



Mauritius Research Council

Information & Communications Technology

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Preface

This report is born out of the discussions and brainstorming sessions that members of this thematic group have been having over the past couple of months. It appears that although many people do accept the fact that ICT can be a strategic vehicle that can really drive various sectors of this country in the right direction with appreciable efficiency, yet research is not identified as an important component so far. We therefore believe that the ever-changing paradigm in many sectors of the economy due the infiltration of ICT in some way or another, has made it compulsory to define a policy to allow the country to embark onto active research and development missions in the field of ICT, if we want to guarantee our survival in the global space.

The ICT thematic workgroup was thus mandated in a first instance to situate the position of Mauritius in the ICT sector. The next step was then to make a current state assessment of the level of ICT penetration in various sectors. The current number of professionals active in the field and the expected projected amount were assessed. A current state analysis of research and development in the field at the level of academia and other research institutes was also made. Further to these assessments, a number of possible initiatives to enhance and develop research in some cases, within a number of priority sectors are made.

This report is consequently a valuable piece of document that sets a framework for the development of a research culture in ICT in Mauritius. The materials are drawn from the active experience of several professionals in the field with diverse background.

**Chairman
MRC**

**Executive Director
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LIST OF ABBREVIATIONS

ADSL	Asymmetric Digital Subscriber Line
ATM	Asynchronous Transfer Mode
BMPL	Business Park of Mauritius
BOI	Board of Investment
CDMA	Carrier Detector Multiple Access
CEB	Central Electricity Board
CIB	Central Information Bureau
CISD	Central Information System Divisions
DBM	Development Bank of Mauritius
EPZDA	Export Processing Zone Development Authority
GIS	Global Information System
GSM	Global System for Mobile
ICT	Information and Communication Technology
IT	Information Technology
IVTB	Industrial and Vocational Training Board
MTA	Mauritius Telecommunication Authority
NCB	National Computer Board
PKI	Public key Infrastructure
R&D	Research and Development
SAFE	South Africa Far East
SME	Small and Medium Enterprises
TAC	Telecommunication Advisory Council
UOM	University of Mauritius
UTM	University of Technology
WAP	Wireless Application Protocol
WASC	West African Submarine Cable
WWA	Waste Water Authority

REPORT

Background

The ICT sector is undergoing very rapid changes. To keep pace with, and even contribute to the ever-changing paradigm it is of utmost importance to develop a research policy and culture at national level. This report is aimed at proposing a strategy that will enable the ICT sector to grow such as to contribute to the national wealth. A current state analysis is first made in this field, barriers to research in ICT are then identified, current initiatives to promote ICT in the country are browsed, a methodology to identify problematic areas in several sectors where ICT can provide a helping hand is recommended, some typical research areas are as well identified.

1 Introduction

While ICT has emerged as the fastest growing sector in a very short span of time and presents countries like ours with numerous opportunities for job creation through high value-added services and thereby increasing national wealth and raising the standard of living of the population, little focus has so far been put on the development of a research culture in ICT in Mauritius. Furthermore, efforts over the past years to infuse Industry-University collaboration in order to promote R & D have not fully materialised. There is thus a strong need at this stage to develop a policy framework for research in Mauritius with regard to the roles that the various players/institutions and regulatory bodies are expected to play, if we really want to succeed in this endeavour. The initiative of the MRC to set up an ICT workgroup to that effect was really appreciated by all those involved within. A total of five meetings were held, and at the very first one, members of this thematic workgroup have unanimously agreed on the fact that ICT is very typical a subject in the sense that it can, in its own integrity exist as an industry, and at the same time, it can cut through all other areas as a major tool to bring solution to other problematic ones. As such, there was a consensus at the very beginning of our discussions that these two facets of ICT be treated separately with regard to developing a research policy framework.

ICT as an industry is an active stand-alone field of research worldwide, however for Mauritius given that ICT presents a relatively new diligence, it might be inappropriate right now to copy the same trend by investing massively on fundamental research projects; these kinds of investments may not directly help in improving the state of our economy immediately. However this does not mean that we should not at all invest in fundamental research, but on the other hand, should capitalise on the resources available locally to solve problems of fundamental nature that will have direct bearing on the IT sector in Mauritius. For example, with the setting up of the cyber city a number of research-based projects involving the security of data transmission over networks will have to be undertaken; new developments in the mobile communication industry will call for the design and implementation of public key infrastructure cryptographic technique over wired and wireless communication, despite the fact that these are fundamental areas within ICT which are being researched worldwide.

The other part of our discussions was concentrated mainly on drafting a methodology for going about identifying ICT-based research and development projects that can help cracking problematic areas in our existing local industries. The latter are mainly those which at some stage were contributing significantly to our economy but are now facing some difficulties, or which might require some support and backing in order to increase the returns they have been yielding so far, or still, to change the way things have been done so far, in order to cope with

the new market requirements. Once the problems in these fields are properly tabled the proper resources in relation to ICT requirements could be deployed to come to desirable solutions. Emphasis is to be placed on in-house and nationally developed projects and strategies that are most suited to our local environment, in order to help the sector cope with the new economic paradigms. The research element involved in such undertakings is on the development, implementation and evaluation of such projects and strategies with respect to the national needs. This is exactly where we believe that ICT will be much more a driver or tool, rather than a mere stand-alone subject. All the more so, areas that are of national interest are addressed on a priority basis.

The remaining part of this document is organised as follows: in the next section we present the scope of this thematic workgroup, then we give an outlook of the current ICT state in Mauritius; this is followed by an assessment of the current opportunities, weaknesses and barriers to ICT development; a methodology to go about identifying the ICT needs in problematic areas, which will later on lead to concrete projects definition, is proposed; a number of immediate ICT research projects relevant to the local ICT sector is given at the end. It should be borne in mind that this listing is not exhaustive since the workgroup has not managed to cover all potential research projects. A list of ICT based project that have been successfully undertaken at the University of Mauritius is included as annex to give an appreciation of the potential which is currently available locally.

2 Scope and Objectives

This Working Group was mandated by the Mauritius Research Council (MRC) to carry out a brainstorming exercise on the research potential in the ICT sector within Mauritius and to make recommendations on strategies and measures necessary to successfully commence and sustain a research programme in the areas identified. The objective of this workgroup was thus to identify priority areas for research in the Information and Communication Technology (ICT) sector that would enable sustainable national development. The following elements were addressed and are covered in this report:

- The relative importance of the ICT sector in Mauritius;
- The current state assessment of the sector;
- The constraints and challenges facing the sector;
- Measures taken to develop the ICT sector;
- The proposed methodology to identify research and development projects in other sectors to enhance development of those sectors; and
- A list of proposed research topics and associated supports required.

