questions can be asked. An interview has the role of soliciting information, to explain and put int a larger context what the ethnographer observed. It helps to classify and organise an individual's perception of the world. Interview types include structured, and semi-structured, informal interviews. They can be individual or group interviews.

Structured and semi-structured interviews are verbal approximations of a questionnaire with explicit research goals. These interviews generally serve comparative and representative purposes - comparing responses and putting them in the context of common group beliefs and themes. At the beginning stage of a study, these interviews tend to shape responses to conform to the researcher's conception of how the world works. Yet it could help to learn how to ask, discover issues to investigate and give a clear role to the researcher, however it is not seen as a method which collects important data. These interviews are considered to be most useful during the middle and end stages of a study for the collection of data about a specific question or hypothesis [Fet89].

The researcher uses informal approaches to discover the categories of meaning in a culture [Fet89]. In an informal interview, everything is negotiable; informants can criticise a question, correct it, point out that it is sensitive or answer in any way they want to [Aga80]. In informal conversations, the interview setting is not obvious to the interviewee and often better information can be gained. These interviews however are the most difficult to conduct appropriately and productively.

Recording

A further difficult task is the recording of data. Firstly, at the moment o something happening one does not know yet what is significant and what should be recorded. Observational and interview material centred on a particular issue can be gathered into working papers as a first step in analysis. Taking notes while observing often distracts the observation, and retrieving from memory can be distorting. The advantage of video is to have an independent analysis of the situation that can be taken elsewhere and analysed to be able to create an inscription, which translates without distortion, that is objectively, and which can be rendered mobile. It solves the problem of what has been seen but went b unnoticed because by reviewing the tape this can be explicated. However, the video captures only segments of a situation whereas human beings have a wider angle to capture information.

### 7.2.3 Current use of ethnography in system design

Using ethnography in the design of computer-based systems has become increasingly prominent, especially within the research community of computer-supported co-operative work (CSCW), but also within participatory design and human computer interaction.

#### 7.2.3.1 Prospect of ethnography in system design

Many authors have recognised the challenge of ethnographic methods reinforcing system design.

> "Within CSCW, the usefulness of the ethnographic preoccupation with the "native" (here the users perspective) has gained increasing recognition and it is now taken for granted that careful in situ participant observations before the design phase are indispensable for the success of a project [Jor96].

Nevertheless, a systematic integration of ethnography in system design is still outstanding in general.

> **"**Observation may be necessary in establishing a mutual learning process with users, aiming towards a shared understanding of the current work practise and in developing realistic visions of future use of computers. Secondly, using ethnography may unveil users' multiple viewpoints on the current work as well as on future use of computers" [SiKe97].

Randell et al. (in [Wes97]) values the gain of ethnography for the contextual analysis.

> "Ethnography can provide adequate account of the 'real world' characterisation of work and uncover tacit knowledge. And because of the 'neutrality' of the ethnographers visa vice the wider organisational context

> [...] opens up space for a sophisticated understanding of real organisational life and its interaction with technical artefacts."

The use of video to represent the activities of those working in organisations and their interaction with artefacts has developed rapidly since the initial research by Suchmann [SuTr91]. Video-based methods allow viewing of the source data again and again throughout the system development lifecycle [JiGo94]. Luff et al. (quoted in [Wes97]) state that

> "detailed, naturalistic analysis of video-recordings of (real world) work and interaction may generate requirements for technological support and innovation and lead to a thorough reconsideration of our traditional conceptions of task and co-operation."

Within the research community, at least a more empirical understanding of the social context of the future system is endeavoured.

> "It seems likely that the use of the more rigorous empirical methods will be valuable in increasing our understanding of the problems in this difficult area, and will pave the way for developing methods that are both efficient and effective. It may be that methods based on ethnomethodology with its orientation towards revealing participants own practices and examining the details of work practices and interaction, will be valuable in this regard." [JiGo94]

Different authors envision an innovative improvement to system design through the use of ethnography

> "Taking the tacit and, in particular, the socio-interactional foundations of in situ organisational conduct seriously may not only support the evaluation of technologies and rapid prototyping, but also allow us to identify systems to further support indigenous practises and reasoning" [LuEtAl93].

#### 7.2.3.2 Integration of ethnography in system design

Many authors describe their attempts of integrating ethnography into system design. Based on this, Anderson [And96] and Hughes et al. [Com94] categorised the different approaches.
Anderson [And96] differentiates between three groups of ethnography related to system design:

1. Integrated: The ethnographer is seen as a member of the design team. The ethnographer is involved at a conceptual stage which is the design requirement analysis, and in the evaluation stage. The objectives are set by the needs of the design orientation.
2. Complementary: Raise designers' awareness or sensibilities through ethnographic analysis.
3. Independent: Findings are not meant to influence design at all

Hughes et al. [Com94] identified the following uses of ethnography within design:

1. Concurrent ethnography: design is influenced by an ongoing ethnographic study taking place at the same time as system development, with little need for requirement documents or a process model.

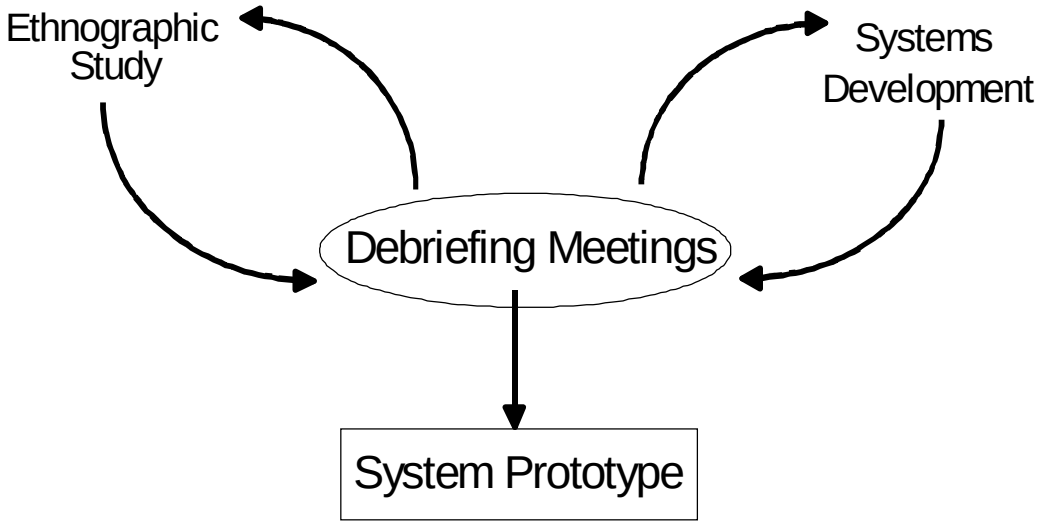



Figure 7-1 Concurrent ethnography [Com94]

2. Quick and dirty ethnography: brief ethnographic studies are undertaken to provide a general but informed sense of the setting for designers.

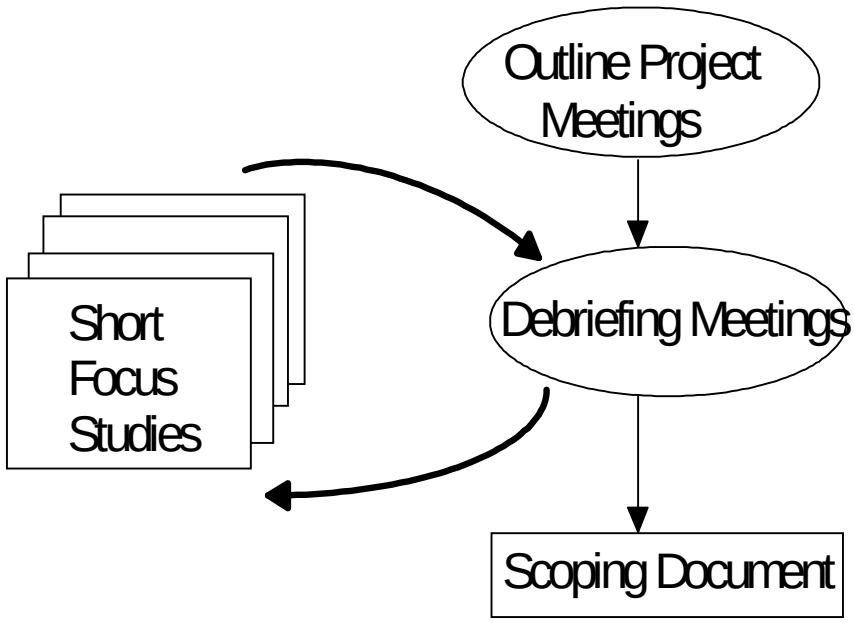



Figure 7-2 Quick and dirty ethnography [Com94]

3. Evaluative ethnography: ethnographic study is undertaken to verify or validate a set of already formulated design decisions, could be developed as a systematic means of monitoring systems in their use. The proposal of continuous but modest redesign through periodic ethnographic field studies of system use may have considerable benefits if appropriately managed.

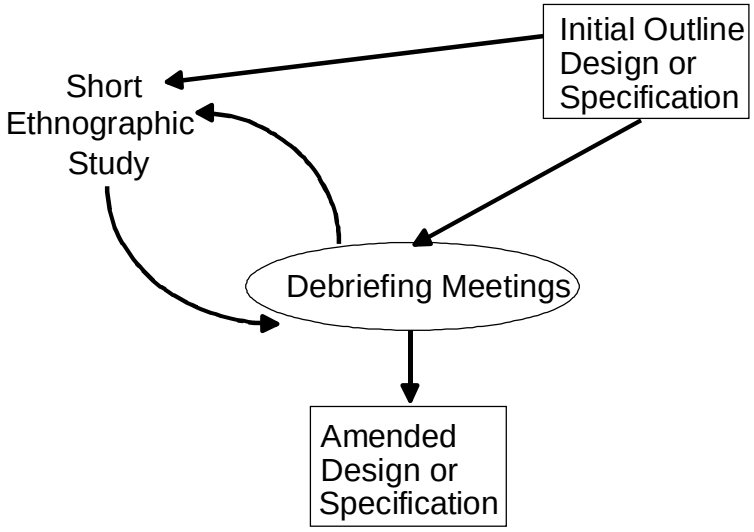



Figure 7-3 Evaluative ethnography [Com94]

4. Re-examination of previous studies
   Previous studies are re-examined to inform initial design thinking.

Many examples of applications and diverse combinations with other techniques can be listed. Sommerville et al. (in [Wes97]), for example, describes an approach according to which the ethnographer regularly returns to the site for short periods of time to report on the progress of his work. The interim records are entered into the Designer's Notepad, a tool designed by Sommerville et al. to replace the debriefing meetings. The ethnographer's attention focused on the records can often suggest a useful organisation. The Designer's Notepad is used by the software requirement engineers simultaneously in order to restructure the requirement specification.

Ethnography and interaction

Suchmann and Jordan [SuJo97] suggest a combination of interaction analysis and ethnographic methods to promote women's knowledge and concerns, engage their hearts and minds and expand their spheres of competence within syste development. A concerted effort to demystify technology and legitimise the authority of local knowledge is undertaken. The knowledge and skills of the prospective users are incorporated into the design process.

Ethnography and intervention

Kensing et al. [KeEtAl96] developed a method called MUST[53] for design in an organisational context within the participatory design tradition. Besides principles like participation, links to project management design as communication process, co-development and sustainability, they include a combination of ethnography and intervention.

[53] a Danish acronym for theories of and methods for initial analysis and design activities.

> "Ethnography and intervention contrast in terms of their basic approaches and intended results: ethnographers originally strove not to change the phenomena they were studying, while interventionists deliberately set up activities to change the organisation in order to learn from the reactions to the change" [KeEtAl96].

