PN-ACW-65

Africa-America Cooperative Program in the Mathematical Sciences

Education for Development and Democracy Initiative

Final Report
Fiscal Year 2003

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Submitted to

United States Agency for International Development

The AAMI is a unique partnership of individuals from African and American universities, the African Mathematics Union, The Orkand Corporation, and NASA. It fits well with the USAID Office of Human Capacity Development's goal of "facilitation of partnerships, linkages and networks", "to help attain sustainable development." As a first step toward achieving this goal we are implementing a regional model approach, similar to the model successfully developed by the *Institute e Matematicas Pura e Aplicada* (IMPA) in Brazil for South America. The focal point of our model is South Africa, a country that has already begun the process of providing leadership in southern Africa in mathematics and science. It should be noted that countries in this region have continued to indicate their strong support for the leadership role being played by South Africa. The initiative is especially timely for South Africa, which possesses a significant research base but must extend that base in populations formerly ignored.

The American institutions from which we are drawing our expertise represent a set of majority research institutions and Historically Black Colleges and Universities (HBCUs), each possessing the necessary experience and commitment to the ideals delineated in our proposal. This group, lead by Florida State University and their partner Orkand Corporation, launched a *Program Management Plan* to initiate the regional model approach in South Africa. This report will summarize programmatic activities accomplished during fiscal year 2003. In particular, it delineates accomplishments in the following programs initiated by partners: Western Cape Education Department Focus Areas; the African Institute for Mathematical Sciences Education Program; the AAMI Network; the South Africa Center of Excellence for Teacher Training; and the FSU International Program.

II. Focus Areas of the Western Cape Education Department

A. Western Cape In-Service Teacher Institute

Background

The legacy of the Apartheid policies of the previous dispensation has presented the present government with urgent challenges that the partnership wishes to both confront and resolve. This is specifically true in the field of Education. In previous years and especially prior to 1994 the teacher training programs, in some sectors of the South African population was poor and inadequate. The consequence is that many teachers lack content knowledge and practice poor methodologies, which disadvantages the already disadvantaged.

We believe that the success of South Africa is dependent on a vital, informed and enthusiastic teaching fraternity that can lead young people toward a better future in becoming responsible and highly skilled citizens of South Africa and of the world in general.

The partnership is working closely with the Western Cape Education Department in an effort to establish an Institute for the continuing development and support of teachers. In this way we hope to address the serious backlog in the knowledge and skills of present teachers, as well as management capacity deficiencies.

The Aim of the Institute

The institute will offer appropriate programs for teachers in the Western Cape Province. The content of the programs and the prioritisation of programs will be determined both by policy requirements and by school and classroom-based research.

Recent research in the Western Cape indicates that teachers require support in three main areas:

- Content knowledge
- Organizational and management skills
- Teaching and assessment strategies.

In addition to this, the introduction of Outcomes Based Education and the recent publication of the new *National Curriculum Statements* make it necessary and, indeed, essential that teachers be re-trained and updated in their content knowledge and suitable methodologies to give reality to our vision of high quality education for the children of South Africa.

The establishment of such an Institution would be to achieve these goals.

SITE OF THE INSTITUTE

The Institute is located in Kuils River, a suburb of Cape Town, which is accessible to disadvantaged communities. The facility is purpose built with lecture rooms and small breakaway classrooms. There are computer facilities available and a well-equipped library. Hostel facilities are available for residential courses. A small number of management and administrative staff will be appointed to oversee the Institute and to quality assure the programs.

PROPOSED COURSES

In the past courses have been run over weekends or in the afternoons. These courses have not resulted in the desired outcomes. It is for this reason that longer courses are envisaged at the Institution.

Courses of between 8 to 12 weeks will be held at the Institute. Such courses will be presented by the best service providers in the province. These include Universities, Technikons and Non-Governmental Organizations. The main functions of the staff of the Institute will be to develop content outlines for programs to be offered and to quality assure the programs as they are delivered.

The initial focus will be on Science, Mathematics, English, Economic and Management Science, Business, Technology and Management. The aim is to initially run 10 courses and then expand.

PROPOSED PARTICIPANTS

Participants would be drawn directly from the classrooms, which empirical research indicates, have the most urgent needs. Experts in the field will select course participants. They would be required to attend on a daily basis from 8:00 AM to 4:00 PM. The teachers who attend such courses will be developmentally enriched in that they would have the capacity and confidence that will enable them to change their attitudes and beliefs and concomitantly their practice. In addition they will be more capable of accepting the challenges and opportunities for occupational development and progress that is related to the life long learners that they could become. Teachers will be engaged to replace course participants in their absence from the classroom.

FY03 ACCOMPLISHMENTS

During the fiscal year 2003, with support from the EDDI program, the partnership launched the first course offered at the Institute. In particular, funds from this grant were used to compensate two lecturers, supplies and other incurred costs for course preparation, travel for participants and lecturers, materials used during the course and refreshments. In addition, as a result of two site visits, with the Western Cape Provincial Minster of Education Andre Gaum, Advocate Dirk Brand and the Institute staff in attendance, the following recommendations were made by the AAMI staff based on a review of the Institute.

1. Linkage arrangements and agreements should be developed between local universities, the African Institute for Mathematical Sciences and the USAID proposed SA Center of Excellence for Teacher Training.

2. An information technology literacy course should be developed for the Institute emphasizing international educational technology standards including the following.

   - Use of input devices (mouse, keyboard, remote control) and output devices (monitor, printer) to successfully operate computers, VCRs, audio tapes and telephones.

   - Use various media and technology resources for learning activities.

   - Communicate about technology using developmentally appropriate and accurate terminology.

   - Use developmentally appropriate multimedia resources to support learning.

- Work cooperatively and collaboratively with peers, family members and other when using technology in the classroom.

- Create developmentally appropriate multimedia products with support from teachers, family members or student partners.

- Use technology resources (puzzles, digital cameras, drawing tools) for problem solving and communication.

- Gather information and communicate with others using telecommunications with support from teachers, and others.

3. The Institute should develop a corporate sponsorship program.

4. A certification program in technology for teachers should be developed.

The Institute should establish a research arm that considers the appropriate incorporation of technology, not only in the classroom, but also in areas such as administrative systems, student portals, eLearning environments, collaborative resources, and digital libraries and information accesses.

B. Maths, Science and Technology Academy

Introduction

The following facts and information serve as strong evidence for the need of a K-12 Academy emphasizing mathematics, science and technology.

1. In South Africa the pass rate in Grade 12 Higher Grade (HG) Mathematics and Science, especially under previously disadvantaged black and coloured learners, is very low.

2. There are various reasons for these failures which could include the following:
   - A huge shortage of educators that can effectively teach these subjects.
   - Insufficient learning and teaching materials.
   - Lacking teaching and learning strategies in schools in these subjects.
   - The basis for these subjects, that should be provided in primary schools, is lacking.
   - An absence of success and positive role models in these subjects.

3. It is also a well-known fact that, especially the standard of Mathematics and Science in South African schools is very poor in relation to most other countries.

4. In-depth knowledge of Mathematics, Science and Technology is crucial for further studies in the natural sciences, physics and technology. These study areas are important for training in related professions, which in turn is crucial for the economic empowerment, development and growth of a country.

5. South Africa is totally dependent on a strong economy for nation building, transformation, development, survival and a dignified existence amongst the nations of the world.

6. It should be noted that not only is strong economic growth important for South Africa, but it is also of vital importance for growth and stability of the other SADEC countries and the broader African continent. Departments of Education in South Africa should therefore do everything in their power to ensure that sufficient learners excel in Mathematics, Science and Technology.

7. It would appear that approximately 20% of Grade 12 learners must obtain positive results in these subjects in order to provide the needs of the country. More than 20% would be a bonus.

8. Thus far a great deal has been done in South Africa to improve the standard of Mathematics, Science and Technology, but without much success.