3 Importance of ICT in Mauritius

The Government is fully conscious of the importance of the "new economy" and has devised a national Information and Communication Technology (ICT) strategic plan to accelerate the country's transformation into a nation where Information Technology and Communication are fully engaged for business competitiveness, civil service efficiency and effectiveness as well as encourage ICT diffusion so as to help achieve an information-based economy. This vision is an integral part of social and economic development for the country. The main objectives of this strategy are to:

- Develop the island into a modern nation and to enhance the nation's competitiveness in the global market place so as to improve the quality of life of the people;
- Drive Mauritius into an Information-based economy and position our country as a regional ICT hub; and
- Develop Mauritius into both an IT exploiter as well as an IT exporter.

A Ministerial Committee chaired by the Prime Minister and three taskforces have been set to boost the development of ICT in Mauritius to:

- Foster the development of Cybercity and Business Parks;
- Set up the E-government; and
- Enable E-education.

In addition, the 2000/2001 Budget has set the tone for heavy investments to be made in this sector in order to achieve the above vision. The Government is confident that this coherent ICT strategy will prepare Mauritius to meet the challenges of the new economy and steer the country in a position of strength in the global E-Market space.

4 Current State Assessment

This section describes the current ICT landscape in Mauritius, with regard to the:

- Institutional framework;
- Telecommunications infrastructure;
- ICT Industry;
- Human Resource; and
- Legal framework.

4.1 Institutional Framework

The Ministry of Information Technology and Telecommunications, created in August 1997, deals with the formulation and implementation of Government policies in the Telecommunications and Information Technology sectors. A number of supporting organisations has also been established, namely the National Computer Board (NCB) which is a statutory body; two governmental departments namely the Central Informatics Bureau (CIB) and the Central Information Systems Division (CISD); the Board of Investment (BOI); the Mauritius Telecommunications Authority (MTA) which regulate the telecommunications sector, and the Telecommunications Advisory Council (TAC).

(a) National Computer Board - NCB

The NCB, established in 1988, is an apex institution whose main role is to foster the development and growth of information technology, information systems and computer related services in Mauritius. It advises the Government on the formulation of national policies in respect of the promotion, development and control of information technology and its applications. It also ensures data protection and security by recommending legislative proposals and conducting regular review and revision of the Code of Practice.

(b) Central Informatics Bureau - CIB

Established in 1989, the Central Informatics Bureau has been responsible for the planning and coordination of computerisation within the Civil Service. The main services provided by CIB are as follows:

- **IT Consultancy:** Promote the use of Information technology in the Civil Service and ensure an integrated and cost effective functioning of the Civil Service through IT.
- **Project Management:** Evaluate and approve IT project proposals and manage projects with collaboration of end-users. Specify standards, quality assurance schemes, and procedures for project implementation.
- **IT procurement:** Assist the Civil Service in the procurement of necessary IT resources by drawing specifications and evaluating bids.
- **Training:** Plan and monitor training programmes for all categories of users in the Civil Service.

(c) Central Information Systems Division - CISD

Created in 1989, the Central Information Systems Division has been devoting itself to operations. It provides on-going technical support for operational systems within the Civil Service. Data capture is conducted for certain Ministries and departments. First level technical support on personal computers, printers and office automation software falls under the responsibility of this unit. The CISD is also responsible for payroll processing for the entire Civil Service.

(d) Board of Investment - BOI

The Board of Investment has been set up under the Investment Promotion Act 2000 with a view to streamlining the legal framework and to make better provisions for the promotion and facilitation of investments in Mauritius. It acts as a facilitator and provides a one-stop shop service to both local and foreign investors ensuring a reliable and speedy processing of applications. The Board of Investment acts as a powerful promoter of investment into Mauritius and has a key role in promoting the island as an investment hub throughout the world.

(e) Mauritius Telecommunications Authority - MTA

Established under the Telecommunications Act 1998, the MTA provides for economic and technical monitoring of the telecommunication industry in accordance with recognized international standard practices, including the promotion of fair competition and efficient market conduct within that industry, and ensuring appropriate control, inspection and regulation of the industry. It also grants licenses, allocates frequencies and ensures safety and quality of every telecommunication service.

(f) Telecommunications Advisory Council - TAC

Set up in 1998, this council advises the Minister of Information Technology & Telecommunications on the quality & variety of telecommunication services, new telecommunication techniques and tariff.

4.2 Telecommunications Infrastructure

Mauritius Telecom Ltd. is the public telecommunication operator for Mauritius, and holds the monopoly till end 2003. It currently provides basic and value-added services over fixed copper/CDMA wireless, mobile GSM, X-25, ATM, Frame Relay and Internet networks and

through Satellite Earth Stations newly constructed on state-of-the-art technologies. These services are available throughout the country and the data communication network is the second largest of its kind in the whole African continent. With a tele-density of 24% compared to an average of 8% for Africa and with a 100% digital network, the country is set to offer one of the best telecommunications facilities in the region.

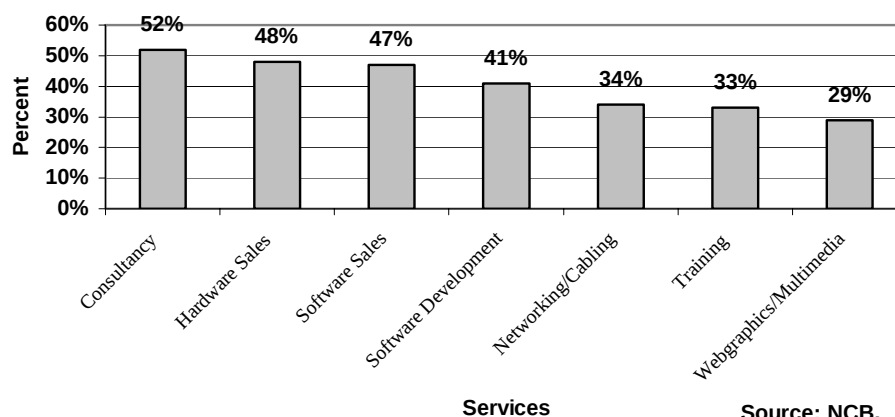
Mauritius Telecom is also an initial party to the SAFE/WASC project, which is scheduled to roll-out at the beginning of 2002, and will provide high-speed connectivity up to 80 Gigabits and boost opportunities for e-Commerce for the country; this will link Western Europe to India and the Far East via South Africa and Mauritius. In addition, the commercialisation of ADSL and WAP services will be a reality in a near future.