This approach resembles much to what I have done in the case study: combination of interviewing lecturers (corresponding to talking to management), and observing and interviewing students. Yet, as the learning process is mostly tacit, neither the lecturer nor the student himself can explicate the understanding process. For example, try to answer the question "How did you come to understand the setting up of equations?" In this case ethnographic methods are not enough, observation must be combined with experiments testing the learning process as was done with prototypes and evaluation cycles to develop an appropriate instructional system.

Plowman et al. [PlEtAl95] examined the transition from fieldwork to system design through a thorough literature study Ethnographically-oriented workplace studies are favoured in situations where specific design solutions are needed. However, contrary to the authors' expectations, detailed design guidelines are typically absent from the publications, but highly generalisable or semi-intuitive recommendations are made. For example, Randell et al. [RaEtAl94] admit that they cannot claim that there is a litera traceability between the ethnographer and the specification of the system components. They only claim that many of the features the system will offer to a user have depended on ethnographic insights. The category of papers with general design recommendations based on detailed analyses represents the highest output. So far there have been very few attempt to translate findings from workplace studies beyond the provision of a few general design recommendations.

> "There is a real danger, therefore, that the 'nuggets of useful information' (Sommerville et al., 1993) generated from workplace studies may become marginalised before they have had the opportunity to show their value" [PlEtAl95].

Hughes et al. [Com94] are convinced that ethnography has much to offer to CSCW, yet much needs to be done to turn it into effective tools for CSC design.

### 7.2.4 Compatibility constraints of ethnography and system design

Many obstacles accompany a smooth integration of ethnography into system design, be it resource restrictions, methodological misunderstandings or conceptual contradictions of the methods. At this stage, there is no actual, practical, design-oriented social science that could be incorporated in leading case studies. Mostly the influence of ethnography can be categorised as consciousness-raising [And96].

Time constraint

For ethnography to be accepted in industrial settings, it has to be in line with usual commercial demands of budget, time and resources. Hughes et al. [Com94] suggest a reduced period of fieldwork, consisting of a few months at most, to save time. Yet they warn that it will restrict on what the method is capable o delivering to designers.

The question of resources further leads to the debate of involving social scientist in addition to system engineers versus the latter applying ethnographic methods. Communication problems between sociologist and IT experts are described in [HuEtAl93] and are due to differences in approaches and terminology. The MUST method therefore advocate that IT professionals start practising ethnographic techniques themselves in their co-operation with the users, rather than involving sociologists in the design process [KeEtAl96]. Yet for system engineers to use the methods appropriately, further training is required which can also be costly and time consuming. Furthermore, one important principle of ethnography has to be re-emphasised, namely the one that assumes to start the study with as few preconceptions as possible. System developers usually already have their goal in mind and are therefore highly focused. The system developers therefore have to free themselves from those goals and open their mind for initial unpredictable learning processes. Any approach, whether sociologists are involved or not, requires additional resources in terms of time or costs which have to be valued in economical terms of the project.

Lacking methodological coherence

The authors of the COMIC project [Com94] blame social sciences for the absence of coherence of methods.

> "Social science is singularly ill-equipped to meet the important needs o system builders and developers because they lack any widespread agreement as to their own methods and approaches with the result that arguments within the social sciences have now been brought to issues in system design."

Yet this criticism is eventually valid for any science involving human interactive methods. No agreement with regard to methods and approaches has been reached in system development so far and should not be aimed for in any way as the development and choice of methods is context-dependent.

A further entanglement of criticism is the accusation of ethnography rejecting formalism while software engineering asks for summarisation and abstraction which requires the use of notations or formalisation. Anderson [And96] holds against this accusation that many ethnographic works are deliberately formal in their structure. They do not use symbolic or mathematical notations bu taxonomies, and taxonomies are formalisations. However the problem is that formalisation rather leads away from the real issue to be resolved: the users' point of view is likely to disappear. Some authors argue that in the process o translating their detailed accounts into more formal requirements, the richness and significance of their work gets lost, distorted or misconstrued.

> "The identification and representation of the complexity of the social which both ethnography and video based analysis provide is undoubtedly an important and worthwhile contribution to the theory and practice of information systems development. But these techniques are not simple panaceas. A fundamental difficulty which both techniques share is that on the one hand they identify this complexity and contextual detail while, on the other, the self same techniques construct inscriptions which become mobile and decontextualised from their production" [Wes97].

This problem of representing the reality is independent of any science and only subject to variation as discussed earlier in this thesis related to system design.

Predictive versus

Yet often software design is based on the development of models based on deliberately, vigorously, and rigidly simplified assumptions. The elegance of the models, along with their economy, is highly regarded, and their aim is to be predictive. Whereas sociology tends to value descriptions or explanations over predictions and the realism of the concepts and propositions used, thei

Holistic versus atomic

resemblance to the perceptions and meanings of participants is highly valued. Further emphasis is on a holistic perspective whereas system engineers

> "need to decompose their problems into manageable segments, achieve a good measure of abstraction in their descriptions of the operations of existing or planned systems, clearly lay out the flows of information, data, channels of communication, and so on, in order that the complex engineering problems and the software requirements can be clearl exhibited in graphical forms" [Com94].

Based on this, the authors of the Comic project [Com94] further argue that the disciplines cannot simply be merged as their approaches differ too much. Attempts of translating ethnographical findings into design requirements demonstrate the contradiction of paradigms, which often is accompanied with difficulties. Sommerville et al. [SoEtAl92] and later Huges et al. [HuEtAl93] present an approach of sequential analysis of the material and the experiences o the field worker and directing these toward the aim of the system design. The designers ask the field worker specific questions about the working place to be computerised. The designer intends to identify further matters to be studied as well as identify design decisions for further prototyping of the system. Four guiding questions are directed to the sociologist:

1. What characteristics of the existing manual system are unimportant and need not be supported in a computerised system?
2. What are important manual activities which need not be supported in a computerised system because the activities are a consequence of the fact that no computer support is available?
3. What characteristics of the manual system must be replicated without change in a computerised system
4. What activities from the manual system may be supported in a way which is different from that used in the manual system

As sociologists remarked, these questions seem to reduce issues about the social organisation of work to a series of apparently individualistic activities giving scant justice to their social character. Furthermore, it directs the sociologis towards a prediction rather than an explanation of the situation. The designers are enforcing their conceptual categorisation on to the sociologist while the latter is aiming for a holistic explanation of the situation. This is where the conceptua differences of ethnographic and system-design approach becomes apparent, viz. holistic versus partial and explanatory versus predictive.

Translating ethnographic findings into design requirements

Consequently, many authors are struggling to translate ethnographic material into specific requirements as envisioned by many authors. A Westrup [Wes97] quotes,

> "In essence, the problem is one of translating the rich, textured, and highly detailed description of sociality that is associated with ethnographic enquiry into a form usable by system designers. ( ibid:246) […] Clearly, however, the ethnographic record must be structured in some way so tha it can be usefully used by engineers who did not actually participate in those studies. Furthermore, if ethnography is to be useful, there must be forward and backward tracability from the ethnographic record to a more structured formulation of the systems requirements" (ibid: 170).

Similar difficulties are reported with regard to video-based analysis

> "though inscriptions can be generated that are immutable and mobile in a physical sense, they remain disordered and require subsequent interpretation and translation into a different notation so as to generate requirements that are viewed as fixed and objective" [Wes97].

### 7.2.5 Expected application of ethnography

Looking at ethnographic studies that are endeavouring to give a holistic descriptive account of a current context and the attempt to use this same accoun to derive requirements for a future computerised system seems paradox. System designers can then justify their decisions - having based them on social methods or ethnographers' accounts and eventually having reduced the ethnographer or the study into concepts of future computer systems. What did we gain? That the accounts or models are closer to reality? Yet the users have not been involved in any future decision and the system engineer presumes a correct interpretation and translation. Ethnography used in such a way means a retrograde step in participatory design. The aim of ethnographic studies is a better understanding of the people under study and should therefore be used to enhance co-operation in system design. Ethnographic studies can lay the groundwork for a symmetric dialogue through uncovering the users' discourse strategies, level of technological understanding, relational structures, time patterns, etc. No more re-interpretation of ethnographic accounts is required and no more pre-conceptualisation of ethnographic studies. Ethnography is to inspire the design process itself, the mode of interaction or the choice of communication methods within system design.

System engineers working in multicultural contexts require specific knowledge, skills and affective readiness for intercultural learning. Cross-cultural education and training can be seen to promote this intercultural learning, culture-general knowledge and factual/quantitative culture-specific knowledge. This, however, must be completed with a local study of the people involved in the system design which can be facilitated by ethnographic methods. Based on these skills and knowledge, the system engineer is sufficiently equipped to develop a system design process which will facilitate a symmetric dialogue in this specific context.

# 8 An approach to dialogical system design across cultural boundaries

After elaborating on the desirability for dialogical system design - especially in multicultural settings -- and on the competencies consequently required from involved communication partners, I synthesise recommendations contained in previous chapters into one complex framework, inclusive of guidelines for system designers working in multicultural settings. In addition, recommendations are given for the Namibian context, followed by the epilogue highlighting the relevance of this research.

## 8.1 A culture-driven framework for dialogical system design

As already explicated herein, it is essential to consider cultural variables in order to increase successfulness of IT projects in multicultural system design settings. The dynamic interdependence between receiving cultures and Information Technology implicates the establishment of synthesised sustainable structures. Yet no current system design methodology sufficiently accounts for a cross-cultural process. I thus present a unique and integrative approach in combining popular participatory design methodologies with hitherto omitted cultural variables. A dialogical approach is considered to be a possible method of working towards implementing relevant and appropriate systems. However, in order to support dialogical design methodology, an inclusive framework has to be established. The presented embedding framework relates to issues previously discussed in this thesis - details can therefore be found in corresponding chapters.

Joint problem identification

Dialogical system design involves at least two autonomous partners, i.e. a system engineer and a user, who co-operate with the mutual intention of designing a system. Within system design, joint problem identification and definition are of utmost importance. Users have to contribute to the identification of problems b stating their viewpoints and interpretations of current systems or organisational structures. Through symmetric dialogue, new meanings and different ways o understanding are uncovered by both sides, even though they are based on differing cultural contexts. Communication methods to be applied necessaril have to be contextual, which means that the selection of methods depends on cultural environments.

Promote cultural sensitivit

Although the comprehension of viewpoints of members of differing cultural backgrounds is limited, it could be precipitated by means of an intercultura learning process. System engineers are to develop cultural sensitivity b reflecting on their own ethnocentric perspectives as well as that of others in order to acquire a polycentric or ethno-relative viewpoint. This enables system engineers to understand, accept and integrate differing user perspectives into processes of system development. Development of cultural sensitivity and intercultural communication competency to guide the dialogue ought be formall promoted through cross-cultural training programmes. Ideally, users should participate in such training to facilitate symmetric exchange of viewpoints within such dialogue.

Develop and choose communication methods

Dialogue in multicultural settings has its inherent difficulties. Usually, at least one of the communication partners would have to be conversant in a forei language. Furthermore, a common understanding of communication codes cannot be presupposed, and methods of specific cultural settings and contexts are not valid in other cultural settings. Thus system engineers are faced with the new task of developing and choosing multiculturally valid communication methods to conduct dialogical design to facilitate problem identification.