9. Perhaps in many instances South Africans wanted to do too much for too many learners with too little resources. The result is that very few learners really benefit from these inputs.

10. It therefore seems as if another approach is needed to solve the problem in question.

11. It is further important to note that attainment of success cannot be postponed for years. In terms of the needs of South Africa, success in the short, medium and long term is crucial. The strategies to achieve good results in the mentioned subjects, must subsequently be in line with this. Short, medium and long-term strategies are therefore needed.

12. Short, medium and long-term strategies do not have to follow in sequence, but can be implemented concurrently.

SHORT TO MEDIUM TERM PROBLEM SOLVING STRATEGY

The strategy entails the following:

- Identify and recruit secondary school learners, especially from disadvantaged communities, with the proven potential to achieve success in the specifically mentioned subjects but also the other required subjects and place them in a world class academy where this potential can be developed speedily and effectively. The curriculum could also include Astronomy and Space Science.

- Recruit a very enthusiastic and competent management team, educators and support staff from various racial groups for this school.

- Equip the school with the teaching/learning materials and technology crucial for success.

- Provide for learners from various racial- and cultural groups.

- Provide hostels and hostel bursaries for the learners in need of such facilities.

- Provide transport for day scholars.

- Recruit sponsors for the school and sponsorships for learners.

A very suitable vacant school with hostel facilities that can easily be converted has already been identified, namely the former Constantia Boys School in Constantia/Tokai, next to the International American School. This school can accommodate 500 learners and has the potential to eventually accommodate up to a thousand learners.

It is envisaged that the opening of the Science and Mathematics Academy be in January 2004. A complete project- and business plan for the project was drafted for consideration and later approved. The implementation of this Academy will, amongst others, have the following benefits:

- The Grade 12 HG Mathematics, Science and Technology results should improved dramatically resulting in more learners enrolling at higher education institutions.

- Many more learners from the so-called black and coloured communities will achieve success in the mentioned subjects.

- The Academy will be able to undertake research with regard to how good practices can be extended to other schools.

- The Academy will develop strategies on how to deal with large class groups.

- The educators can be utilized to provide specialist training for other educators.

- The Academy could be utilized for curriculum development.

- The Academy could be utilized for adult training and for assistance to learners who cannot be accommodated in the school, for example after school hours, over weekends and during school holidays.

- The Academy could draw sponsorships that will reduce departmental expenditure.

FY03 ACCOMPLISHMENTS

During FY03, the AAMI team made two site visits to the Maths, Science and Technology Academy to review the wireless network plan. In addition, a review of the continuing site renovations and a status report of future plans with the AAMI. In addition, recommendations on technology selection, such as, servers, printers, scanners, cabling, switching and other educational technology were made. These selections were made in a fashion that allows future alignment of the Academy's educational technologies with other network infrastructure of the AAMI. The aim here is to allow the Academy an easy fit into the AAMI network once renovations are completed.

Finally, curriculum plans for Space Science were discussed. The desired outcome is for the Academy to receive educational enhancement material in Space Science from the Florida Space Authority. The Florida Space Authority has over the past decade worked closely with universities in Florida in an effort to develop multi-media educational material to be incorporated into existing mathematics and science curriculum throughout the country. During this fiscal year, the AAMI team began exploring ways in which the Academy could tap into this valuable resource. Of course the first step in this process was to obtain the Florida Space Authority as an active partner.

C. Khanya Project

BACKGROUND

The Khanya project is a Western Cape Education Department initiative, which was born out of a need to increase educator capacity in the schools of the province. The name Khanya is derived from a Xhosa language word meaning 'light' or 'enlightenment' and the purpose of the project is to use technology to enlighten the minds of learners by supporting the curriculum delivery process.

The need to use technology for curriculum delivery is as a result of diminishing educator capacity. A number of factors contribute to this situation:

- Fewer entrants to the education profession
- Educators entering alternative professions
- Educators being head-hunted by overseas education institutions
- Many remaining educators not sufficiently skilled
- HIV/AIDS is taking its toll among educators

The purpose of Khanya is therefore not to replace educators, but rather to empower them to improve curriculum delivery quality. Initially, the emphasis in primary schools was on improving literacy and numeracy and in secondary schools on Mathematics, Science and English. It therefore should be clear that the primary focus of the project should be on enhanced curriculum delivery, rather than implementing technology just for the sake of technology.

ACHIEVEMENTS

The Khanya project started in April 2002 and to date has an involvement with 148 schools. Each one of these schools is provided with a computer laboratory (25 - 40 state of the art PC's, networked and connected to the Internet, together with other required peripherals). In some schools additional computers are installed in classrooms, to further integrate the use of technology with traditional classroom tuition.

Each school is viewed as a separate sub-project, tailored to the needs of the particular school. The sub-projects are individually taken through the following phases:

- **Initial Planning:** Develop a high level project plan, complete with costing
- **Negotiation:** Consulting with the school, its Governing Body, the local community and other donors who will assist to carry the cost in the partnership
- **Detailed Planning:** Develop detailed implementation plans
- **Infrastructure Preparation:** Preparing the venue in terms of electricity provisioning, sturdy work-surfaces, network cabling, security (which in itself is a major undertaking in many high crime areas)
- **Installation:** Installing hardware and operating software, including Internet connection
- **Software Installation:** Installing selected educational software
- **Educator Training:** At least two educators are trained as LAN administrators, and the rest of the staff members are trained in basic IT skills (eight modules of training, specially geared towards the educator's use of IT in the classroom, have been prepared)
- **Facilitation:** The most unique feature of Khanya is the use of facilitators (experienced educators, with experience in the use of IT in curriculum delivery, are contracted onto the Khanya project to spend at least one day per week over a period of one year or more, to assist educators in adapting to the use of technology in curriculum delivery)

A project structure has been established with 65 staff members, including administration staff, sub-project managers, facilitators and researchers. The project is in full swing and is poised to incorporate all the schools in the province over the next few years. Early results indicate that the use of technology has a dramatic impact on improved curriculum delivery.

NEXT STEPS

The next step is to start with another wave of implementation. 110 schools have been selected and the project procedure will start with each one of them within the next month.

FY03 ACCOMPLISHMENTS

During the FY03, two Khanya project site visits were completed. The major outcomes of these site visits were as follows:

- It was proposed that the Khanya sites be networked by the AAMI partnership.
- It was also proposed that the AAMI staff provide Information and Communication Technology (ICT) for Khanya teachers.
- Finally, it was recommended that Khanya teachers be provided with Web based educational software developed by institutional members of the AAMI.

INTERNET -BASED NETWORK

In an effort to support groups such as the Khanya Project, the AAMI staff in FY03 began the process of designing an Internet-based network. The network will support a cadre of researchers and educators from different regions of Southern Africa that are pursuing a common scientific or educational project over an extended period. This network will possess various capabilities including the ability to enable distributed lectures, meetings, and instruction on an interactive basis among the participating institutions. For example, these institutions will be able to interact electronically, via the Internet, in a collaborative fashion. The environment will be implemented using a combination of available Internet related technologies, e.g., electronic whiteboard and interactive video teleconferencing. Software and mathematics related content materials, generated internally by AAMI teams, will be posted periodically to the network Web Server and will be available to the participating researchers and educators. This activity represents an efficient approach to overcoming the problem of isolation and counteracting the brain drain of scientists and educators in Southern Africa.

In addition, as a first task, the AAMI Coordination team has begun work with the Association for Women in Mathematics (AWM), which has been successful in improving the access of women to mathematics in the United States. In the long run, this will help to achieve the goal of full participation by women in the AAMI Collaborative Internet environment. AWM has its headquarters at the University of Maryland, facilitating easy interaction, and its President, Jean Taylor, has demonstrated her interest in facilitating the Association's participation in a joint coordinating effort by her attendance in a meeting between the Director of the AAMI and herself, accompanied by others at the University of the Western Cape. AWM's participation will serve as an additional resource and base of experience to the AAMI African participants. Once again, this effort has been moved along during this fiscal year under the direction of the PI.