Two companies, namely Emtel Ltd. and CellPlus, a subsidiary of Mauritius Telecom, service the mobile cellular phone sector using GSM technology. The total number of mobile cellular subscribers has reached over 210,000 today, and is growing at a fast pace. On the other hand, Telecom Plus is presently the sole Internet Service Provider. Today there are some 35,000 subscribers to this service and it is estimated that there are over 150,000 Internet users.

4.3 ICT Industry

As per the IT Company Directory of the National Computer Board, over 150 IT companies are presently operating in Mauritius. This number includes foreign companies mainly from Europe and the USA that are involved in call centre activities, software development, web and CD-ROM publishing. The chart below shows the types of services offered by these companies.

Diagram I: Percentage of IT Companies by Services Offered, 2000



The market is dominated by a large number of small companies deriving revenue primarily from PC sales. Only a small number of companies operate as total solution providers. A new survey is under preparation and would provide updated figures. Apart from Microsoft and IBM, no IT multinational has a base in Mauritius.

4.4 Human Resource

Qualified and adequate human resource is essential for the development of the ICT industry and permeation of ICT in the different economic sectors. While the country do possess a number of skilled project leaders, software engineers, programmers and other ICT-related

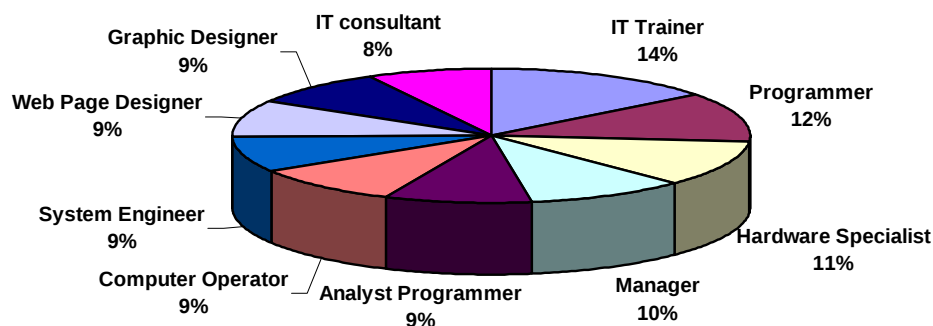
supporting skills, several studies and surveys have revealed an imbalance between supply and demand, both in numbers and skill-set required. Table 1 summarises the results of a spot survey conducted by the National Computer Board in March 2001 on the current number of IT professional available and estimated requirement for the year 2005.

Table1: Summary of current number of IT professionals and projected figures for 2005

Year	No. of IT Professional	Remarks
1998	1,100	Estimated
2000	1,900	Estimated
2001	2,200	Forecast
2005	5,000	Forecast

Diagram II shows the type of vacancies that were advertised in this sector from January 2000 to June 2000.

**Diagram II: Types of Jobs Advertised in the IT Sector
January 2000 to June 2000.**



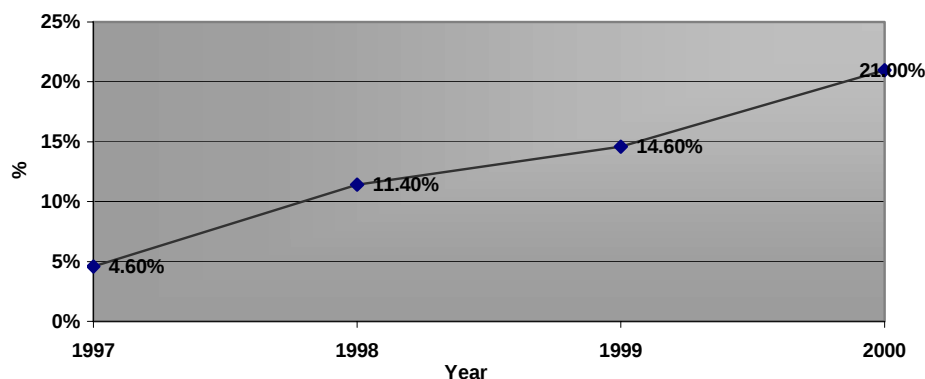
Source: NCB, 2000

On the supply side, there are presently the University of Mauritius (UoM), the University of Technology (UTM), the Mauritius Chamber of Commerce and Industry Training Centre, the Rishi Dayanand Polytechnics and a limited number of private institutions that delivers IT Diploma. The overall enrolment for the year 2000 amounts to 1,290 and the output for the same year were around 400. Although there is a significant number (around 50) of IVTB approved training institutions delivering IT courses of various levels (mainly certificates and diplomas), the quality of the courses as well as the skill-set of those trainees (around 16,000 in year 1999) need to be re-assessed and aligned with industry requirements.

Finally, a total of around 80 foreign IT professionals have received work permits in year 2000 to cater for our shortage in the supply of skilled IT manpower.

Regarding household use of IT, a recent survey carried out by the NCB¹ revealed that in 2000, 21 %of household are expected to be the owner a computer as compared to 4.6% in 1997

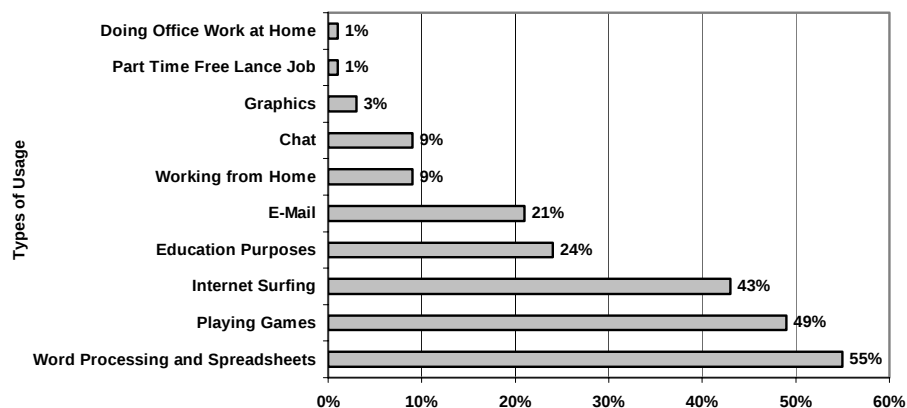
Diagram III: Growth in Computer Ownership by Households; 1997 to 2000 (%)



Source: NCB : IT Household Survey 2000

The same study also revealed that computer are mostly used at home for word processing and spreadsheets, playing games and internet surfing as shown in the diagram below.