Increase methodological skills

Study closer context

System engineers are only able to make appropriate decisions if they are resourceful within a set of relevant methods. Ideally, system engineers would be sufficiently trained in social science methodologies to conduct ethnographic studies[54] on socio-cultural contexts of users, especially for the drawing up of multiculturally valid methods. It is clear that researchers should be culturall sensitised to enable them to conduct successful ethnographic studies. Results of these studies could then be used to merge design structure with cross-cultural problem identification. Problem identification involves continuously changing interpretations of reality and thus contributes to an ongoing update of ethnographic studies determining method decisions. Such cyclic information update allows for changes and corrections of method choices, thus promoting flexibility and accuracy of system design processes.

Study broader context

System design has to be looked at from within a context of social, political, economical and other factors influencing design processes. A holistic perspective is only obtained by merging relevant information on those factors. Information on politics and economy of countries, for example, is easily obtainable via press and other media.

Joint solution design

After jointly defining the problem, system engineers and users are ready to jointl design a solution. In order to maintain symmetric dialogue – for which it i necessary to avoid model-monopolies of system engineers - continuous upgrading of users' technological skills is essential since contents and methods o technological training are determined within contexts indicated by relevan ethnographic studies. In this way, users conserve their autonomy and are enabled to make valuable contributions to designing. Furthermore, both partners have to acknowledge cultural variables within system designing. They have to realise tha cultural values inherent to the technology to be transferred differs from those values of the receiving environment, and then correlate them to make culturall sensible decisions. The user has to synthesise his cultural values with those introduced through Information Technology.

[54] The ethnographic studies can be conducted by an ethnographer or the system engineer skilful in ethnographic methods.

The following graph schematises the above-mentioned tasks of system engineers and users before and during system designing:

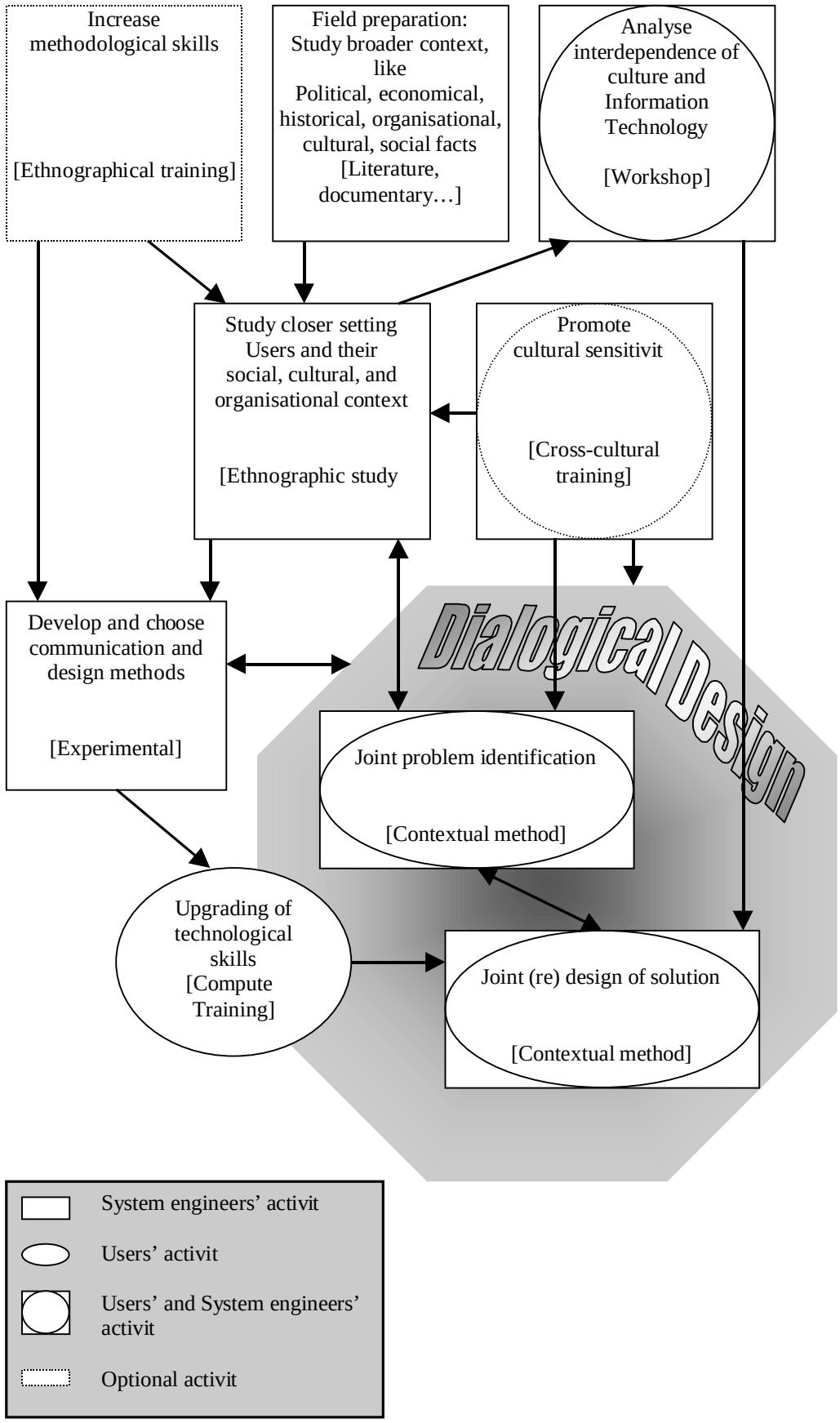



Figure 8-1 Culture-driven framework for dialogical design

For an industrial application of this framework, there clearly are constraints with regard to budget, time and other resources. Obviously, any additional activities would increase expenses and be more time-consuming. Yet training costs for users could be budgeted for separately. The software engineers' training - including ethnographic methodology and cross-cultural training - could be considered as a general upgrading of skills which are not project-bound. Field preparation is in the interest of every individual working in a new environment and therefore only needs to be initiated within the organisation.

The costs of ethnographic studies - likely to be the most expensive investment, have to be evaluated against the gain expected from the project. The results of ethnographic studies are proportional to the time invested, therefore cutting on the duration of field studies would result in a restriction of the valuability of data. The study could be outsourced to social scientists who then jointly discuss valid methods for the system design processes with system engineers. The assistance of social scientists could even be extended to facilitating dialogue during system design processes. This would decrease expenses and time with regard to the training of system engineers. Yet outsourcing raises the communication problem across disciplines. However, all in all I believe that the additional use of resources is worthwhile when considering the prospective increase in quality and sustainability of the implementation. Further constraints could be social or political contexts not allowing a participatory system design methodology.

## 8.2 System designers' guide through the multicultural world

**-DON'T WORRY (RULE NO. 1)-**

The guide comprises recommendations for dialogical processes organised [55] around the key concepts of the framework of this thesis in alphabetically order. [Note: Int. stands for intercultural.]

Account — Describe non-understandable attitudes and situations, rather than to judge them as bad, useless or insignificant.

Anticipation — Anticipate possible behaviour and reactions of others.

Anxiety — Negative feelings are likely to arise if problem-solving strategies do not seem to work. Relax and try other strategies.

Assumptions — Make as few assumptions as possible in non-familiar fields - the likelihood o them being correct is minimal; always search for validation.

Autonomy — Maintain your autonomy when familiarising yourself with host countries, respectfully support the autonomy of users and acquire information to maintain a symmetric dialogue.

Communi-cation — Study the culture-dependent scripts or communication codes, listen actively, and direct intellectual and emotional concentration to the communication situation.

[55] Not only because the author was under time pressure (as in Hitch Hikers guide through the galaxy)

| | |
|---|---|
| Context | Any process is to be seen within broader and narrower contexts of political, social, economical, historical and cultural factors. Aim for maximal familiarity with the context for a better understanding of the problem in order to make valid choices for the design process itself. |
| Co-operation | Create a positive atmosphere of motivation, commitment, trust and respect to facilitate co-operation. |
| Criticism | This is anticipated for improvement of design ideas - yet be aware that criticism is not perceived as polite and helpful by all cultures; therefore, do not count on it for design decisions. |
| Culture | Variables influencing all processes of e.g. Information Technology Transfer at a macro level, whereas teaching, learning, designing, and perceiving the world are influenced by it at a micro level. Consider the cultural values immanent to Information Technology itself and those immanent to the embedding culture, both of which have to be synthesised. Acquire sensitisation to cultural differences. |
| Design | A co-operative, creative, and mutual learning process. |
| Dialogue | The communicative exchange of viewpoints (perspectives and intentions) between at least two autonomous partners. Symmetry should be anticipated. |
| Ethnocentri-cit | Be aware of your own ethnocentric habits, biases and perceptions of the world; avoid ethnocentric behaviour (try first to understand the others within their own culture). Through dialogue, you can acquire the necessary skills for successfu intercultural communication and a polycentric or ethno-relative view. |
| Ethno-graphy | A method to study users and their environment in order to shape design processes. |
| Empower-ment | The buzzword. |
| Evaluation | A continuous process. Evaluate yourself but do not fall into self-doubt. Evaluat processes with the aid o meta-communication and discourse control |
| Flexibilit | A necessary characteristic of survival, adaptation and the capability of changing already taken decisions |
| Informant | A local person assisting you, giving you information, correcting your interpretations and transmitting messages to the others, etc. Local expertise should be made use of at all levels at any given time. |
| Int. Competency | The required skills and behaviours for the management of intercultural encounters, in which your culturally self-evident system confronts another self-confident cultural system and where yours, for example, may lose its self-evidence. Intercultural competency includes flexibility in handling situative factors, the ability to deal with differences and the unknown, knowledge of languages, empathy, awareness of role distance, tolerance of ambiguity, utilisation of unused interpretation patterns, conflict resolution expertise, evaluation of alternative formulations and behaviours, finding ways of ascertaining understanding, and also a lot of patience, enthusiasm, commitmen and respect. |

Int. training

A special programme to train intercultural competency by increasing awareness, knowledge and acceptance of cultural differences. It includes confrontation with prejudices and ethnocentrism, the challenging of stereotypes and it also covers types of behaviour and emotion. Any system engineer going abroad should undergo such training.

Interpret-ation

Attempt at all times to validate your interpretations in a joint process. Keep raw data as they might need reinterpretation along design processes in order to be able to refer to those data once new considerations come into play.

Learning

The entire project should be considered as a learning process or a challenge rather than a proof of your skills. Endeavour to understand specific orientation system of perception, thinking, valuation and acting of others. Reflect on own ethnocentric perspectives, on cultural dependence of problem solving strategies and on the intercultural encounter itself. This mutual learning process can be considered as a joint knowledge exchange. According to Freire [Fre73], the aim of learning is not the absorption of extraneous knowledge, but the perception of ones' own life condition as a problem, the solution of which offers itself in the form of reflection and action. The teacher does not remain the sole "knowing" part of the interaction. A mutual learning process oriented on the life condition o the student and the content of the teaching material takes place. Working with oppressed people, Freire discovered their fear of freedom and inability to criticise. The central problem is: How can the oppressed as divided, unrealistic creature [56] contribute to developing an education system in order to gain freedom from dependence? To realise this conscious education, the teacher's first step is to train his students in critical thinking. Educational work aiming at liberating consists of actions of realisation and not of transfer of information. In his specially developed literacy programmes, Freire first analyses the environmen with the aid of ethnological methods, using firstly observation and "coding o existential situations" instead of questionnaires and interviews. The content o such lessons is based on their outcome, and they are presented in form of problem solving.

Method

Be aware that familiar methods might no longer be valid in a different cult ral setting. A contextual method-development based on results from ethnographic studies is necessary.

Openness

Openness is the most important attitude: openness to the unexpected, openness to new experiences and new viewpoints.

Power

Power relations have to be carefu lly analysed and considered in process designing. If you are in a position of power, do not abuse it to make your life easier - it would lessen the quality of your work. Do not practise intimidation: it destroys a co-operative atmosphere.