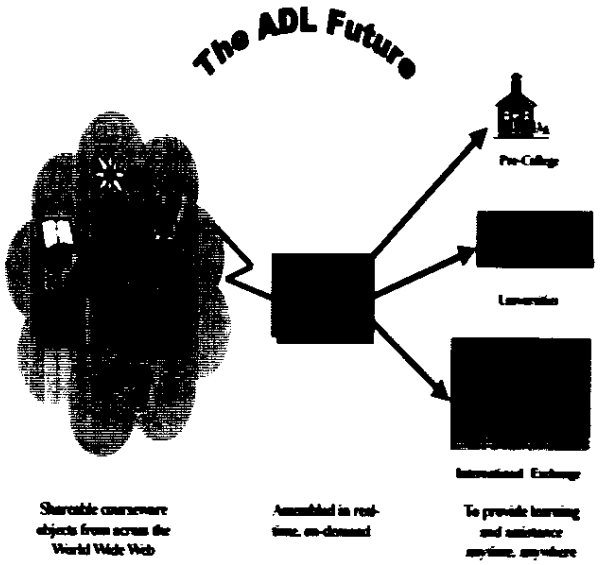
The need to build such a network fits naturally with our plan to have South Africa and Ghana serve as the centers of a regional model serving southern

Africa and western Africa respectively. South Africa and Ghana already play such a role in the eyes of many African researchers and educators. Research and education technologies adopted in South Africa are more likely to be considered for adoption by other countries.

In general, we are designing a system that employs the Internet as a vehicle for providing supplementary materials. (While some countries may have infrastructure problems that do not provide a computer on every researcher's desktop connected to the Internet, it is substantially easier to find a means to get a machine with such access in the library, a research center, or at a local Internet Cafe.) Thus providing an opportunity for colleagues and AAMI participants to maintain contacts begun at workshops. Complementing this effort, the Institute for Mathematics and its Applications is setting up research communities on their Web site. We have begun to participate and work toward connecting our research colleagues in this effort.

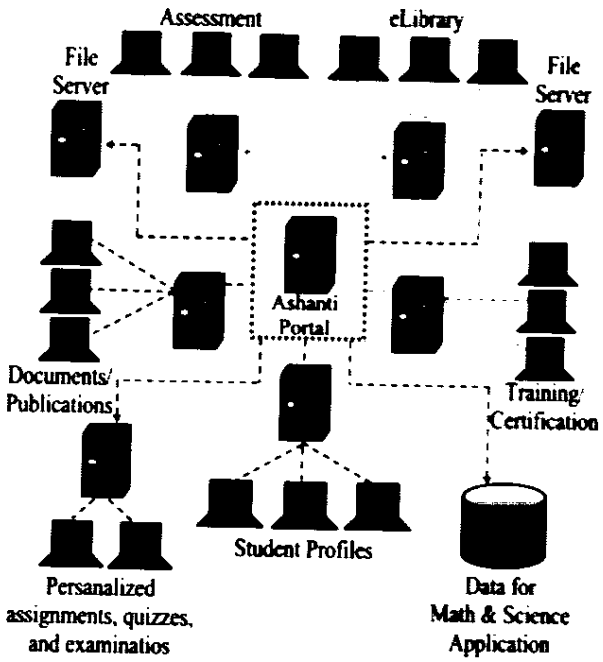
Once this component of the infrastructure is complete and on line, it is our intention to make available courses and educational materials from universities in the U.S. and other parts of Africa via the Internet.

Implementation of the AAMI Collaboration/Instructional Web Environment



The AAMI during this funding period began the process of designing an interactive, multi-disciplinary Web-based environment to facilitate both collaboration and instructions among participating school, colleges and universities on an international basis (See figures below). The AAMI Partners recognized the many recent advances in the specification and development of standards and protocols for Internet-based instruction and Distance Learning. Organizations such as the Department of Defense (DoD) Advanced Distributed Learning Initiative (ADL) have taken the leadership in developing the Shareable Courseware Object Reference Model (SCORM), which provides a framework as well as specifications for the next generation of distributed learning technologies, products and software. The AAMI Collaboration/Instructional Environment will initially focus on current off-the-shelf technologies and products in order to design and implement a comprehensive learning environment. In parallel with this, the AAMI Partners have been working in cooperation with other organizations, such as the Florida State University Office of Distributed and Distance Learning (ODDL), who are focused on applying SCORM and other emerging standards to the next generation of web deployable learning tools and systems. AAMI will

seek to continuously integrate the latest, proven technologies (based upon accepted standards) in order to improve and update its delivery of instructional content and associated web-based educational services to participating institutions.



The newly designed User Support Office will be responsible for managing the day-to-day operations of the Web server and support distributed operations of both primary and distributed Virtual Classroom Servers, located at selected institutions. During this phase of the project, the AAMI staff put in place a plan that will put VESO (see figures below) in a position to establish and manage the network services required to run all virtual classroom sessions involving AAMI institutions. The planning and organizing of the class content, the delivery of instruction, and research collaboration will be the responsibility of each institution (e.g., FSU), which is established as a Virtual Classroom Instructional site. AAMI staff will continue to coordinate the planning and implementation of the required servers and implementation of the associated application software (e.g., video teleconferencing and whiteboard). During this phase, it was established that VESO will have complete responsibility for providing network and operation management support, including:

- User Accounts and Access privileges.
- Assisting AAMI Institutions in resolving access problems.
- Maintaining a service request log,
- Prioritizing user requests for services,
- Managing AAMI education and research related information posted to the Web server,
- Maintaining the AAMI Industry *Registry*,
- Maintaining an Electronic Clearinghouse (including on-line documentation and information), and
- Maintaining an on-line collaborative (i.e.. Interactive Discussion) environment. This includes the establishment and maintenance of a topic-based. searchable discussion database.

It was determined that the AAMI VESO staff will have primary responsibility for the full implementation of the proposed network configuration. It was also determined that the staff would by and large be composed of Africans. AAMI Development team has an established network implementation approach to ensure that all critical design and functional issues associated with implementing the overall configuration are fully specified in order to mitigate numerous problems which can often arises during a full

scale implementation.

A key aspect of the VESO is to provide centralized AAMI management for performance optimization; standardization of equipment, software, and protocols; and management staff and user support throughout the duration of the AAMI program activities.

Another key aspect of the overall activities of the joint AAMI Learning Environment Development team during this phase has been the design of a Virtual Classroom Environment as part of the proposed AAMI program. This Virtual Classroom will enable distributed instruction on an interactive basis among the participating institutions. These institutions (i.e., faculty and students) will be able to interact electronically, via the Internet, in a collaborative fashion. The Virtual Classroom will be implemented by the integration of *off-the-shelf* Internet related technologies that have been reviewed by the AAMI staff during this phase, including:

- On-line Course and Seminar Registration,
- Student Academic Tracking Software,
- Electronic whiteboards,
- Interactive video teleconferencing,
- Live Discussion "Rooms" for Collaboration and Information Sharing. Searchable Discussion Database,
- Live, Moderated Virtual Seminars, and
- An AAMI Virtual, Interactive, Math Library.