Diagram IV: Types of Computer Usage by Households in 2000



Source: NCB : IT Household Survey 2000

Percentage

4.5 Legal Framework

A number of legislation has been introduced to provide an environment conducive for the development of the Information and Communication Technology sector.

The Copyright Act 1997 provides the appropriate legal framework for the protection of intellectual property rights, including software and electronic databases. The Telecommunication Act 1998 provides for the establishment and management of Mauritius Telecommunications Authority with extensive powers to ensure a better regulation of the telecommunications sector in the interest of consumers and providers of telecommunication services. The Information Technology Act 1998 makes provision for the admissibility of

¹ Avalaible at <http://www.ministry-education.gov.mu/>

electronic document as evidence of fact in court cases. It also introduced legislation with respect to data protection and security, computer misuse and the patenting of software. The Electronic Transactions Act 2000 provides the appropriate legal framework to serve as the foundation to facilitate electronic transactions and communications and give a new orientation to the traditional way of doing business by fostering the conduct of transactions by electronic means.

A number of new legislations - collectively known as Cyber Laws - are currently under preparation to enforce the existing ones and cater for forthcoming needs. These new laws will cover (a) Privacy and Data Protection, (b) Computer Misuse and Cybercrimes, (c) Consumer Protection, and (d) Copyright. The introduction of these new legislations are expected to give a boost to the development of Information and Communication Technology sector by ensuring proper regulation of the telecommunications sector, protection of intellectual property, and protection and security of data.

5 Constraints & Challenges

The development and expansion of the ICT sector in general and more specifically research have been hindered by a number of constraints, namely:

- **Manpower.** A shortage of qualified IT Professionals due to insufficient training capabilities and brain drain problem.
- **Funding.** Lack of funding is understandably the most important constraint in research. However for greater commitment in research, it is believed that more funds should be made available.
- **Awareness.** Insufficient awareness on importance of research, supports and funds for potential entrepreneurs.
- **Support.** Limited ICT entrepreneurship through lack of support (absence of an incubator) and/or too stringent conditions attached with existing support schemes.
- **Price.** Telecommunications services and prices are not competitive enough due to the telecom sector being still in a situation of monopoly.
- **Policy and culture.** Absence of research policy in ICT as well as absence of an entrepreneurship and research culture.
- **Size.** The smallness of the market acts as a brake to investment in innovative products and services.
- **Mentality.** Some organisations are not keen in improving things in their organisation despite the fact that they are not operating at their saturation level. They are happy with their current profit level and dare not venture to make it better.
- **Incentive.** There should be more incentives from government and private sector to encourage industries to invest in research. Elements such as tax rebates might help. On the other hand fresh graduates embarking on research projects should be properly supported. Most probably the CRPE Act will need some amendments.
- **Research valorisation.** Proper recognition and appraisal of all the people involved in research projects should be established to encourage more and more others to opt for this line. At national level research, researchers, and research culture should be strongly valorised.
- **Administrative latency.** This is a constraint that lay very heavily of many projects.

- **Regulation.** The MTA has not been so active in promoting research in such a dynamic field as ICT so far. Instead, we have seen that a number of technologies that could have otherwise been beneficial to the economy have been disallowed.

In order for Mauritius to embark in the digital economy and become the regional ICT Hub, the following challenges have to be met:

- Produce adequate qualified ICT Professionals and curb brain drain;
- Develop an environment conducive for creativity, innovation, research and technological advancement;
- Ensure the successful transition from a manufacturing-based to a service-oriented economy; and
- Being able to compete in the global marketplace.

6 Proposed Measures to Develop ICT Sector in Mauritius

In presenting the 2001/2002 Budget, the Deputy Prime Minister and Minister of Finance has stated the importance for our country to master new technologies and be innovative and creative so as to increase our development prospects and the quality of life of our people. A new policy framework has been proposed that aimed at:

- Spreading the use of ICT throughout the country and developing an ICT culture at all levels;
- Developing world-class infrastructure and providing the necessary connectivity to the international network;
- Promoting the application of knowledge to add value to what we produce; and
- Implanting in Mauritius a vibrant ICT industry and knowledge-based activities in its own right.

The overall objective is to develop Mauritius into a Cyber Island and a knowledge hub, and the necessary resources and efforts will be marshalled to fulfil this ambition. The following measures were announced:

- A strategic ICT partnership is established with India to realise our vision of making Mauritius become a cyber-island;
- A Ministerial Committee - chaired by the Prime Minister - is set up to spearhead the development of ICT in Mauritius. Three task forces are set up to look into the establishment of a Cyber City, the implementation of the e-Education and e-Government projects. A line of credit of US\$ 100 million is secured from the Government of India for the implementation of these projects;
- Business Parks of Mauritius Ltd. (BPML) will set up the Ebène Cyber City Project. It will comprise a cyber tower, a business tower, a knowledge complex, a multi-media complex, a Government administrative complex, common facilities and residential units. The new city will have its own direct international connectivity. BPML will also be responsible for the implementation of a business park at Rose Belle;
- In order to promote Mauritian entrepreneurship and tap the talent and potential of young people for innovative ideas in ICT, the necessary support and facilities will be provided. The DBM will set up a Venture Capital Fund for start-ups in the ICT sector and other high

value-added activities. The Fund will provide direct investment in shares, up to Rs 250,000 per project; the DBM will also grant to newly registered SMEs in the ICT sector a 1 per cent reduction in the rate of interest during the first two years on any new loan contracted from the Bank. Finally, the National Computer Board will set up an ICT incubator to promote start-ups.

- Rs. 200 million will be provided for the setting up of 354 computer laboratories and of fully equipped reading rooms in primary schools;
- Provision is made for the recruitment of 330 Information Technology teachers at the primary level;
- A provision of Rs. 10 million is made to finance scholarships in IT and biotechnology;
- Large-scale training, retraining and re-skilling programmes will be devised to improve the employability of job-seekers and facilitate their redeployment in ICT, among others;
- The implementation of various computerisation projects in ministries and departments will be accelerated and a total provision of Rs 180 million is made for Government IT projects. Provision of Rs. 40 million is made for the setting up of the Government On-line Centre whereby on-line access to government information and services will be provided to citizens and investors;
- Provision of over one billion rupees are made for the promotion and dissemination of ICT; and
- The legislative framework will be reviewed to meet the requirements and exigencies of the emerging Net Economy. New legislation relating to the regulatory functions of the Mauritius Telecommunications Authority as well as to data privacy and protection, electronic consumer protection, computer misuse and cyber crimes will be introduced.