Prejudice

Premature judgement lacking sufficient validation should be avoided at all times, even though it is a human characteristic.

[56] divided: "to be" means "to be like" the oppressors

Problem — It is no big feat to solve vague and self-defined problems [57]. Yet the difficulty lies in the identification of the problem relevant to the users concerned. A problem is not a universal fact but a person-dependant view of a situation.

Project — Projects can be perceived in many ways differing from their original intention and projection of visions by following predetermined ideas. Any project can be considered to be a revolution in the sense that radical changes of existing systems result. In this context Freire reminds us of those many revolutions and political and educational strategies which failed because their leaders or teachers onl planned from within their own view of the world without considering the affected people. System developers planning out of their own perspective without sufficient consideration for users doom the system to be a failure. Freire's concept of conscious education through dialogue therefore can find its application equally in system design. Another view of projects has been brought forward b Mack [Mac00] using the metaphor of an exploration, since projects have to cop with permanently changing conditions. This approach seems also challenging for a multicultural setting with permanently unpredictable conditions.

Role — Be aware of the role you play and take into consideration expected behaviour of other participants towards you.

Reflection — Continuously reflect on your actions and feelings; reflect about the structure of the process itself, and reflect on each individual encounter. Process the effects o the different experience through self-reflection (resonance perception). Initiat reflection on the side of users.

Relationship — Build up a relationship of trust; it enhances commitment and motivation of users to participate. A superficial relationship with representatives of the host country is not sufficient

Represent-ation — Base your representations on common local forms (like street theatre, stories, etc.).

Respect — Respect should be shown to people and for their decisions.

Sincere — Be sincere at all times and verify sincerity of users by utilising various applicable methods.

Stereotype — Learn to differentiate between cultural and individual characteristics.

System engineer — They are responsible for the outcome of a software project and therefore aim for a symmetric dialogue to obtain maximal valid input from users.

User — As experts in the domain of application, users are main resource partners in system designing.

Validation — Nearly everything needs to be validated at all times. But how?

Viewpoints — They are formed out of perspectives which are subjective views of reality dependent on perception systems of individuals. Perceptions are culture-

[57] as we all know the answer is 42 to the question of life, the universe and everything (see Hitch Hikers Guide through the Galax

dependent, thus it has to be expected that users perceive situations differently. Objectify and express your own form of perception and identify similarities and differences.

## 8.3 Consequence for the Namibian context

Having been a computing lecturer at the University of Namibia for six continuous years, I have been involved in endless informal talks with innumerable resident computer specialists, students and Namibian friends. In time, I managed to build up a picture of my surrounding that contains very few "surprise effects", meaning most reactions of people have become predictable to me. Based on this knowledge, I formulated recommendations specific to Namibi [58].

### 8.3.1 Recommendations for teaching computer science

The frequently quoted statement of:

"Teach your students the way you would like to be taught"

cannot hold if the educational and social backgrounds of students differ entirely from that of the teacher. For me personally, for example, the more abstrac something is, the more comprehensible it is to me, and the more practical examples there are, the more confused I get - which is rather the opposite for Namibian students. Therefore I would rather say:

"Assess the students' requirements and teach them accordingly".

Through my lecturing experience, interviews as well as informal discussions with students, I became aware of specific difficulties students had with the assimilation of abstract computer science concepts. Many different context-relevant examples still have to be worked out in co-operation with the students. Related practical exercises can enforce conceptual understanding. Assignments have to be carefull chosen and possibly evaluated with the students, to ensure that assignments are challenging enough without being frustrating. Develop a consciousness - on the students' side - of the associated values of Information Technology, like abstraction, progress, efficiency, rationality, and with regard to problem-solving attitudes.

Moreover, I realised a students' lack of awareness of individual study styles. It is therefore ideal to vary teaching methods. Firstly, this enables students to identify their own learning styles. Secondly, the students maintain their level of concentration. Based on psychological findings on the fluctuation of concentration, I advise to vary teaching styles even within one lecturing period. Many different styles are available, e.g. lecturing, questioning, group work, practical computer work, self-testing, etc. Active participation of students is of utmost importance. Yet most Namibian students are not used to this kind o interaction and therefore go through various phases of rejection and denial until they reach stages of acceptance and enjoyment in class participation. Not only factual knowledge should be transferred - a passion for the subject is to be conveyed.

[58] Several recommendations are equally applicable in other countries.

Most students in Namibia (this includes foreign students) are very lecturer-dependent. It is therefore important to build up a positive relationship with students, based on commitment, respect, empathy, fairness, openness and freedom from oppression. This includes sensitivity for reactions of students during lectures – ranging from very active to complete passivity - and initiating corresponding actions, allocating time for their requirements during practica sessions and holding formal and informal discussions with students. This enhances motivation and commitment of students and encourages them to work harder. However, great care has to be taken by the lecturer to promote the autonomy of students who enter into a relation of total dependence on the lecturer. Solidarity among students may be encouraged through group projects, yet one has to consider lingual and ethnical groupings. If time allows, the teacher should strive for each individual student to discover his or her area of interest in order to facilitate maximal support of technological skills. This is possible via long-term individual project-based work. After having established a positive atmosphere, just about everything is negotiable (as far as the curriculum allows), and students will come up with own ideas of work to be covered. Thus they turn into masters of their own education.

### 8.3.2 Factor relevant to system design

Common attitudes of Namibian users are fear, mistrust of the (foreign) consultant, low motivation and reluctance, leading to their hiding of or falsifying relevant information. Therefore, the first step is to create a co-operative working atmosphere. System engineers should begin by building up a relation with the individuals of the project - preferably in a one-to-one setting - to avoid inter-relational interference, e.g. an employee does not express himself because of the presence of his senior. System engineers have to be conscious of the way they are perceived by the individuals and to react accordingly.

In any case, system engineers are to have a clear understanding of their role within the co-operative process, of how the information is to be processed and what the expectations concerning the process itself are. An atmosphere of trust and solidarity is to be built up in order to promote the commitment of users. System engineers can address assumed problems without delay, yet at no time should they criticise or judge, but show tolerance for human failures. On the other hand, the user should be conscious of his autonomy and responsibility t contribute essentially to the design of his own future workplace. To motivate users to participate, the benefits and requirements of the project have to be expounded on personal, organisational or even national levels. For obvious reasons, investigations into the priorities of individuals are to precede presentations. After an atmosphere of solidarity is built up, it is favourable to emphasise the importance of individuals to assist in order to complete the project successfully. Generally the users' extrinsic motivation can be build up through certificates of accompanying training programmes or for participation in the design process. Yet there is the risk that people are attracted who solely hunt for certificates instead of being motivated to co-operate.

The main method of communication consists of semi-formal interviews. The individual informative sessions can be complemented with group sessions in form of discussions, interviews or workshops. Whenever active participation is

expected from users, group members should be selected carefully. It may be advisable to separate according to sex, lingual groups or organisational rank.

Another helpful strategy is to select one informant in a group and initiate group meetings without oneself being present. Within a familiar group of equals, peopl usually lose their fear to criticise. Moreover, language barriers hindering some people to make relevant contributions may also be overcome in such meetings.

Once the users are familiarised with and confident about the developmen process, they can contribute to it with innovative ideas and constructive criticism

## 8.4 Epilogue

This research covers distinct topics related at various levels. Therefore results and applications are diverse.

This thesis may serve as guideline for system engineers or computer teachers working in different cultural settings than their own. The framework is culture-general and therefore country-independent. It is just as valid for German system engineers working in India as for Indian system engineers working in Germany In both cases, the system engineers have to familiarise themselves with the hos country's system of conduct to be able to enter and maintain successful dialogue with system users.

Furthermore, the framework can be applied to any cross-cultural project, whether related to Information Technology or not, as long as a co-operative process is envisioned. This work thus lays the foundation for cross-cultural dialogue.

Cross-cultural course design is one of the numerous applications of this work. Especially the immanent values of Information Technology and their influence on the assimilation of the target group are explored.

Prototype

Even though the design of a prototype of a tutorial system was an additional by-product of this part of the research, at no stage was it my intention to develop a research version of a 'state-of-the-art' knowledge-based information system or a commercial product. Although the prototype has been used as learning-aid for a specific module at the University of Namibia, it requires further technical and conceptual improvements. The University of Namibia has allocated some funding for further development of the system.

Even though this thesis is now complete, I do not consider this research to be exhaustive, but rather as a starting point for a new field of study. In order to complete this thesis, I had to temporarily abandon parts of my research. On my journey as a researcher attempting to obtain a holistic perspective - oscillating between practical and theoretical findings - I crossed disciplinary and cultura borders. Any crossing of borders or leaving of familiar ground is accompanied with anxiety and uncertainty. And believe me, I have been going through many emotions during this research, from the feeling of being lost in insurmountable and incomprehensible publications of certain fields of study, to the confrontation with unexpected behaviour of people and invalidating results. Yet, with time I learned to find my way and make sense out of the vast complexity encountered. I

have always known that any crossing of borders opens new horizons and is thus enriching. With this thesis, I demonstrate the benefit of interdisciplinary and intercultural research for the field of computer science which is not equipped with solutions to communication strategies, and even less so for cross-cultura communication. While there are social sciences with fundamental results within the context of this topic, a cross-cultural system design naturally would involve theories and methods of computer science, psychology, sociology, and ethnology. I therefore envision a new field of study, termed ethnocomputing, in which findings of various disciplines can be merged and new theories derived. I would, for example, like to initiate an interdisciplinary dialogue between system analysts, psychologists, intercultural trainers and educationalists to work out relevant cross-cultural training programmes for system engineers working in multicultura settings. I also hope to initiate a stronger movement for rethinking traditional uni-disciplinary and uni-cultural curricula. The International Women University which was held in Germany in the summer of 2000, introduced pioneering work in this regard. For a period of three months, graduated women from all over the world and of different disciplines took part in project-based studying. Although my explication of the complexity of cross-cultural communication has been confirmed, I believe many more relevant problems can be defined and solved within cross-disciplinary and cross-cultural dialogue. I therefore hope to contribute to a theoretical and practical improvement of cross-cultural and cross-disciplinary dialogue through this research.

# Appendices

## A. Student questionnaire 1995

Dear Student,

The following questionnaire is part of my PhD study on computer assisted transfer of technological knowledge.

In order to guarantee the empirical accuracy of the implementation, I would be grateful if you could co-operate by completing the questionnaire.

The survey aims to determine how the technological knowledge should be presented in order to guarantee the best acquisition by the student. Through co-operating you can improve the presentation of the courses.

Please complete the enclosed questionnaire and return it before the 6th of October 1995.

Whenever there is a table please tick as many fields as are applicable for you.

Please do not hesitate to contact me if you require any further information.

I thank you for your participation and I apologise for any inconvenience.