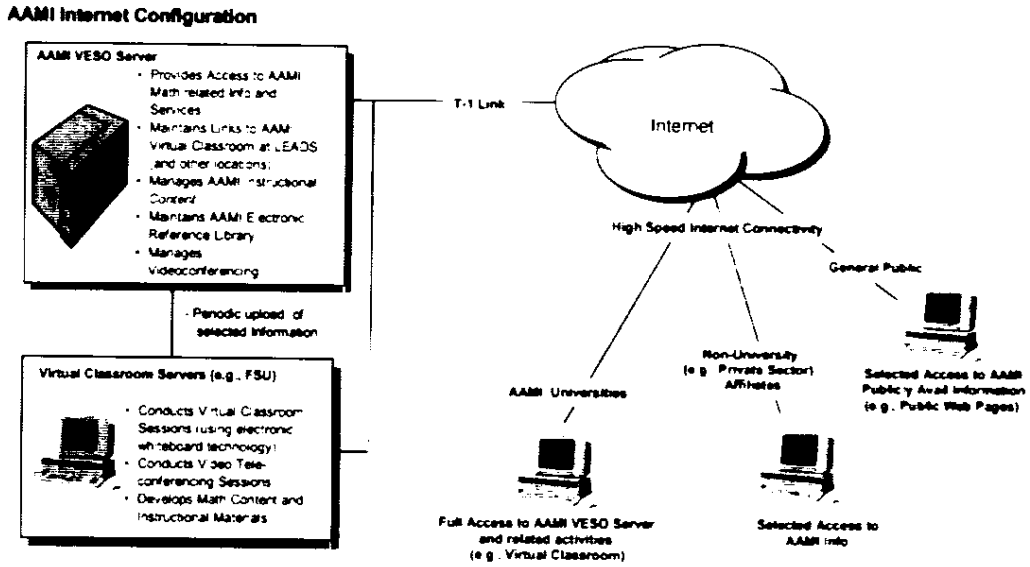


Figure VESO-1. AAMI Distance Learning Environment

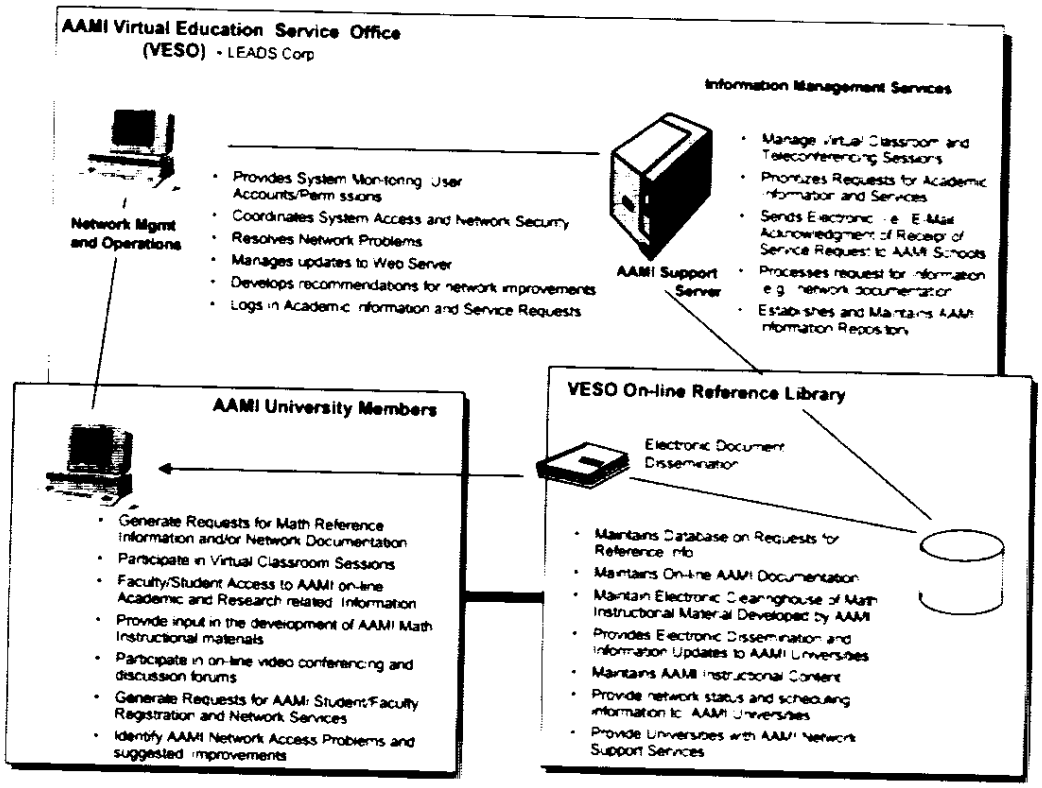


Figure VESO-2. AAMI Virtual Education Support Office (VESO)

III. The African Institute for Mathematical Sciences

BACKGROUND

The AAMI partnership joined a new joint effort between the University of Cape Town, the University of Stellenbosch, the University of the Western Cape, Oxford University, University of Cambridge, and the University of Paris. The major activity of this group, for this funding cycle, was the launching of the African Institute for Mathematical Sciences (AIMS).

The African Institute for Mathematical Sciences (AIMS) is a new educational center now being established in Cape Town, South Africa with the goal of strengthening scientific and technological capacity across the African continent.

AIMS with partial support from this project will focus on a unique, intensive nine-month postgraduate course developing strong research skills as well as providing an overview of many of the most exciting areas of mathematical science.

The course will lead to a Postgraduate Diploma in the Mathematical Sciences, formally accredited by the three partner South African Universities and endorsed by the Faculty of Mathematics of the University of Cambridge.

The AIMS institute formally opened in September 2003.

The AIMS project has received enthusiastic support from the international academic community. Outstanding African and international scientists and educators have volunteered to teach at AIMS, ensuring a course of the highest international quality. Students are now being recruited from all over Africa as well as a contingent from outside Africa. The AIMS course will serve as a stepping-stone to careers in research, education, industry or government. The pan-African character of the student body and the international mix of lecturers will offer unique opportunities for building friendships across cultural and national boundaries, contributing positively to bridging the North-South divide. AIMS graduates will remain in contact long after they have completed the course, providing a powerful network working together for African progress.

AIMS is located in Muizenberg, Cape Town, in a beautiful building (formerly an 80-room art-deco style hotel), which has been donated to the project. Students and visiting lecturers are housed within the building, allowing for maximal interaction in an informal and collegiate setting. AIMS is also has a computer laboratory, a library and excellent teaching facilities.

Muizenberg is an area of outstanding natural beauty within a half-hour drive of each of the local Universities and Cape Town international airport. There is a direct train service to the centre of Cape Town. Several important museums, a theatre and tertiary educational colleges further enhance the setting. The beach on False Bay, 50 yards from AIMS, is one of the finest in the Cape.

The AIMS Course

The partnership has worked together collectively to construct an AIMS curriculum that will provide both a strong foundation in mathematical and computing research skills. and an overview of cutting edge developments in the mathematical sciences.

This term a "Skills" courses will be offered. Topics include:

- The Art of Scientific Approximation
- Mathematical Problem Solving
- Probability and Statistics
- Mathematical Modelling
- Methods of Mathematical Physics

In addition, once again working closely with staff members from the AAMI, "Review courses" were designed in a fashion by which they would be given in tandem by overseas lecturers and local academics. They will cover some of the most exciting areas of science today, with mathematics as a unifying thread. Topics include, with those in blue denoting topics selected for this academic year:

- Fluid mechanics
- Quantum physics
- Wireless communication
- Astronomy and astrophysics
- Fundamental physics
- Nano-technology
- Bio-informatics
- Disease and ecological modelling
- Computer science
- Complex systems
- Numerical analysis
- Applications of complex variables
- Geometry and topology
- Financial mathematics

Courses will be student-centered but highly demanding. As a rule, students will study only one subject at a time for two or three weeks, with morning lectures and related afternoon problem solving and computing sessions. Additional lectures may be held in the evenings.

The goal will be to develop well-rounded scientists, with creative problem-solving skills and a strong grounding in generally applicable mathematical and computational methods. A course of such breadth is unique worldwide, offering students an exposure to a range of sciences and allowing them to make an informed choice as to their future scientific specialty.

Launch

On September 18th and 19th, 2003, AIMS held its official launch with the theme "*A Bright Future for Science and Mathematics in Africa*". The AAMI, with funds from the EDDI program was a co-sponsor and co-organizer. The list of invited dignitaries included Vice Chancellors Brink, (University of Stellenbosch), Ndebele (University of Cape Town) and O'Connell (University of the Western Cape). National Minister of education, Kader Asmal, and the National Minister of Science and Technology, Ben Ngubane. In addition, round table discussions were held and invited scholars gave lectures. Finally, the Institute held its open house with tours and presented demonstrations.