7 Research Areas

Research is fundamental to the progress of any nation. However, if research is undertaken blindly without a proper framework, or just for the sake of doing research then it becomes a mere funds waster. It is therefore imperative to know before hand the areas where research funds should be channelled, such that positive returns are generated in the long run. Thereafter the research efforts become more justifiable. The ongoing sections present the major areas in which the workgroup believes that funds should be focussed. The ICT and non-ICT sectors have been treated separately for reasons that were explained earlier. The main criteria borne in mind by members during this exercise were:

- 1) Availability of local resources;
- 2) Direct impact on the life of citizens;
- 3) Possibility of joint research with overseas institutions keen in entering into such ventures;
- 4) The level of importance of the subject areas to our national interest.

List of Research Projects

7.1 *ICT Sector*

A number of potential research projects are outlined hereunder:

- A study on the regulations/laws and make provision for consolidation concerning the ICT sector in Mauritius.
- Study to devise a scientific model, which is suited for the purpose of Mauritian ICT economy, for calculating the number of IT professionals needed together with their expected profile in the years to come.
- Computer-aided learning environments (pre-primary, primary, secondary, vocational)
- Study on quality and standards to be established for the tertiary ICT training, and criteria for equivalence of ICT qualifications at the National Equivalence Council
- Study to identify and implement ways and means to disseminate IT Culture and Literacy in Mauritius (while making optimum use of existing infrastructure, e.g. community and youth centres).
- Study on the development of intuitive interface that facilitates interaction with the computer and access to Internet. These interfaces can be efficiently used to make common people's life easier through electronic information/service delivery. Voice recognition is one of the technologies that can be considered to this end.
- Study on the Mauritian consumers & citizen in general vis-à-vis the Internet.
- Geographical Information Systems and related applications.

7.2 *Non-ICT Sector*

ICT can potentially help in improving efficiency and productivity in several sectors of the Mauritian economy, as well as the quality of life of our fellow citizens. A methodology is proposed for identifying ICT-based research and development projects that can help cracking problematic areas. Implementation and assessment of that methodology on its own is presented as a research proposal in section 7.3. Once the problematic areas are properly tabled the proper resources with regard to ICT requirements could then be deployed to come to the desirable solutions. The fields identified hereunder are typically the prominent ones where it is believed that ICT research effort should be focussed in that endeavour:

- Agriculture
- Textile
- Environment
- Health
- Tourism
- Education
- Marine and Bio technology
- Public services
- Transport
- Services department
- Human resource modelling

Despite the fact that the themes are quite diverse and even different from each other, yet the same general approach may be adopted to ultimately undertake relevant ICT-based projects in each of them at the micro level. A generalised methodology is presented. Within each of the above-named sectors it is important in the first place to know where that sector currently stands before taking any decision to move ahead, and deciding on the direction of the movement. It is of paramount importance as well to know the penetration of ICT within these

sectors. Thereafter, a lucid picture of the relevant problems to be addressed should be clearly formulated.

7.3 List of research proposals

The research proposals given in this section is divided into two parts: the non-ICT and ICT sectors. For the former, a methodology is proposed as the research to be undertaken within each of the fields identified in section 7.2. The generalised methodology is adopted as a means to avoid duplication, but should be applied to each field.

I Non-ICT research proposal

Topic: Identifying problematic areas in different non-ICT sectors of Mauritius where ICT can provide a helping hand.

General methodology

Step 1: Current state analysis

To gain an understanding and an appreciation thereto of the current thematic sector state, some reliable data should be available. This can be obtained from reliable archives or other up to date sources. Otherwise, this has to be obtained by conducting a survey among the major players within the thematic fields. A significant research element should emerge at this very stage, regarding the way in which an appropriate survey is to be conducted, data are collected, and useful information are then derived and presented in meaningful format.

Step 2: Brainstorming session for specific problem identification.

Following the current state analysis, some sort of taskforce or workgroup should be set up, with members being representatives of the players within the thematic fields where major problems have been identified, representatives of the MRC, academia, and the ICT workgroup. MRC being the driver of this project is ideally positioned to set up this group and electing the relevant members in order to give a good sample representative of the actual industry. The selected members from the thematic sectors will then be called upon to meet in order to table some or most of the problems that they are currently facing in some details; the problematic areas to be addressed should be confined to those that have direct bearing on productivity, service quality, man-power planning, among similar others. Even in cases where a representative simply has a feel that something is not going on well as expected in his/her sector, without any firm quantitative evidence to back the argument, appropriate note should be made. This on its own will hint for a profound research to quantify the above.

Step 3: Problem definition and objectives statement

This stage will deal at somewhat the grass-root level of the problem(s) such that formal problem definition will be drafted and agreed by all parties concerned on matters dealing with economic, social and regulatory issues. This is precisely where a number of micro level projects can be thought of, and the aims and objectives in each case formulated. An important research element in this phase will undoubtedly be the feasibility study of all the micro level proposals that would have been suggested to address the problems defined above. This will require tremendous human skills and resources, and if need be, people with the right skills from overseas should be contacted and hired.

Step 4: Project implementation

This phase will automatically succeed the recommendation of the previous one. As far as possible we should try to use resources in terms of materials and manpower that are locally

available. However, in certain cases we might have to look elsewhere to ensure better price-per-function guarantee. Even if the latter solution is fancied, this should not be taken as something bad since the industry and academia would have mastered the required skills to embark on similar projects in the future (e.g. the case of Singapore).

Step 5: Commissioning, evaluation, and lesson learnt

This phase is very crucial in this entire project lifecycle. Once a given system or strategy would have been put in place, researchers from academia and industry should be given the opportunity to experiment with the same and to make any necessary changes accordingly. This is what in the future shall allow more and more innovations to be possible, rather than sitting down and waiting for new crisis to show up in order to take further actions. This dynamic interactions with currently existing systems are on their own, the motto for successful research programmes in the long run. At this stage research in itself becomes easier, and start showing its fruit over a shorter time-span.

Research team: composed of people from each of the fields identified, people with ICT background, and a legal person.

Effort: dependent on complexity of each field

II ICT research proposal

(a) Topic 1 A study on the regulations/laws and make provision for consolidation concerning the ICT sector in Mauritius.