Yours sincerely,

_____

Heike Winschiers

## Perso

1. Sex

| | | | |
|---|---|---|---|
| Male: | 20 | Female: | 3 |

2. Age:_____
3. Nationality: _____
4. Language proficiency? (Please specify if fluent, good, fair, poor)
   Mother tongue:_____

| Language | Speak | Read | Write |
|---|---|---|---|
| | | | |

## Details of training and experience

### School education

5. What schools did you attend?

| Name | Region | From To |
|---|---|---|
| | | |

6. Did your school offer computer classes

| | | | |
|---|---|---|---|
| Yes: | | No: | |

If yes

a) at what level_____

b) which computer classes did you attend?_____

c) specify the content, equipment (hardware and software):

7. What was the teaching language of your school?_____

### Higher education

8.What are your major subjects?_____
9.In which university year are you?_____

### Apprenticeship

10. Trade:_____ From:_____ To:_____

11. Work experience

| Employer | From: To: | Nature of work |
|---|---|---|
| | | |

## Information use

1. Is your school knowledge enough to cope with the university subjects?

2. How do you understand best? If

| | Often | Sometimes | Seldom |
|---|---|---|---|
| An expert/lecturer explains | | | |
| A colleague/student explains | | | |
| It is explained in a book | | | |
| Other: | | | |

3. What do you have to do to remember best the new learned?

4. How would you like things to be explained? (Tick as many as you want)

| | |
|---|---|
| With a lot of examples | |
| In relation with the rest of the worl | |
| In your mother tongue | |
| From general to specific (top-down) | |
| From specific to general (bottom up) | |
| With a lot of details | |
| With graphs | |
| In relation with already known things: through differences and commonness | |
| Other: | |

5. You are given a problem and a new book on the specific topic. How are you going to use the book to retrieve the information you need to solve the problem?

| | Often | Sometimes | Seldom | Never |
|---|---|---|---|---|
| Look at the table of content | | | | |
| Look at the index | | | | |
| Go roughly through page by page | | | | |
| Read the introduction chapter | | | | |
| Read page by page | | | | |
| Other: | | | | |

6. How often do you use the following information sources to get any subject specific information, or to solve any computer related problem?

| | Often | Sometimes | Seldom | Never |
|---|---|---|---|---|
| Libraries | | | | |
| Subject books | | | | |
| Encyclopaedia | | | | |
| User manuals | | | | |
| Journals | | | | |
| On-line help | | | | |
| Colleagues | | | | |
| Friends | | | | |
| Lecturers | | | | |
| Famil | | | | |
| Computer network | | | | |
| Others: | | | | |

## Computer and Computer Science

1. Do you have a personal computer? If yes, describe Hardware and Software.

2. What do you use the computer for
   If you do not have one for what could you imagine using it in your private life?

3. What fears do you have concerning computers? (like breaking it, loosing all the information saved, being dominated by the machine one day,...)

4. What features do you associate with computer and information technolog (like task automation, games, and efficiency.)? Please value with +(positive), -(negative), o(neutral).

5. What are you interested in?

| | |
|---|---|
| How to use a computer as a tool. | |
| How a computer works/functions? | |
| How to repair a computer | |
| How to program? | |
| How to design new systems | |
| How to improve computer capacities | |
| Other: | |

6. What do you like about computer science? special areas like operation systems, programming and special characteristics like solving problems, designing programs or systems)

7. What do you dislike about computer science?

8. What are the difficulties you have with the application programs used?

| | |
|---|---|
| Remember where to find the required functions (like cut, past ..) | |
| Remember the meaning of the items (like "paragraph") | |
| Knowing what functions exists (like grammar check,..) | |
| Remember commands | |
| The language used | |
| The relation with the rest of the system (dos, os2) | |
| Other: | |

9. What are the difficulties you have with programming?

## Computer Courses

1. In which domains do you have difficulties to understand/follow easily?

| | |
|---|---|
| Theory of computer | |
| Abstract knowledge (logic, computability, complexity) | |
| Learning application software (word processing, spreadsheets, databases) | |
| Programming | |
| Other: | |

2. To learn the functionality and possibilities of computers would you prefer to

| | |
|---|---|
| Play around with a given computer | |
| Have a human being explaining | |
| Get a computer guided introduction/tutorial | |
| Other: | |

3. What motivated you to take computer courses at the University?

4. What should be the aim of the computer courses

| | |
|---|---|
| To prepare the student for the specific local working marke | |
| To prepare the student for further studies | |
| To prepare the student for life in the local society | |
| To prepare the student for life in the global society | |
| To give the student basic knowledge: | |
| To give the student the knowledge he needs at his workplace | |
| Other: | |

5. What suggestions concerning the structure/content of computer science courses do you have in order to achieve the aims you just named (like more practicals, outside projects, ...)?

6. What are your plans after graduation?

| | field/task | Company/university |
|---|---|---|
| Working | | |
| Studying | | |
| Work and then continue studies | | |
| Other: | | |

## Opinions

1. What do you think a person should know in every day life? (like how to plant mahango, repair a car,...)

2. Do you think,

| | Yes | I do not know | No |
|---|---|---|---|
| People who are computer literate are more advantaged. | | | |
| More people in Namibia should be computer literate | | | |
| Computer assisted teaching helps a lot. | | | |
| Higher technological standard implies a "better life" for individuals in the country? | | | |
| It would be nice to get most of your information via computer (instead through information personal communication, telephone, books,...)? | | | |
| It would be nice to have the interface (application programs) in each ones mother tongue. | | | |

3. How important is the following in your life? Give marks between 10 (very important) and 0 (not important)

| | | | |
|---|---|---|---|
| Famil | _____ | Responsibility | _____ |
| Friends | _____ | Degrees | _____ |
| Job | _____ | Money | _____ |
| Leisure | _____ | Cultural tradition | _____ |
| Religion | _____ | Time | _____ |
| Efficiency | _____ | Sport | _____ |
| Nature | _____ | Knowledge | _____ |
| Progress | _____ | Communication | _____ |
| Correctness | _____ | Computer | _____ |
| Politics | _____ | Games | _____ |
| Respec | _____ | Power | _____ |
| Technolog | _____ | Security | _____ |
| Fun | _____ | | |

4. Do you belief what you are told b

| | Always | Mostly | Sometimes | Never |
|---|---|---|---|---|
| A lecturer | | | | |
| A textbook | | | | |
| A friend | | | | |
| TV | | | | |
| Newspapers | | | | |
| Famil | | | | |
| Any person | | | | |

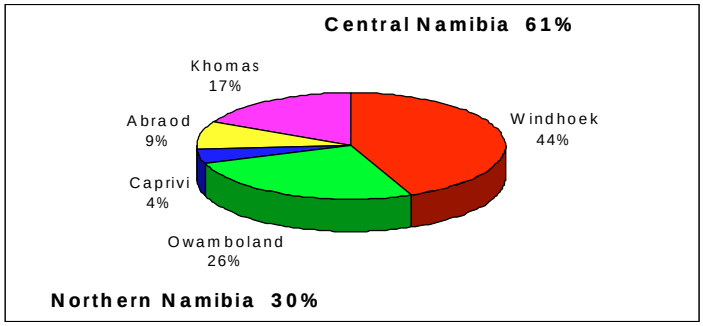
5. Any comments concerning the subject or the questionnaire itself:

## Results

The questionnaire was distributed to all (34) Computer Science Students registered in 1995 at the University of Namibia. 3/3 third year students, 4/8 second year students and 16/23 first years students returned the questionnaire.

## Perso

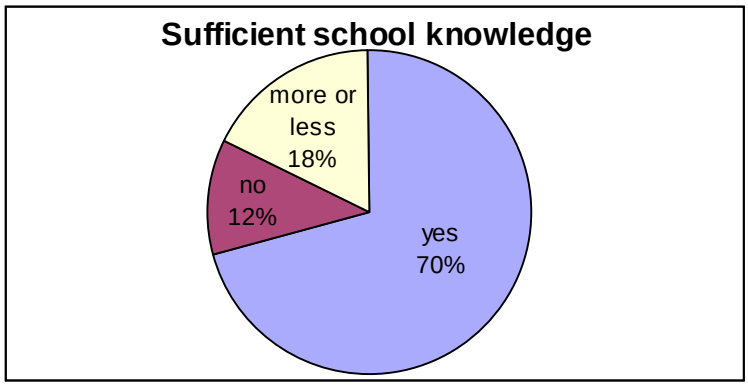
1. Sex: Female: 3 Male: 20
2. Age: range between 18-26
3. Nationality: (see fig. 4.3.)
4. Mother tongue: (see fig. 4.3.)
5. What schools did you attend?




6. Did your school offer computer classes? Yes: 4 No: 19
7. What was the teaching language of your school? (see fig. 4.4.)

## Information use

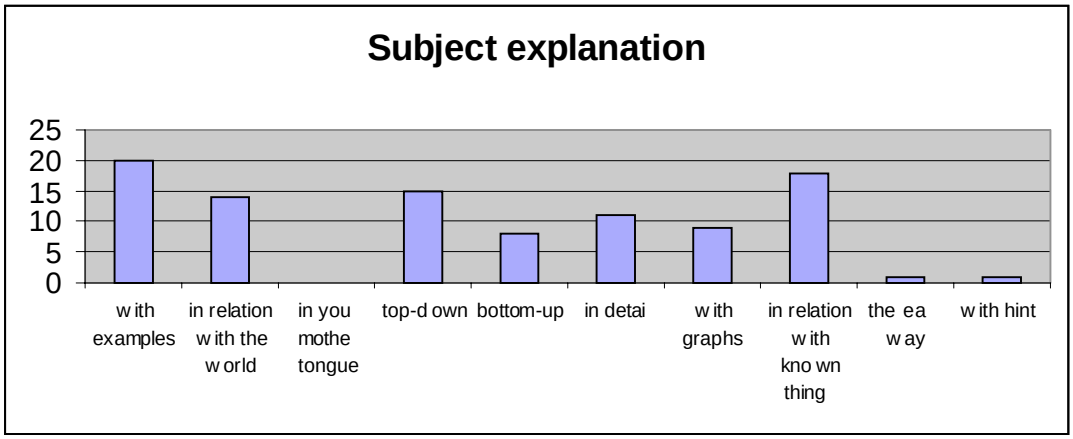
1. Is your school knowledge enough to cope with the university subjects



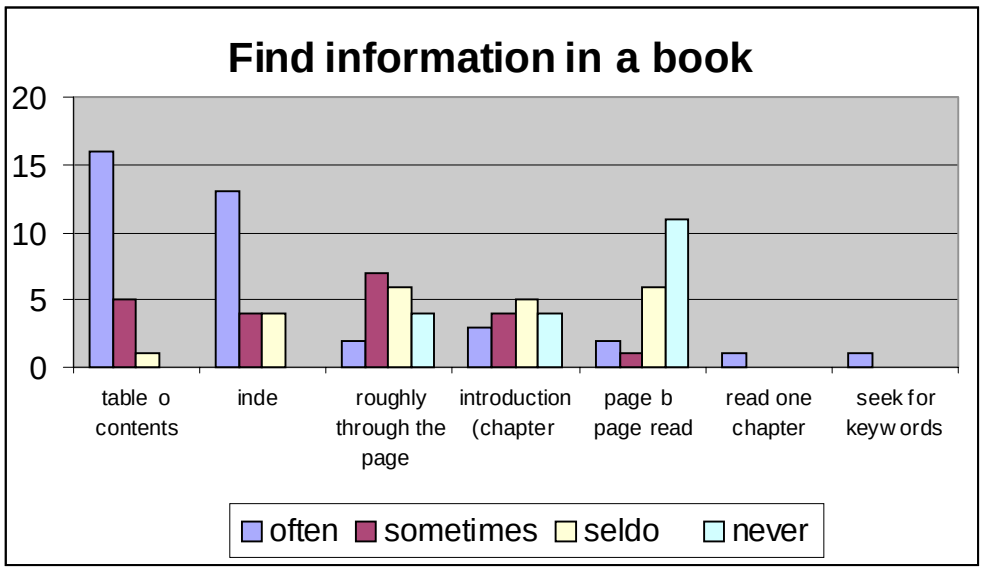

2. How do you understand best?

3. What do you have to do to remember best, the new learned
   Revise/read it again, practising, memorising, organising/summarising, relate it to real life, catch out keywords, reading journals.