Software Development

During FY03, the following database of object-oriented modules were chosen to be developed and incorporated into future AIMS curriculum. In addition, each model-based module was selected based on their likelihood of application in African industrial settings.

- *Structural Mechanics Module*

The Structural Mechanics Module extends the software called FEMLAB by using an electronic environment, which provides customized user interfaces for structural analysis. During the fiscal year 2003, AAMI staff reviewed this module and selected the following models for incorporation into the AIMS curriculum.

- ✓ Static Analysis of a 2-D beam
- ✓ 2-D Model of a steel aluminium component
- ✓ Plate Model of a Vibrating Machine

- *Electromagnetics Module*

The Electromagnetics Module is an application module designed for solving and modelling electromagnetic industrial problems. In fact, the Electromagnetics module is a collection of application modes for FEMLAB that handles both static, time-dependent, time-harmonic, and eigenfrequency/eigenmode problems.

- ✓ Linear Electric Motor of Moving Coil Type
- ✓ Spherical Capacitor
- ✓ Aperture Antenna
- ✓ A Tunable MEMS Capacitor

- Chemical Engineering Module

The Chemical Engineering Module has the capability of playing an important role in the development of new engineering processes and prototypes. Once again, the application areas were chosen based on African industry.

- ✓ The Turbulent Channel Flow
- ✓ MEMS Heat Exchanger
- ✓ Maxwell-Stefan Diffusion in a Fuel Cell
- ✓ Boat Reactor for Low Pressure CVD

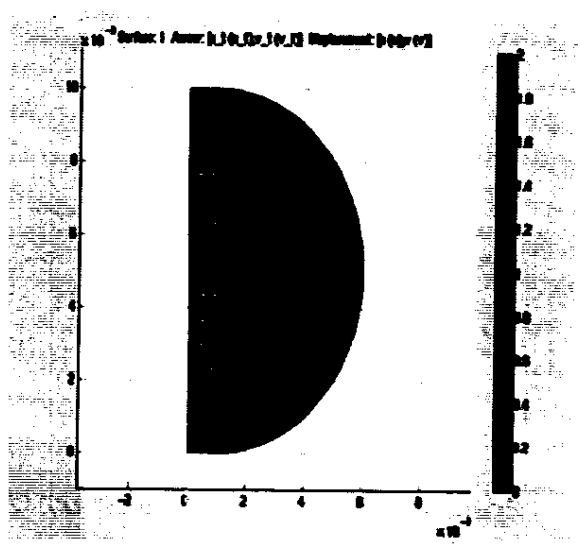
- General Model Library

A Model Library used as an introduction to simulations has been designed by the AAMI staff. The first selection of models to be included are as follows:

- ✓ The Acoustics of a Heat Exchanger
- ✓ A Vibrating Membrane
- ✓ Skin Effect in Circular Wire
- ✓ Flow Past a Cylinder
- ✓ Heat Generation and a Disk Brake
- ✓ Heat Distribution in a Radioactive Rod
- ✓ Simulation of a Micro Robot
- ✓ Vibrations and Milk Container

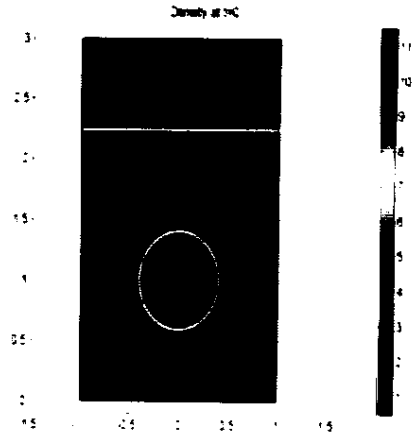
Below are figures giving examples of the output from several of the above-mentioned modules.

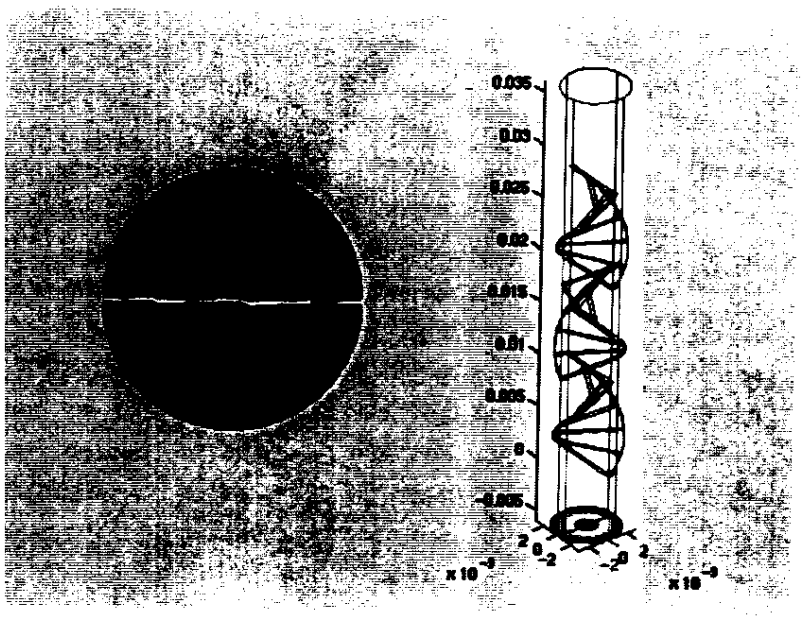
The figure on the right is an example of the type of graphical interface used during the geometric design for a given application. In particular, it is the geometry used for the interface of a solid wall with a bell-shaped flow of a fluid.



Each module will consist of a tutorial, animation and a PowerPoint presentation.

The picture to the right was taken from the model library. It introduces students to the area of Computational Fluid Dynamics. Here the student is instructed to develop a simulation of a bubble located in one fluid, rising into a second fluid using the software provided by AAMI staff. In fact, the picture to the right shows the solution to this problem.





The above figure is an educational simulation used to assist engineers in the design of a cylinder mixer. Such a device is often used in industrial applications in order to mix two different fluids in a cost-effective manner. The task given to the students is to use the software in order to optimize the process.

The above sample figures illustrate the complexity and sophistication of the software that will be incorporated into the AIMS curriculum. Clearly such software will serve as an effective tool to train future African computational scientists.

IV. Proposed SA Center of Excellence for Teacher Training

President George Bush has initiated an USAID initiative to funds three Centers of Excellence in Teacher Training in Sub-Saharan Africa. As a bridge activity from the EDDI program to the center, we reviewed and recommended the adoption of the following activities led by AIMS.

V. FSU International Program

Working closely with FSU's International Program staff, a study abroad program for South Africa was developed and advertised. This program included many of the elements described in this report. In fact, the process of building a business plan began during this cycle, with the plan taking into consideration the following issues, actions and guidelines.