Synopsis: ICT is a very fast developing field worldwide. In Mauritius as well we are witnessing the same exponential growth. However, without a proper legal framework, the development of this sector might be undertaken in an unplanned fashion, such that further growth becoming in the very long run might turn out to be difficult. In this research, it is proposed to review the current regulations, understand the current and future ICT trends for Mauritius, and eventually propose a number of measures to enhance the regulatory framework such that ICT growth is not unduly hindered.

(b) Topic 2 Study to devise scenarios, which is suited for the purpose of Mauritian ICT economy, for calculating the number of IT professionals needed and the expected profile in the years to come.

Synopsis: A reliable model is among the most important tools that help decision-makers in their planning tasks. Given that ICT is currently undergoing important changes in the country, it is of paramount importance that some very important measures are taken at this very instant in order to guarantee a sustained development. Capacity planning is one of the important issues that need to be addressed in that purview. As such, an effective model that describes a reliable and unbiased interrelationship between the various parameters involved, and their variations over time, is fundamental to the success of the long-term plan. The objective of this proposed research is to devise such a model, and to test and validate its effectiveness.

(c) Topic 3 Computer-aided learning environments for all educational levels

Synopsis: ICT over the recent years has become an increasingly obligatory tool in several sectors. Among others, e-learning with the help of ICT is taking real momentum in different countries of the world. In Mauritius, we cannot blindly copy the way this is done elsewhere and expect that we shall reap the same benefit. The proposed ongoing research aims at 1) understanding the current model(s) that exist(s) in other countries, 2) looking at the specificities in the education sector of Mauritius, 3) analysing various scenarios with the help of most of the players of the education sector, and 4) recommending a model or strategy that will be ideally suited for the local context.

(d) Topic 4 Study on quality and standards to be established for the tertiary ICT training, and criteria for equivalence of ICT qualifications at the National Accreditation and Equivalence Council

Synopsis: With the ever-increasing demand for professionals in ICT, many more institutions will be called upon to run ICT courses and award appropriate certificate, diplomas and degrees. However, to ensure that the awards are of acceptable quality some proper measures need to be taken. The objective of this proposed research is to look into this issue and to propose a strategy that will ensure a predetermined quality level.

(e) Topic 5 Study to identify and implement ways and means to disseminate IT Culture and Literacy in Mauritius.

Synopsis: The penetration of ICT in Mauritius is quite low as compared to countries like Singapore. One of the best ways to go about inculcating an ICT culture among the common people is to open up the subject by making optimum use of existing infrastructure such as community and youth centres. The aim of the proposed research is to develop a strategy for achieving the above-mentioned goal. Ways to evaluate, modify and finally adapt the proposed strategy to the real-life environment will also be devised.

(f) Topic 6 Study on an intuitive interface for the computer.

Synopsis: The prime requirement in bringing computer and Internet tools to the general public is to have very user-friendly and easy-to-use interfaces to these elements. These interfaces can be efficiently used to make common people's life easier through electronic information/service delivery. Among others voice recognition is one of the technologies that can be exploited to this end. The particularity in this case is to adapt the system to cope with the popular dialects.

(g) Topic 7 Study of the use of the Internet by Mauritian.

Synopsis: Although ICT is currently a very dynamic subject, yet the degree of acceptance of the general public is the final litmus test to decide how far ICT will find its place in

the citizens' trend of living. The proposed research will try to understand the way Mauritians in general view the Internet and associated elements. It will then propose ways and means by which we can clear out some misconceptions and hence make this outlook better. It will further propose means by which a structured ICT policy for Mauritius can be initiated throughout the country.

(h) Topic 8 Geographical Information Systems and related applications.

Synopsis: ICT is potentially the tool that can access a very wide range of people from different places at the same time. Such feature is considered interestingly important to a number of applications such as traffic monitoring, pollution control, and others, which require the above-named feature. The objective of this research is to identify a number of sectors and infrastructures such as water utilities, CEB, WWA, among others that can benefit from GIS, and to recommend ways in which this can be deployed around the country.

(i) Topic 9 Study and implementation of a Public key Infrastructure (PKI) Cryptographic technique over a mobile telephone channel.

Synopsis: This project is an attempt to study a Public Key Infrastructure Cryptographic technique to be implemented over a mobile telephone channel, which allows a computer to access a remote Local Area Network. A simulation of the most feasible solution should be carried out with the result analysed and effectively presented.

(j) Topic 10 Implementation of an online digital certification system using a security server on a corporate intranet/extranet platform.

Synopsis: Digital Certification provides the basis for secure Client/Server communication over corporate intranet/extranet platforms. However the digital Certificates issued to a server is normally a static one, which expires after sometime. This project attempts to implement on a security server, online generation of digital certificates, which will be communicated to registered Web Servers online and which will be seamless to users.

(k) Topic 11 Voice over IP

Synopsis: The quality of most current Internet real-time voice transmission systems is not satisfactory because of the current Internet's delivery and scheduling mechanism. The Internet has been traditionally designed to support text-based non-real-time data communications, but not real-time voice transmissions, such as Internet phone. These real-time applications have quite different characteristics. The first significant characteristic of real-time applications is their high delay sensitivity. Each packet generated by a source is routed to the destination via a sequence of intermediate nodes. The end-to-end delay is thus the sum of the delays experienced at each hop on the way to the destination. Packets may be rejected at the intermediate nodes because of buffer overflow. Hence, another important characteristic of a packet-switched network is its packet loss rate. The above two potential problems should be considered in order to develop a high-quality real-time voice transmission system. The purpose of this project

is to examine the necessary components of a real-time voice transmission system by studying Internet voice-traffic behaviours and to design and compare reconstruction methods/Channel coding to conceal loss and improve transmission quality.

(l) Topic 12 CHALLENGES IN MOBILITY SUPPORT FOR THE NEXT GENERATION INTERNET SERVICES

Synopsis: There is a variety of emerging technologies and protocols enhancement designed to extend Internet services to mobile users, including operation over more dynamic, heterogeneous wireless interconnections. Many different approaches and protocols have been proposed and there are even multiple standardization efforts within the Internet Engineering Task Force that address portions of the overall goals. In this research project it is proposed to study some of these emerging technologies with a view to provide insight into how some of these pieces may fit together to realize seamless Internet services for user on the move or in application spaces with little to no pre-existing communication infrastructure.

(m) Topic 13 Application of IT in medicine

Synopsis: In recent years public safety officers and rescue service teams have shown interest in Data transmission like medical telemetry, digital images, location telemetry and text. In this project it is proposed to develop these technologies so that improved pre-hospital care to patients while in transit from the casualty site to the hospital can be given as well as to provide paramedics first hand specialist advice on treating patients in this field.