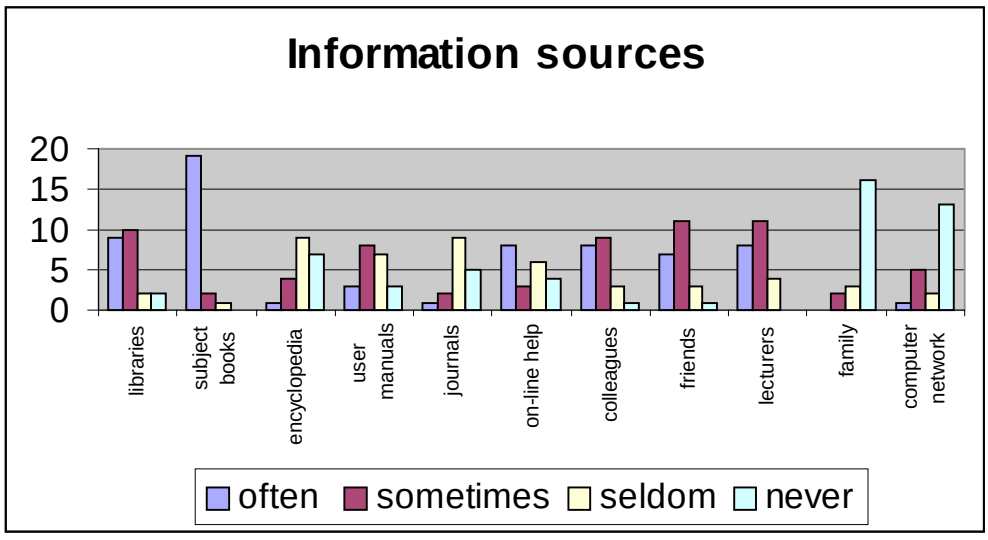
4. How would you like things to be explained? (Tick as many as you want)




5. You are given a problem and a new book on the specific topic. How are you going to use the book to retrieve the information you need to solve the problem?




6. How often do you use the following information sources to get any subject specific information, or to solve any computer related problem?



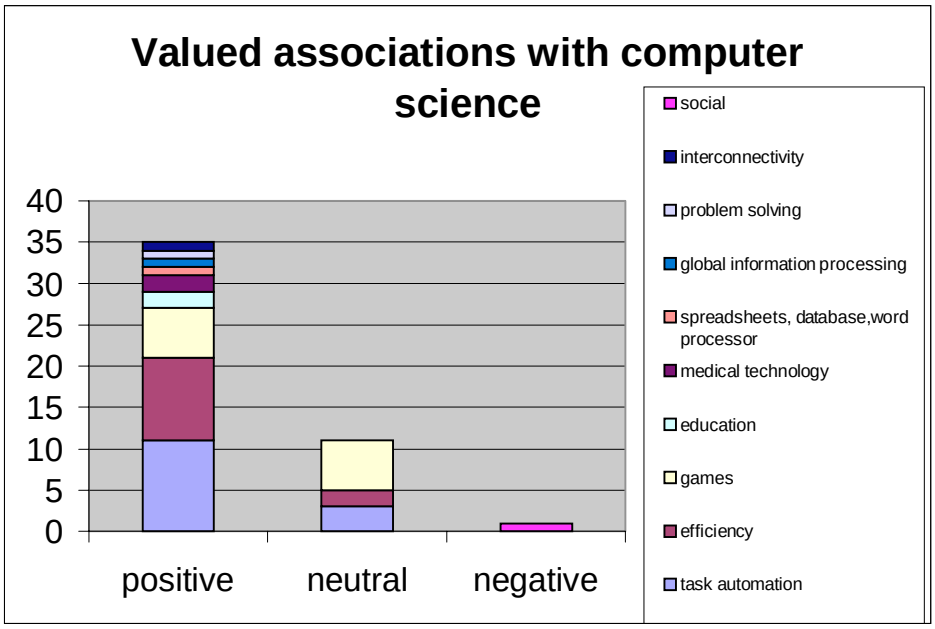
## Computer and Computer Science

1. Do you have a personal computer?
   18 no and 5 yes

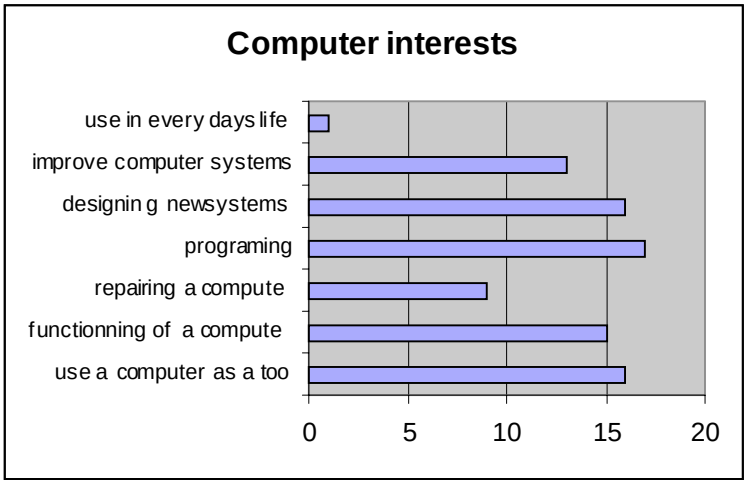
2. What do you use the computer for
   Programming, games, writing, store data, finances, familiarize, work, diary, music, teaching others, problem solving, math, multimedia, e-mai

3. What fears do you have concerning computers
   Loosing information, breaking it, none, not know all that need to be known, loosing Internet connection, loosing job because of computer, being dominated by computer, viruses, confidentiality, being lost in the subdirectories/programms and having to reset, being too fascinated

4. What features do you associate with computer and information technolog (like task automation, games, and efficiency.)? Please value with positive, negative, neutral.

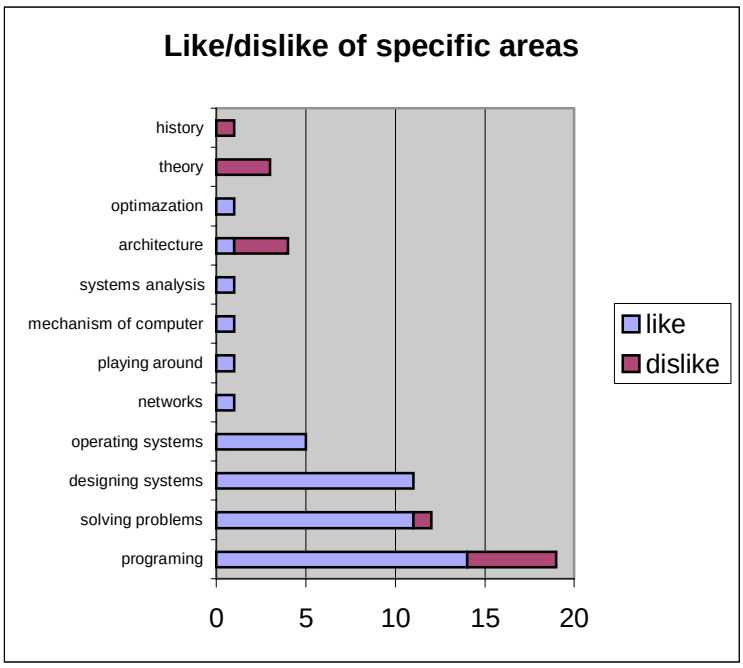



5. What are you interested in?

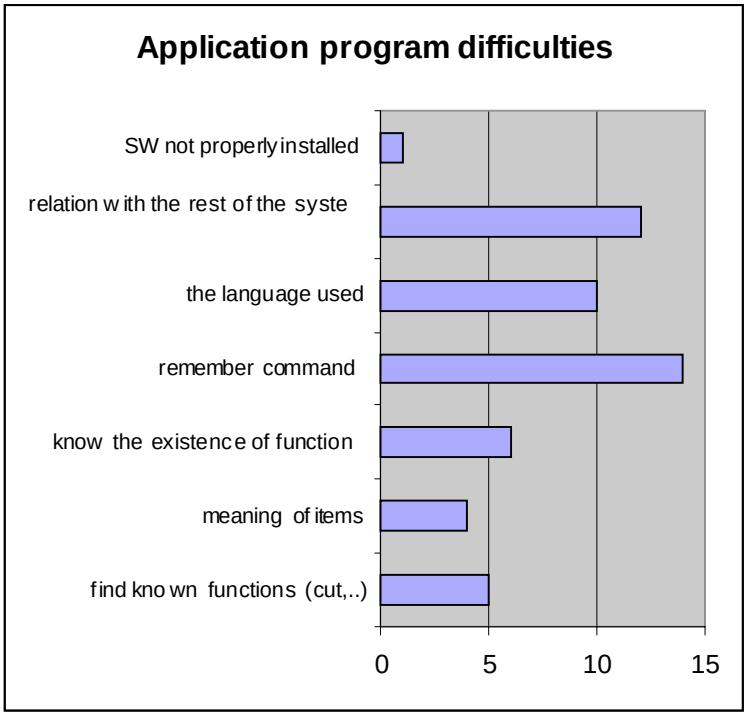


6. What do you like about computer science?

7. What do you dislike about computer science?



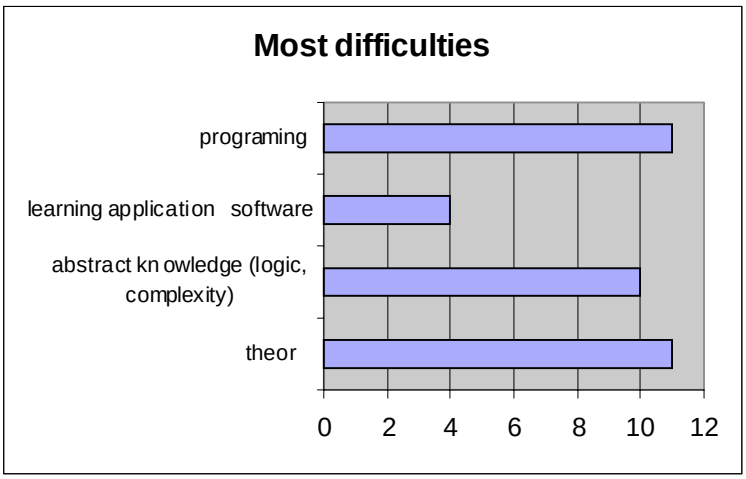

8. What are the difficulties you have with the application programs used



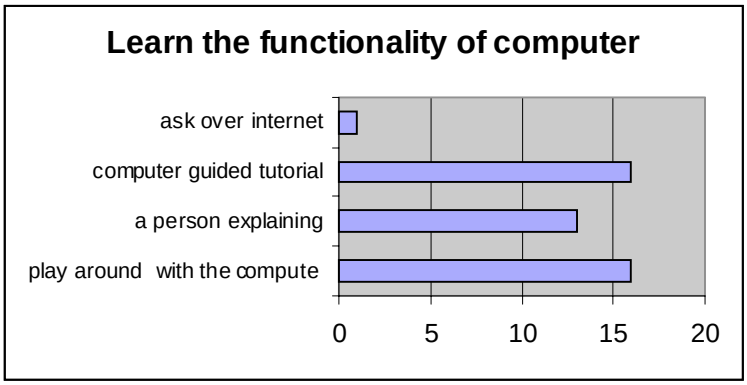

9. What are the difficulties you have with programming
Syntax, convert ideas into program code, system/global variables, keywords and their usage, debugging, recursive programming, lack of manuals, using library functions, wrong commands, lack of knowledge of possibilities, efficiency, which language to use, type mismatch, loops