Starting Point

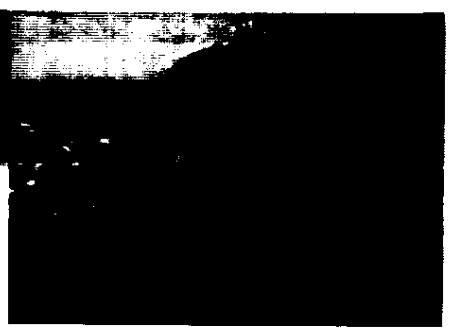
- ✓ Developed an outline of the program
- ✓ Explored and developed roles for Partners
- ✓ Prepared a funding request from Department of Energy
- ✓ Planned a Pilot Program

Program Development

- ✓ Developed a profile of Targeted Student Audience
- ✓ Set Realistic Scientific, Educational and Career-Promoting Objectives
- ✓ Focused the Research Component
- ✓ Strived for Overall Balance of International and Domestic Components
- ✓ Sought Reciprocity through Bi-Directional student Movements
- ✓ Linked with South African scholars and South African institutions of quality
- ✓ Determined "critical mass" and optimal program size
- ✓ Established Institutional Commitment of Participating Universities. U.S. and South Africa, MOUs will be used in the future
- ✓ Frequency of the Program Offering to be considered
- ✓ Realistic expectation for Longevity were considered
- ✓ A Management Team was Identified and Approved by FSU's International Programs
- ✓ In the future we will Establish and Monitor program Costs
- ✓ Cost Effectiveness, Efficiency. and Scaling effects related to Program Size were developed through a series of meetings with FSU's International Programs
- ✓ Realistic Costs for the Project Director was also considered and discussed
- ✓ Staff Time Commitments were modeled
- ✓ AAMI Affiliations and Partnerships were Recruited
- ✓ Calendar Issues were noted on all potential participant campuses
- ✓ Duration of South Africa Site Program was Established
- ✓ Funding Application relative to Program dates was also taken Into Consideration
- ✓ A Long-term Funding Sustainability Strategy was Designed
- ✓ Expected Academic Background and Previous Experience by Program Participants were outlined
- ✓ Scientific Research Expertise of South African hosts and Overall Strength of the corresponding Institutions were also considered

Below is a figure describing the resulting advertised Specialized Program. Note that the theme "Computational Science and Economic Development of South Africa" fits will the AAMI Program.

Africa | South Africa • Cape Town
Specialized Program



Computational Science in Economic Development of South Africa

James C. Turner, Jr., Program Leader

Computational science, uniquely able to predict from sophisticated simulations, is vital to improve Africa's infrastructure. This program develops strong computational skills and provides an overview of an exciting, growing field. It is an unparalleled opportunity for cross-cultural partnerships with international students and scientists.

A step toward careers in research, education, industry, or government, the program uses case studies for simulation training. Each student will help devise a project on African economic development, to include simulation software.

The program site is the fully equipped, internationally known African Institute for Mathematical Sciences in Muizenberg, near downtown Cape Town. Excursions include the De Hoop Nature Reserve; the Castle of Good Hope; Robben Island, where Nelson Mandela was incarcerated; and a 19th-century historic waterfront with museums, IMAX and fine restaurants.

ELIGIBILITY

The program is open to science teachers, science education majors, engineering majors, computational science and information technology majors, or any student interested in the subject.

HOUSING

The African Institute for Mathematical Sciences, an international student residence with dining hall, was formerly a premier, 80-room art deco hotel. Recently renovated, this beautiful, comfortable building is one block from Muizenberg's wide beach and turquoise blue water.

Quick Facts

Location: Southern Africa at the tip of the continent
Population: 43.7 million
Time Zone: EST + 7 hours
Area: 471,008 sq mi, slightly less than twice the size of Texas
Language: 11 official languages including Afrikaans, English, Ndebele, Pedi, Sotho, Swati, Tsonga, Tswana, Venda, Xhosa, Zulu
Currency: rand

DATES AND FEE

All fees are subject to change. For payment deadlines, see the inside front cover.
June 21 - July 30, 2004 (6 weeks)
$4200
CT99

Fee includes: all registration and instructional costs for up to 6 undergraduate or 6 graduate credit hours, housing, program social/cultural excursions and activities, health insurance, international student ID card, T-shirt or cap, full-time academic and administrative support, entry visa

Not included: round-trip international airfare, passport, food, books and supplies, personal travel/activity spending money

COURSE OFFERINGS

For course descriptions, visit www.international.fsu.edu.
CIS 5900 Directed Individual Study
CIS 5930 Selected Topics: Scientific Computing

REGISTER EARLY • SAVE $100
www.international.fsu.edu

During the fiscal year 2003 the AAMI staff produced a very detailed sustainability program, tapping the resources of the existing State-to-State Partnership between the Western Cape Province and the State of Florida, below we give an Executive Summary of that Program. Our goal is to engage USAID and the private sector in the funding of this program.

Florida Space Authority
&
Enterprise Florida, Inc.

Proposal to the

U. S. Agency for International Development

A State-to-State Entrepreneurial – Academic Partnership (EAP)

Executive Summary

PREPARED BY

Dr. James C. Turner Jr.

Abstract

A unique partnership between Florida Space Authority, Enterprise Florida Inc, WESGRO, and the African Institute for Mathematical Sciences, will collaborate with USAID to provide activities, infrastructure, and services that assist Florida and the Western Cape realize their vision of becoming world-class leading learning regions, which successfully equips its people and businesses with the ability to acquire and apply

knowledge effectively in a global economy. Technology used to support this collaborative effort includes the development of a web portal, which will support the participation of both regions in the Global Knowledge Economy. The portal will provide access to business services, information, management practices, and economic development techniques for businesses, universities and economic development organizations.

There is a crucial relationship between technology, education and economic development when strategically applied to issues of sustainable development. When appropriately applied, technology can serve as a great impetus for diverse communities to join the global knowledge based economy. Historically, technologically advanced communities have demonstrated the highest rates of economic development, the highest commitment to democratic values, and have created an enduring and sustainable quality of life in the communities they serve.

Key Personnel

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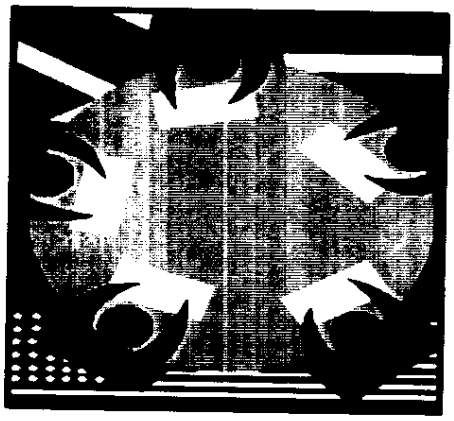


Entrepreneurial - Academic Partnership

[redacted]

The enfranchisement of the peoples of African descent in Southern Africa and the inauguration of Nelson Mandela as President of the Republic of South Africa in 1994 were milestones marking one of the most significant transformations of modern time. During the ensuing decade we have witnessed unprecedented advances in communications and information technology (IT) this time marking a transformation of our educational system and the international marketplace. Business and educational

institutions in the 21st century must operate in an IT environment where change is the norm, and the pace of change is accelerating at such a rate that institutions structured on classical 20th century lines will be unable to adapt. The world is generating information as never before; it is also learning as never before. Competition for economic success in the global economy will be increasingly sophisticated, highly motivated and well-capitalized. The State-to-State Entrepreneurial – Academic Partnership, referred to as simply the partnership, believes that to succeed in the rapidly evolving environment of the future it is necessary to understand and leverage the complex forces shaping our educational institutions and the global economy in which they are embedded.

[redacted]

In recent years, research and development efforts in mathematics, science, and engineering have served as catalysis for economic development by facilitating the creation of technology-based industries. Assessing, maintaining and enhancing our state's technological base have become high priorities. Often these priorities have manifested themselves in the form of state programs and infrastructure offering opportunities to Small Businesses (SBs) and universities to develop and market new technological advances. These efforts are typified by Innovation Park in Tallahassee and the International Space Research Park at NASA's John F. Kennedy Space Center. Unfortunately, small businesses, including women-owned or disadvantaged businesses, may lack the requisite infrastructure and appropriate models for adequate participation in technology incubation and global commercialization.

Universities in Florida and the Western Cape are uniquely situated to provide a wide range of resources and assistance to SBs throughout all of the stages of the "innovation chain"; however, as academic institutions, their organizational structure, internal systems and processes are more suited to the front end of the technology development process. On the other hand, the organizational structure of SBs, with their market orientation, is better suited for the commercial application of new exploitable technologies and products. Collaborative efforts between partner universities and the SBs that are designed to maximize their respective capabilities in the technology development process would be beneficial not only to them but to both regions. By sharing expertise both entities would increase their participation in technology development and commercialization.