8 SUMMARY

This report has presented the importance of ICT to the development of Mauritius. A number of sectors that can benefit directly from ICT as a tool have been surveyed. Barriers to research in ICT, as well as incentives measures to promote ICT in Mauritius were briefly visited. A list of prospective themes for research In ICT is given. A possible methodology to identify potential research areas in different sectors for ICT in Mauritius is recommended.

9 Annex

Annex 1: COMPOSITION OF WORKING GROUP

Chairman	Mr K Mohee, NCB
Members	
Mr A Bissonauth	De Chazal Du Mee
Dr S Soyjaudah	University of Mauritius
Dr K Oolun	University of Mauritius
Mr S Baichoo	University of Mauritius
Mr R Bigaignon	Microsoft Indian Ocean Islands
Mr D Hurkoo	Telecom Plus
Mr O Lew Kew Lin	EPZDA
Mr T Saha	Prime Minister's Office
Mr D Lim Fat	Information Management Services Ltd
Mr H Patil	Happy World Computers
Participants	
Prof S Bhoojedhur	Chairman, MRC
Dr A Suddhoo	Executive Director, MRC
Mr S Abacousnac	National Computer Board
Co-ordinator	Mr D Chuckowree

9.1 *References and Additional Readings*

1. The NCB Website (<http://ncb.intnet.mu>).
2. Ministry of Finance, National Budget Speech 2000/2001.
3. The Telecommunications Act 1998.
4. NCB, (2000), *IT Household Survey to Assess ICT Usage by Households in Mauritius*, available at: <http://ncb.intnet.mu>.
5. NCB, IT Company Directory of the National Computer Board, available at: <http://ncb.intnet.mu>.
6. Mauritius Research Council (2000), *Science and Technology Study*.
7. NCB, (2001) *IT Manpower Spot Survey*, results available at: <http://ncb.intnet.mu>.
8. R W Nowlin and R Sundararajan. "A Forward-Electronics and Computer Engineering Technology Program". *IEEE Transactions on Education*. May 1999. Vol. 42. pp. 118-123.

9.2 Annex 2: Completed/on-going PhD Research work in ICT at UoM

- 1 Error Protection techniques for time varying channels by K M S Soyjaudah (completed)**
- 2 Real-time Adaptive Filter System For Active Noise Cancellation In Verbal Communication Systems by M K Oolun (completed)**
- 3 Novel Data Compression Techniques for image processing applications by Sunilduth Baichoo (Transferred to PhD)**
- 4 Combined Channel Coding and Modulation for Future Mobile Communication Systems by Gianeshwar Ramsawock (Transferred to PhD)**
- 5 A study of combined source coding, channel coding and modulation techniques by M Hosany (Transferred to PhD)**
- 6 Field Oriented Control Of Inverter-Based Induction Motor Drive With Compensation For Parameter Variations by M.I. Jahmeerbacus (Transferred to PhD)**
- 7 A totally integrated data security environment for computer network and radio communication systems by S. Govinda. (Transferred to PhD)**
- 8 Studies of the performance of VOIP using queing networks models by S. Jharee. (started)**
- 9 Study and implementation of Gallagher codes to provide combined coding and cryptography by Clarel Catherine. (started)**

9.3 Annex 3: List of completed undergraduate development projects in ICT at UoM

#	Title of Projects
1	A PC based data acquisition and display system
2	Design and implementation of a microprocessor based series inverter
3	A differentially encoded quadrature phase shift keying modem
4	QAM modem
5	Energy management control
6	A frequency synthesizers for spread spectrum
7	Error correction code and convolution coding
8	Computer controlled greenhouses
9	Modelling and simulation of temperature controlled systems
10	A microcomputer based weighting and pricing system
11	Comparative study of Array codec with increasing number of parity columns
12	A microcomputer based call logger
13	A fast control and data acquisition system for MRT
14	Study of error control coding schemes and software implementation of the simple codec
15	A PC based pump management system at St Louis Power station
16	Design and implementation of a QRPS
17	Design and implementation of trellis codec
18	A microcomputer based power protection system
19	Temperature control of a composting system
20	Microcontroller based half bridge inverter
21	Combined coding and modulation using product code
22	49 levels QRPS
23	A PC based monitoring and protection alarm system
24	Stream encryption
25	Combined coding and modulation using RC technique
26	Study of cyclic codes
27	Telephone initiated home monitoring system
28	Microcontroller based DC chopper
29	Design of a programmable logic controller on the control system of a carding machine at Ferney Spinning Mills
30	An efficient family of burst error correcting product codes
31	Simulation, design and implementation of a pulse width modulated dec to ac inverter
32	Design and implementation of a combined source and channel coding scheme
33	Microprocessor based fan controller
34	Design and implementation of a 8085 based target system for the control of a washing machine
35	A study of parallel decoding and implementation VRVC codes
36	Trellis coded modulation using QAM technique in Gaussian and Rayleigh fading channels
37	Combined coding and modulation using error control code / runlength limited (ECC/RLL)
38	Securing data transmission

39	Design and implementation of a pulse width modulated switch mode de-dc converter with voltage feedback
40	Design and implementation of a PC based automated overhead rail material handling system for a small making up textile plant
41	Design and implementation of a virtual instrument for level and temperature measurement
42	Trellis coded modulation codecs using conventional codes and phase shift keying modulation
43	Adaptive trellis coded modulation convolutional codes
44	Study of a CCS at Beau Plant Sugar Estate
45	Parallel viterbi decoding
46	Embedded convolutional coding
47	Solar tracking system for heliostat field
48	Adaptive TCM using block codes
49	Transmission of data over power cable (power line carrier)
50	Combined channel coding and modulation using turbo codes
51	Source and channel coding using turbo codes
52	Design and implementation of a data acquisition system
53	Design and implementation of a low cost PC based oscilloscope
54	A combined Huffman and convolutional coding scheme with modulation
55	Adaptive filtering on voice grade corrupted signals using a PC platform
56	Voice source code rate adaptation for CAC in ATM network
57	Fractal image compression using quadtree partitioning
58	Comparative study of convolutional codec using viterbi, Fano and stack decoding algorithms
59	Automated parking using PLC
60	Fuzzy logic speed control of a DC motor drive
61	Design of a PLC based automation system for the spool creeling operation at Ferney Spinning Mills
62	Virtual instrumentation technique for temperature monitoring during thermal processing of canned food products
63	Performance analysis of cryptographic techniques used in SSL and SET
64	Modelling and performance study of frequency hopped spread spectrum systems in mobile channels
65	Study and implementation of Gallager codes to provide combined coding & cryptography
66	Present day Bluetooth Technology merits and limitations
67	Performance evaluation of turbo codes over AWGN, Rayleigh fading and ISI channels
68	Fractal image compression using HV partitioning
69	Voice over IP "Packet Loss" concealment techniques
70	Adaptive coding system employing separate as well as concatenated reed solomon and convolutional codes
71	Design & implementation of a Public Key Infrastructure cryptographic technique over a wired and wireless communication channel
72	Study and implementation of a Public Key Infrastructure cryptographic technique over a wired and wireless communication channel