## Computer Courses

1. In which domains do you have difficulties to understand/follow easily

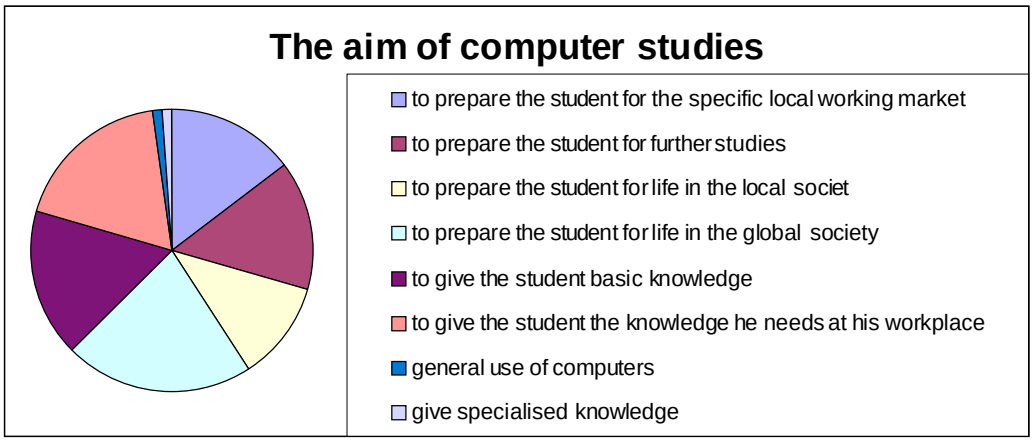



2. To learn the functionality and possibilities of computers would you prefer to



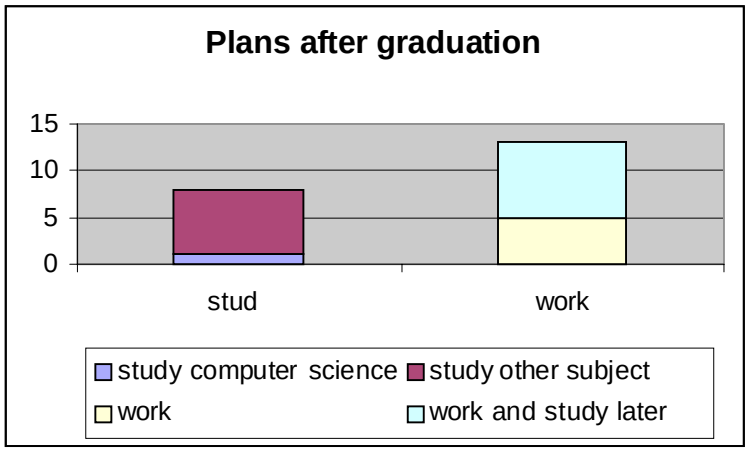

3. What motivated you to take computer courses at the University?
   Curiosity/interest(6), everything computerised(5), to be computer-literate for the job(3), family/friend(3), have fun(2), increase job choice/opportunities, lack of computer-experts in Namibia, the word "computer", do programing projects, use of computer in engineering, impressed by possibilities of computer, being succesful, and become a programmer

4. What should be the aim of the computer courses



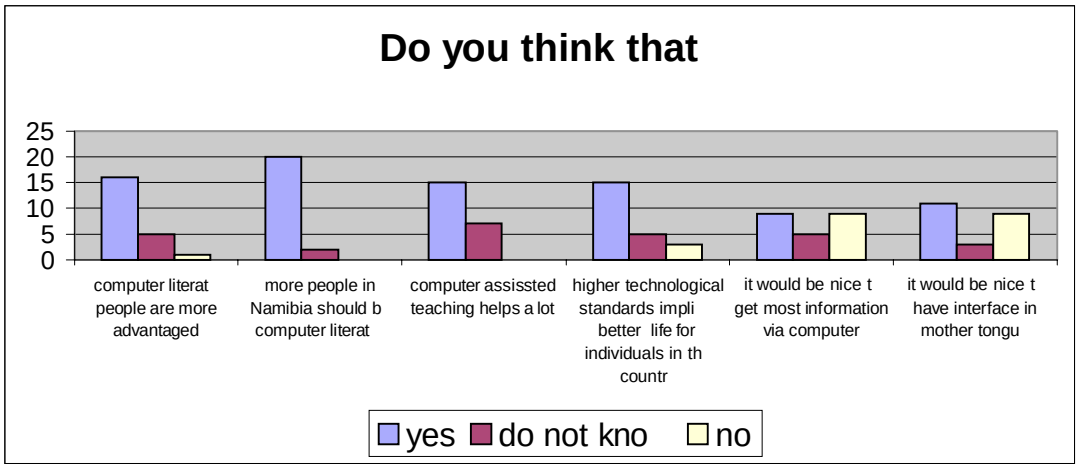
5. What suggestions concerning the structure/content of computer science courses do you have in order to achieve the aims you just named?
   More practicals(10), outside projects/holiday jobs(10), outside visits(3), use o SW/languages the local market is using(2), one language more into depth(2), more tutorials, more communication student-lecturer more multimedia to use and to present, helpful lecturers, courses on the usage of interne

6. What are your plans after graduation?

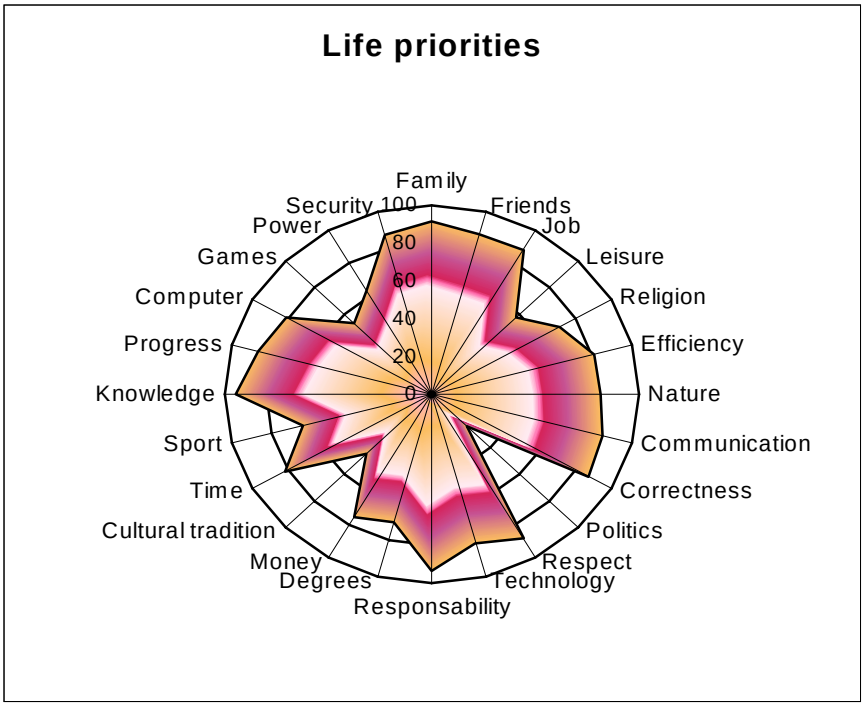



## Opinions

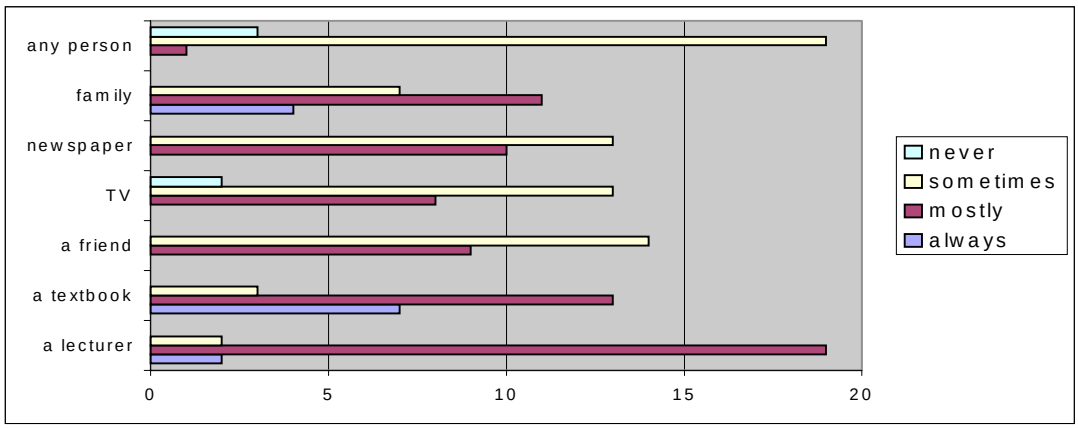
1. What do you think a person should know in every day life?
   To be computer literate, communicate, adapt to a situation/survive, technology, read and write, health care, repair cars/radios, special job skills, functioning of the own body, calculate, drive a car, laws of nature, cook, first aid, family planning.



2. How important is the following in your life?

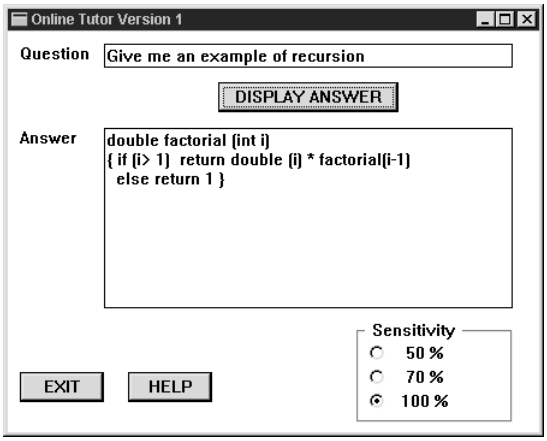



3. Do you belief what you are told b



## B. Students' prototype evaluation 1996

This is an example of one of the student's prototype with it corresponding evaluation by the second year students.




The student attempted to create a system with a language parser and generator using a probability algorithm.

The other implemented systems were evaluated much better and used as a basis for the next prototype implementation.

Dear second year student,
This evaluation is part of my PhD study, which aims to improve the computerised transfer of IT knowledge. The third year students have developed prototypes, which have to be evaluated by you, the second year students. Please do not consider who the designer of the system is (whether it is a friend of yours or not) but evaluate the system itself. Try to be as critical (positive/negative) as possible and answer all the questions.
Evaluate the prototype under the following assumption: You are a student who missed the lecture on the topic "recursion" and you use now the information system to retrieve the necessary information[59].

1. The user interface **itself** is :

| excellent | good | fair | poor |
|---|---|---|---|
| 1 | | 2 | 1 |

2. The **use** of the user interface is:

| eas | manageable | difficult | impossible |
|---|---|---|---|
| | 1 | 3 | |

3. The **features** of the system are:

| excellent | good | fair | poor |
|---|---|---|---|
| 1 | | 1 | 1 |

4. The **use** of the system is:

| flexible | normal | rigid | too rigid |
|---|---|---|---|
| | 1 | 3 | |

5. The **organisation** of the user interface is:

| clear | acceptable | need improvement | confusing |
|---|---|---|---|
| 1 | 1 | 2 | |

[59] the values are the answers of the second year students

6. The **sequence** of different information windows is

| good | adequate | not enough/too much | not adequate at all |
|---|---|---|---|
| 1 | | 3 | |

7. The choice of the interface **language** is:
(like choice of words on the buttons, questions ...)

| very good | good | acceptable | bad |
|---|---|---|---|
| 1 | 1 | 2 | |

8. The given **information/help** is :

| clear | concise | not informative | confusing |
|---|---|---|---|
| | 4 | | |

9. Does the representation of the information fit with your way of approaching a new topic?

| yes | more or less | not at all | do not know |
|---|---|---|---|
| | 1 | 2 | 1 |

10. Do you prefer this representation of the information to a compact text representation?

| Yes | in general yes | no | do not know |
|---|---|---|---|
| 1 | 1 | 1 | 1 |

11. What is good about the system?
- help facility (2)
- interface well organised (2)
- nothing (1)

12. What is bad about the system?
- not user friendly (4)
- not informative (1)
- not flexible (2)

13. How would you improve the system?
- topics must be clearly defined (3)
- questions must be general and not specific (2)
- add more features and information(1)

14. Any comment:

## C. UDITS evaluation

The performance of the students was evaluated with one assignement and one Test given to all students.
The exercises are categorised into four type indicated behind each as,

(R) Repetition/Recall
(D) Define
(A) Apply
(C) Construct

# Exercises on Recursion

1) Given the recursive formula F(N) = 10 - F(N-2), with base case F(0) = 2, wha are the values for F(6) and F(8)? What is the value of F(5)?Predict the value of F(2104).