Floridians and South Africans in Western Cape, including under-represented groups from both regions, would become full participants in employing science and technology for economic and social development only if they have the necessary tools and resources, and implement the appropriate strategies. Indeed, the limited technology-based business starts and growth among under-represented groups have negatively impacted the economic development of their communities, which ultimately detracts from the global competitiveness of American and African business and industry.

The most difficult challenges facing a business enterprise that wants to provide technology products and services include: (1) *identifying opportunities* in existing, new and emerging technology markets; (2) *obtaining the technology skills* to respond to these

opportunities; (3) the *investment capital*; and (4) *developing the organizational and managerial systems* to implement and sustain the technology enterprise, especially in its formative years.

Technologies of Economic Significance

The United States Department of Defense (DOD) and Department of Commerce issued two reports, *Critical Technologies Plan*, and *Emerging Technologies: A Survey of Technical and Economic Opportunities*, respectively, that identified the critical and emerging technologies that have the potential to promote economic development through creation of new products and industries or through large advances in productivity and quality of existing industries. These critical and emerging technologies are listed below in a table describing a comparison of national critical technologies with Department of Commerce emerging technologies.

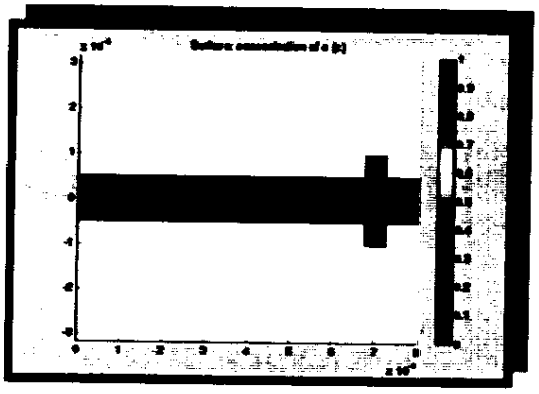
NATIONAL CRITICAL TECHNOLOGIES	COMMERCE EMERGING TECHNOLOGIES	DEFENCE CRITICAL TECHOLOGIES
MATERIALS		
• Materials synthesis processing	• Advanced materials	• Composite materials
• Ceramics	• Advanced semiconductor devices	• Semiconductor materials and Microelectronic circuits
	• Superconductors	• Superconductors
• Composites • High-performance metals & alloys	} Advanced materials	} Composite materials
MANUFACTURING		
• Flexible computer integrated manufacturing	• Flexible computer integrated manufacturing	
• Intelligent processing equipment • Micro-and nanofabrication • Systems management technologies	• Artificial intelligence	• Machine intelligence and robotics
INFORMATION & COMMUNICATIONS		
• Software	• High-performance computing	• Software producability
• Microelectronics and optoelectronics	• Advanced semiconductor devices • Optoelectronics	• Semiconductor materials and microelectronic circuits • Photonics
• High performance computing and networking • High-definition imaging and displays • Sensors and signal processing	• High-performance computing • Digital imaging • Sensor technology	• Parallel computer architectures • Data fusion • Signal processing • Passive sensors • Sensitive radars • Machine intelligence and robotics
• Data storage and peripherals • Computer simulation and modeling	• High-density data storage • High-performance computing	• Photonics • Simulation and modeling • Computational Fluid dynamics
BIOTECHNOLOGY & LIFE SCIENCES		
• Applied molecular biology • Medical technology	• Biotechnology • Medical devices and diagnostics	• Biotechnology materials and processes
AERONAUTICS & SURFACE TRANSPORTATION		
• Aeronautics • Surface transportation technologies		• Air-breathing propulsion
ENERGY AND ENVIRONMENT		
• Energy efficient technologies • Pollution minimization, remediation, and Waste management		

Technologies of Initial Programmatic Focus for the Partnership include:

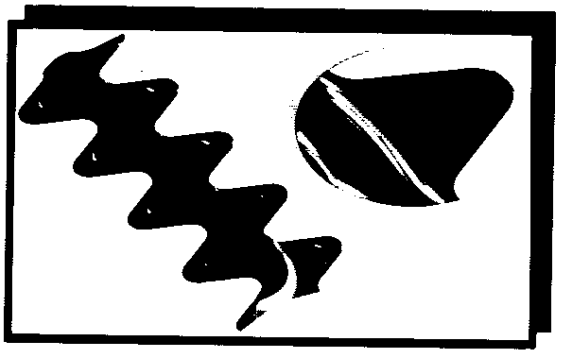
- **MATERIALS**
  - Materials synthesis processing
  - Composites

$$\begin{cases} \rho \dfrac{\partial \mathbf{u}}{\partial t} + \rho(\mathbf{u}\cdot\nabla)\mathbf{u} = -\nabla p + \mu\nabla^2\mathbf{u} + \mathbf{F} \\ \nabla\cdot\mathbf{u} = 0 \end{cases}$$

- **MANUFACTURING**
  - Flexible computer integrated manufacturing
  - Micro-Nanofabrication



- **INFORMATION & COMMUNICATIONS**
  - Software
  - Microelectronics
  - High performance computing
  - Computer simulation and modeling
- **BIOTECHNOLOGY & LIFE SCIENCES**
  - DNA microarray technology
- **AERONAUTICS & SURFACE**
  - Space transportation technologies



- **ENERGY & ENVIRONMENT**
  - Energy efficient technologies

Access to Capital and Financing for Technology Development and Commercialization

Perhaps the most significant barrier that has impeded the entry of small businesses into technology incubation and commercialization, in addition to access to scientific and technological research ideas and inventions, is early-stage financing. Clearly, without access to capital for technology development, prototype development and testing, even the best scientific and technological research ideas and inventions cannot be transformed into viable products. Financial resources often made available include private capital sources and networks, university-industry research partnerships, industry-government cooperative research and development agreements, government-university collaborations, and state and federal programs to promote technology transfer and commercialization.

Private sources and networks include "angel" investors and venture capitalists. The so-called angel investors are often the best source for early-stage seed capital for emerging technology companies while venture capitalists generally do not fund technology start-ups that do not have proven track records. Many states, as part of their economic development strategies have established venture capital pools to support small firms in high-risk but potentially high payoff technology activities. However, small disadvantaged

businesses and women-owned businesses have traditionally not participated in a significant manner nor benefited from private financing sources and networks presumably due to their lack of track records in the technology products market arena.

The Western Cape Provincial Department of Economic Affairs, Agriculture and Tourism recently stated, in a white paper entitled "Preparing the Western Cape for the Knowledge Economy of the 21st Century,

> *"In today's world no country or region is untouched by the forces of globalization and the rise of the knowledge economy. Such forces present obvious opportunities for wealth creation and the betterment of the human condition in those countries and regions that are well-equipped to take advantage of them,"*

In order to tap this opportunity the Florida Space Authority, in conjunction with its state partner Enterprise Florida Inc. and their counterparts in the Western Cape, propose the establishment of an infrastructure anchored by a Space Enterprise Institute (SEI) and Technology Commercialization Institute (TCI). After these institutes have been established, complimenting existing infrastructure, Florida and the Western Cape will be poised to have their role as gateways to the Americas and Africa enhanced, respectively. In addition, a portal will be built, serving as an education, training, and e-Commerce delivery system. Collectively, the institute, the center, and the portal will assist each region in preparing its citizens to actively participate in the "Global Knowledge Economy." Capturing the sprit of this proposal the e-business portal will be called the "Knowledge Acquisition Portal," or simply KAP.

Space Enterprise Institute (located in Florida)

Targeted Programs

- Incorporated 501 (c)(3) (not-for-profit organization)

The university research centers that have been established in Florida and the Western Cape have primarily focused on science and technology basic R&D that require multi-disciplinary and inter-disciplinary approaches. By and large, these centers have operated as academic units and have been funded through grants and, cooperative agreements. However, most businesses and industrial organizations conduct their R&D and technology development projects through contracts.