73	Passing digital data through power lines
74	Fractal image compression with HV partitioning
75	Study of cryptographic protocols and the design of a new voting protocol
76	Study the channels codes used in GSM and investigation of their performance
77	Study of the Entropy of different language and the efficiency of compression techniques
78	Joint source and channel decoding using variable length trellis
79	Solving the unit commitment problem with genetic algorithms
80	DNA based algorithm for load balancing in Telecommunication Networks
81	Unequal error protection (UEP) using convolutional & turbo codes
82	Performance comparison of direct sequence and multi-carrier approach for CDMA 2000
83	Arithmetic coding based continuous error detection
84	Using channel coding in spatial watermarking
85	Design & implementation of a Data acquisition over public switched Telecommunication Network
86	Automobile parking control
87	Fuzzy control
88	Design & implementation of a PC based maximum power point tracker for solar panels
89	Design & implementation of a PC based power line monitoring system
90	Design & implementation of a closed-loop illumination control system
91	Fuzzy logic voltage control of a buck-boost converter
92	Design & implementation of a speech recognition system
93	System identification and compensation using a DSKplus kit
94	Design and Implementation of a Program Visualization System
95	Design and Implementation of a Computer Aided Traffic Control System
96	Development of an expert system shell using C++
97	To develop a PC based image processing software package using (C++).
98	Implementation of a Client/Server system
99	Implementation of a simple RPC system.
100	Design and implementation of a system Management Interface Tool for Unix machines (SMIT Tool).
101	Pascal to C Translator
102	Designing an Antivirus software
103	Simulation of a traffic flow at a junction where a robot is to be installed
104	A Graphical Editor for Programmable Logic Device
105	Development of an X-Based Distributed Application using Remote Procedure Calling
106	Development of an Intel 80486 Microprocessor Tutor
107	Providing file protection on Dos Machines
108	Implementation of a Transaction processing System
109	Simulating the Growth of a Sugar Cane Plant Under Different Climatic Conditions
110	Simulation of the flight of an aircraft powered solar cells
111	Implementation of a Distributed system Architecture
112	Development of a software tool for colour prediction in textile Industry
113	Study of generalised array codes in a Gaussian Channel using Trellis Decoding
114	Scanning a text in memory and filling in the missing letters
115	Serial line Monitor

116	Design of a Graphical Tool to Help Program Microcontroller Based systems
117	Turing Machine: An expert system on Geography
118	A pattern-making and Grading Tool for Textile Department.
119	A Learning package for E.V.S using object oriented Programming
120	Image Segmentation
121	Use of Fractals for representing Natural Phenomenon
122	Comparison of Lossless data Compression techniques
123	Implementation of a graphics package for Design of garments. (Graphics)
124	Distributed Systems
125	Encryption (Communication)
126	File Compression (JPEG)
127	Sliding Window Protocol (Data Communication)
128	A Hair-dressing software (graphics)
129	An integrated environment for CLISP
130	A graphical user interface for remote systems
131	Modelling the motion of objects
132	French to English translator
133	Traffic flow simulation along a stretch of road by graphics
134	Fine tuning of a Short-wave Receiver
135	Sending Fax from a Local Area Network
136	Nested Transaction Processing System.
137	Implementation of a Multimedia Communication System Using UUCP Protocols.
138	Development of an Interactive Database on the Internet Using Java.
139	Setting up of a Distributed Database System on the University Campus Network
140	Implementation of a Secure File Transmission System on the University Extended LAN.
141	Study and Implementation of Array Codes in the JPEG Compression.
142	Fine Tuning of a Short wave Receiver.
143	Trellis Coded Modulation Using Convolutional Code.
144	Secure SMTP.
145	Sending Fax from a Local Area Network
146	Use of Fractals for representing Natural Phenomena.
147	A Graphical user interface for Remote Systems.
148	A Simulation Tool to evaluate potential of Wind Energy.
149	Implementation of a Sliding Window Protocol on a TCP/IP Link.
150	Interprocess Communication
151	Design & Implementation of a Dynamic Domain Name Server for Host Configuration on a Local Area Network.
152	Design and Implementation of a simple DBMS on Linux Operating System.
153	Implementation of a graphics package for Design of garments. (Graphics).
154	An Audio/Video Phone

155	A Multimedia Presentation Package
156	Implementation of the Corba Portable Adapter in GOPI
157	A Comparative Study of Three Corba Platforms
158	Search by Shape
159	Learning Tool for Different Sorting Algorithms
160	Building a Flight Reservation Application on the Web
161	Building a Co-operative Simple Word Application
162	Search Engine for Retrieving Information from the WWW
163	Proxy Server Cache Simulation
164	Single Lane Traffic Analysis
165	Conversion of a 2D Computer-Generated Cartoon into a 3D Computer Generated Cartoon
166	Generating a 3D Human Face that Speaks
167	Show a 3D Picture of the Solar System at Various Points in Time
168	Locating Items in a Shelves-Based Store
169	Study of the Cost of Transparency on the Sun Systems
170	Development of a Simulation Tool to Evaluate Strategies for the Optimisation of the Regional Maritime Transport Network
171	Learning Tool for Experimenting with Digital Electronics Circuits
172	Tool for Experimenting with Geometric Shapes
173	Tools for Evaluating Information about Accesses to Web Pages
174	System for Handling References of Journal/Conference Papers
175	Study of Error Probagation in Huffman and Arithmetic Coding
176	Implementation of Error Detection/Correction Capability in Arithmetic Coding
177	Comparison of Huffman and Arithmetic Coding for Image Compression
178	A Graphical File Comparison System
179	A Web-based Patient Slot Reservation System for Hospitals Using Different DBMS Platforms
180	A Secure Email Service with Secure Multicast Support
181	A Computer-based Training Tool for PC Building and Maintenance
182	A Virtual Laboratory for Science Subjects
183	An Interactive Learning Environment for Foreign Languages
184	Virtual Tourism
185	TD Poker
186	Real-time Travelling Salesperson Problem