(A)

2) What is the advantage of using recursion

(R)

3) What is/are the base case(s) o

a) Towers of Hanoi
b) Selection Sort

(R)

4) Does the Binary Search have to be implemented with recursion? If not how can it be implemented?

(R)

5) Using Binary Search, indicate the sequence of numbers 37 would be compared given the following list 1, 4, 7, 12, 26, 32, 39, 42,47,51,55,63,74

(A)

6) What control structure appears most commonly in a recursive procedure

(C)

7) When a function is called recursively, the actual parameters and local variables of the calling version are saved until its execution is resumed.

a) true
b) false

(R)

8) Does the following program satisfy the criteria of a recursive function? Why/ Why not?

```
recursive  int N){
        if N = 12
                return 5
        else
                return 5*recursive(N+1);
```

(A)

9) What is the output for recursive(7), recursive(20)?

(A)

10) A function can be recursive but a procedure can no

a) true
b) false

(R)

11) How many “moves” will be made in the Towers of Hanoi problem, if we are having 5 disks

(A)

12) What is the following function doing?

```
int Puzzle(int Mumble){
        if Mumble < 0
                return 0
        if Mumble = 1
                return 1
        else
                return Mumble * Puzzle(Mumble - 1);}
```

(A)

13) A palindrome is a word which read forwards and backwards the same, like ABBA.

13.1) Describe how you would determine whether the following are palindromes:

a) aeeeccacceeaccaeeea

b) aaaessoaseasaesaosseaaa

13.2) Which action do you keep on repeating?

13.3) When do you stop, when can you definitely say that the word is a palindrome or not?

13.4) Write a recursive algorithm that given a word determines whether the word is a palindrome or not.

(C)

# Computer Science Test

1) Recursion is an example of(cross as many as you want):

a) selection b) data structure c) repetition d) control structure

(R)

2) When can one have infinite recursion? Give an example.

(C)

3) What is the base case of the Factorial function

(R)

4) In which cases would you not use recursion to implement an algorithm? What would you use instead? Give an example.

(C)

5) What is wrong with the following program?

```
Wrong(N){
        if N = 1
                return N;
        else
                return 7*Wrong(N-1);}
```

(A)

}

6) Describe in natural language the strategy of the recursive algorithm of the Towers of Hanoi.(4 lines)

(R)

7) What is the output of the following function if test(9), test(-5) are called respectively:

```
Test(int N)
        if N > 0
```

```
        test = N + Test(N-3)
    else if N==0
        test = 0
    else
        test = Test(N+2) -N
```

(A)

8) Define and describe recursion

(D)

9) Write the recursive program to calculate the function with the formula F(N) = 2*F(N-2) and F(0) = 0, F(1) = 1

(C)

10) Write a recursive algorithm/pseudocode/C-code to sum up the numbers in an array. (Hint: Do not forget, that the sum of all the numbers equals the sum of all the numbers except one plus this one separately. Or think of how the factorial function works recursively)

(C)

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# About the author


| | |
|---|---|
| **Name:** | Heike Winschiers |
| **Date/Place of Birth:** | 10.12.1967, Erlangen, Germany |
| **Nationality:** | German |
| **Children**: | Naska Winschiers, 12.06.1989 |
| | Tamara Winschiers, 03.02.1998 |
| **Languages:** | German, English and French fluent, Spanish fair |
| **Qualification:** | Masters in Computer Science |
| **Contact:** | heikew@polytechnic.edu.na |


## Education:

### Schools:

| Year | School | Town | Country |
|---|---|---|---|
| 1973 - 1977 | Herzog-Ulrich Schule | Lauffe | Germany |
| 1977 - 1978 | Hoelderlin Gymnasium | Lauffe | Germany |
| 1978 - 1981 | French Secondary | Sousse | Tunisia |
| 1981 - 1983 | French Secondary | Baghdad | Iraq |
| 1983 - 1984 | French Secondary | Frankfurt | Germany |
| 1984 - 1985* | French Secondary | Freiburg | Germany |

- 1985 final examination: Baccalaureate C (Mathematics)

### University: Studies of Computer Science

| Year | University | Specialisation | Degree |
|---|---|---|---|
| 1985 - 1988 | Erlangen-Nürnberg, Germany | N.A. | Bachelor (Vordiplom) |
| 1988 - 1992 | Hamburg, Germany | Artificial Intelligence, Natural Language Processing | Masters Degree (Diplom) in Computer Science |

### Attendance of Training courses

| Year | Course | Organisation |
|---|---|---|
| 1998 | Networking essential | MS Namibia |
| 1998 | Core Technologies of Microsoft Windows NT 4.0 | MS Namibia |
| 1998 | Microsoft NT Server 4.0-Enterprise Technologies | MS Namibia |
| 1998 | Administering Microsoft Windows NT 4.0 | MS Namibia |
| 1998 | Microsoft SQL Server | MS Namibia |
| 1999 | Improving teaching and learning | University Namibia |
| 2000 | Facilitator training | International Women University |

## Research Experience:

**Masters Thesis** **MARCH 1991 - MARCH 1992**

University of Hamburg

**Functional specification of knowledge based machine aided translation system and prototypical implementation of the user interface**

Based on my empirical studies of translators' tasks and requirements as well as a market research on translation systems, I formalised (with SADT) the translators' working process in order to determine task adequate tools and information. I worked out a system specification and implemented a prototype of the user interface and the information module in C++.

**Research project** **January 1993 - January 1994**

University of Hamburg

**German-Bulgarian knowledge-based machine (aided) translation**

Based on my Masters thesis a co-operative project with Bulgaria was initiated for which I was employed as a researcher. I formally described the generation of bilingual domain information in the translation context after analysis of Conceptual Graphs (knowledge representation formalism) and terminological databases. I was working on translation algorithms for terms, which do not have equivalents in the target language.

Funded by Volkswagen Stiftung

**Ph.D. researc** **February 1994 - Marc 2001**

University of Hamburg-Namibia

**Dialogical system design across cultural boundaries**

Hardly any system design methodology accounts for the issues that arise in a multicultural environment, as encountered in most so-called third world countries. Misconception of the real problem, followed by misunderstandings between software experts and user due to cultural differences, therefore results in the implementation of non-sustainable systems.

In my thesis I work out a framework which integrates the cultural variable into system design in order to improve the validity of system design.

The theory is based on the evaluation of my teaching and system design experience in the Computing Department of the University of Namibia. Looking at the limitations of existing system design techniques I integrate theories and methods from other disciplines, such as ethnology, education and psychology.

Funded by Villigst

**Research project** **January 1999 - January 2000**

University of Namibia

**Development of a distributed tutorial system**

Based on my Ph.D. implementation I initiated and co-ordinated a departmental research project. The aim is to identify means of assisting students in the

assimilation of abstract concepts and algorithms through interactive examples and animations.

Funded by the University of Namibia

# Educational experience:

## Lecturing

**January 2001 – now**

Polytechnic of Namibia

In the Information Technology Department, I am currently teaching Software engineering and programming to students enrolled for the newly established Diploma course.

**January 1995 – December 2000**

University of Namibia

In the Department of Computing, I have been teaching mainly courses (2nd–4th year level) in the area of Software engineering, Object oriented and visua programming as well as algorithmics. I applied different techniques like, projects, workshops, user evaluations with video recording, interviews, discussion groups as teaching and system design methods.

## Project supervisio January 1996 – December 2000

University of Namibia

**Group projects** (third year level):

1. Multiple Choice testing system ( 5 students)
2. Donors management system (12 students)

**Individual projects** (fourth year level):

1. Tutorial system
2. Subject Assessment Syste
3. Interactive Testing Module
4. Internet Advertisement System
5. Interactive Chicken Incubation Lesson

All projects include a complete software development cycle with requiremen engineering, specification, implementation, testing and embedding phase of a fully functioning prototype. The implementation includes coding in Visual C++, MS SQL databases, Java Script and HTML depending on the project.

## Project Facilitatio **JULY 2000 – OCTOBER 2000**

International Women University (IFU)

I have been facilitating the collaboration of post-graduate students from differen countries and disciplines in the area of INFORMATION within two projects:

- Knowledge Architectures
- Cultural modes, self-expression in the new media

Relevant questions of cultural and disciplinary variety in the design and organisation of information presented in the world wide web were discussed from a gender viewpoint. Project results comprised prototypical implementations, websites, and design conceptions.

**Teaching** **February 1995 - April 1998**

Windhoek International School Namibia

I taught, supervised and assessed projects at IGCSE (International Genera Certificate of Secondary Education) level.

**User Training** **November 1992 - January 1993**

Mothers' community centre Hamburg, Germany

I trained women in application programs like, accounting and word processing.

## Other experiences

**Curriculum development**
**1995**

University of Namibia

I designed with my colleagues a four-year modular B.Sc. computing curriculum, which has been implemented in the Computing Department in 1996.

**Programming** **November 1986 - Marc 1987**

Fraunhofer Institute for Integrated Circuits Erlangen, Germany

Program development in C and evaluation of databases.

## Publications

"Benutzungsschnittstelle und Komponenteninterakti einer wissensbasierten, integrierten, computergestuetsten Uebersetzungsumgebung", Master Thesis, University of Hamburg, Germany, 1992 (co-author Claudia Kieselbach)

"The role of Knowledge Bases in Machine Aided Translation", Technical Report 1-93, University of Hamburg, July 1993 (co-author Galja Angelova)

"Computergestuetzter Wissenstransfer in Entwicklungslaender", Newsletter No. 10, Fachgruppe Informatik und Dritte Welt, Gesellschaft fuer Informatik e.V.,199

"Information Technology Diffusion in Namibia", Proceedings o Simposio de Informatica - Informatica e desenvolvimento-, Maputo, Mocambic, June 1996

"Knowledge Acquisition in a computing environment", Proceedings of the 27t Southern African Computer Lecturer's Association Conference, South Africa, 22-24 June 1997

"User Dependent and Computer Assisted Knowledge Transfer", Proceedings o the 12th Annual M & PhD Conference in Computer Science, University o Witwatersrand, Johannesburg, South Africa, 26-27 June 1997

"Experiences in the co-operative design of an Instructional System", Technology in Interactive Education Congress, University of Natal, Durban, South Africa, http://www.un.ac.za./tie ,27-28 January 1999

"Reflections on teaching Computer Science to ~~previously~~ disadvantaged students", Proceedings of the 29th Southern African Computer Lecturer's Association Conference, University of the Free State, South Africa, 27-29 June 1999

"User centred system design in a multicultural environment", Proceedings of the 14th Annual M & PhD Conference in Computer Science, University of the Free State, South Africa, 29-30 June 1999