To compete effectively in the world of contracts, the *Space Research Institute* with its close ties to partner universities must adopt new organizational arrangements and

structures. The most effective organizational structure for competing for contracts is through a research institute that is incorporated as a 501(c)(3) not-for-profit organization. This institute would allow the State-to-State Partnership to address research, organizational and contract management issues that would be of concern to both federal agencies and private sector companies. For example, for small disadvantaged and women-owned businesses, the institute would be in a position to facilitate effective consulting arrangements and collaboration for special programs aimed at these firms. The establishment of a not-for-profit research institute would allow the participating partners to effectively address areas of concern in contract and management such as:

- Structured Response to Request for Proposals (RFPs)
- Capability Database and Program Marketing
- Proposal Planning and Preparation
- Subcontracting Arrangements
- Proposal Costing
- Work Authorization and Statements of Work
- Project Planning, Work Breakdown Structure (WBS) and Work Packages
- Performance Tracking and Milestone
- Fiscal Controls, Cost Accounting and Invoicing
- Project Reporting and Deliverables
- Quality Assurance (QA) and Quality Control (QC)
- Inventory

➢ Transfer of Technology Program

The proposed R&D Institute will be a leading intermediate organization in Florida coupling small businesses and academia in the key enabling disciplines of computational science, information technology, and engineering. In a knowledge-driven economy, these areas are vital to formulating industrial strategy, creating new business and increasing profitability. The careful application of cutting-edge scientific ideas provides new understanding and cost-effective solutions across a wide range of business sectors, leading to improved productivity, new products and increased market share.

Companies and agencies of all sizes will be able to work with the Institute to foster core research in the computational science and information technology base. The greatest value added will come from harnessing the best scientific ideas to the most important industrial challenges. The Institute will achieve this goal by providing a single point of entry to a suite of services provided by outstanding computational scientist from departments across the state of Florida. It will develop mechanisms for applying the talents of these scientists on behalf of industry, and in doing so will establish and sustain comprehensive, flexible, innovative and high-quality interactions, involving two-way flow of ideas and people, to the mutual benefit of all participants.

The Institute will put in place a program structure providing 'technology transfers', who are senior scientists and engineers with extensive experience of industrial-academic collaborations, to manage the coupling between academic research and industrial end-

users. These scientists and engineers will be available to guide the exploration of possible research paths, to undertake feasibility or pilot studies, to interpret industrial needs to the academic community and, conversely, to advise on the application of academic research results to industrial operations.

The Institute will adopt as its view that the underpinning of industry by computational science and information technology has greatest value if research results are made freely available as widely as possible. When dealing with issues of Intellectual Property Rights (IPR), the Institute will use the relevant rules of State Government schemes, and more generally facilitate the contractual negotiation between the inventor and the exploiter, while respecting any commercial sensitivities. Recognizing that IPR is often a barrier to exploitation, the Institute will not for its part seek to retain any such rights.

Participants

There will be no membership fees or other entry barriers to participation in institute activities. There will be three classes of participants. First, *industrial participants* will be members of the end-user communities in the areas chosen for Institute activity. As such, they will be involved at all stages, from the formulation of research areas to implementation and exploitation, and their collective interests will set the research agenda for the Institute. The second class will be composed of *enabling participants*, who will provide specific capabilities in technology translation, generally relating to a particular business sector. They will typically intermediate research organizations or State Government agencies, which provide crucial scientific data or expertise, direct links to new industrial participants through their members or clients, and routes for dissemination, exploitation and commercialization. The final class, *academic participants* represent the academic resource available to the Institute. Their commitment comes through providing input to the design and supervisions of research programs and providing academic infrastructure for training programs. Clearly, on occasion there will be the need to draw academic participants from beyond the boundaries of computational science and engineering.

Staff

The various participants will be coupled to the Institute through the activities of the activities overseen by the Institute Director and Technology Translator. The Institute Director, Dr. James C. Turner Jr., will have a full-time appointment and will be responsible for day-to-day management. He will be responsible for planning a mix of activities and their funding, overseeing the coupling of the Institute with its participants, preparing and monitoring the budget, and leading the team of Technology Transfers.

Management Structure

The various elements of the management structure of the Florida R&D Institute are as follows.

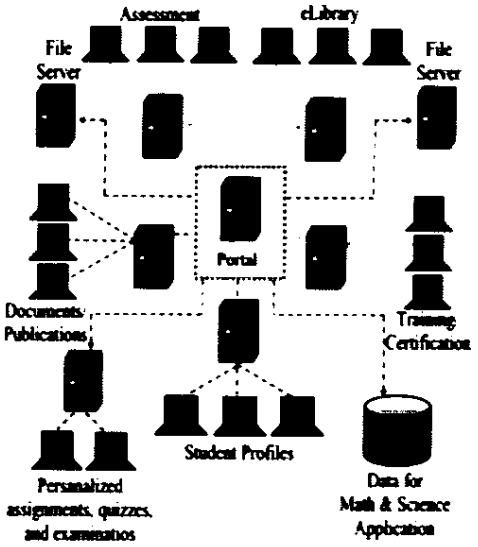
The **Institute Council** with responsibility for the overall strategy of the Institute.

The **Advisory Board** composed of a group of senior industrial scientists appointed by the Institute Council will provide a source of industrial advice on Institute programs, introductions to new industrial participants, and advice on routes for exploitation and dissemination. The Board will participate in Plenary Meetings twice each year. However, it is expected that most of Board's business will be conducted frequently and as required in small groups or electronically.

The **Scientific Committee**, appointed by the Council, will be a group of senior academics providing an extended base of academic expertise. The Scientific Committee will give advice to mirror that of the Advisory Board, so as to ensure that the best mix of university talent can be assembled to match industrial need. The members of this committee will act as points of contact with their respective university departments. As with the Advisory Board, the Committee will participate in Plenary Meetings twice each year, and occasionally at other time as appropriate, but most of the business will be conducted in small groups or electronically.

➢ Next Generation Education and Training Technology

The Space Enterprise Institute proposes to design, develop, and implement next generation educational and training technologies to support the goals of the Entrepreneurial-Academic Partnership. In particular, the partnership will develop region-wide strategies for using learning and information technologies to enhance existing education and training facilities and programs. This will be done in a manner to leverage existing practices, promote the use of technology-based learning and provide a sound economic basis for future investments. High-level systems requirements for learning content material developed by the partnership include reusability, accessibility, durability and interoperability. In the figure on the right is architecture of a mathematics education portal we intend to develop.



Portal features
Novel computer architecture;
Learning management system;
Functions
Electronic collaboration;

Training;
Blended Learning (eLearning + traditional learning);
Audio-video conferencing;
eLibrary
Authoring and editing of educational tools;
Public key-based security;
Multimedia streaming delivery;

Benefits
Enhancement of education and training
Improved learning environments
Cost-effective
Customized student training

Below we give additional illustrative examples of the type of technologies that we shall consider for inclusion in this effort.

➢ Knowledge Acquisition Portal (KAP)

Being successful in the knowledge economy requires mastering a new set of knowledge and competencies. These include basic academic skills, such as literacy, foreign language, mathematics, and science skills and the ability to use information and communication technology. Workers must be able to use these skills effectively, act autonomously and reflectively, join and function in socially heterogeneous groups.

Education is inadequate in most African nations. Coverage is insufficient, access is inequitable (especially in tertiary education and in employee and adult training), and the quality of education is poor. Adult literacy rates are low, and too few children complete basic education. International assessments of secondary school students in mathematics and science show developing and transition economies trailing significantly, especially when students are tested on ability to apply and use knowledge. In the transition economies of Africa, the quality of education is inadequate and the education system is too rigid. Rote learning, exam-driven schooling, and the soaring cost of private education have long been policy concerns in some countries.

Traditional education methods are often ill suited for providing people with the skills they need to be successful in a knowledge economy. Clearly shown by the table below, the traditional learning model differs from lifelong learning methods in important ways.

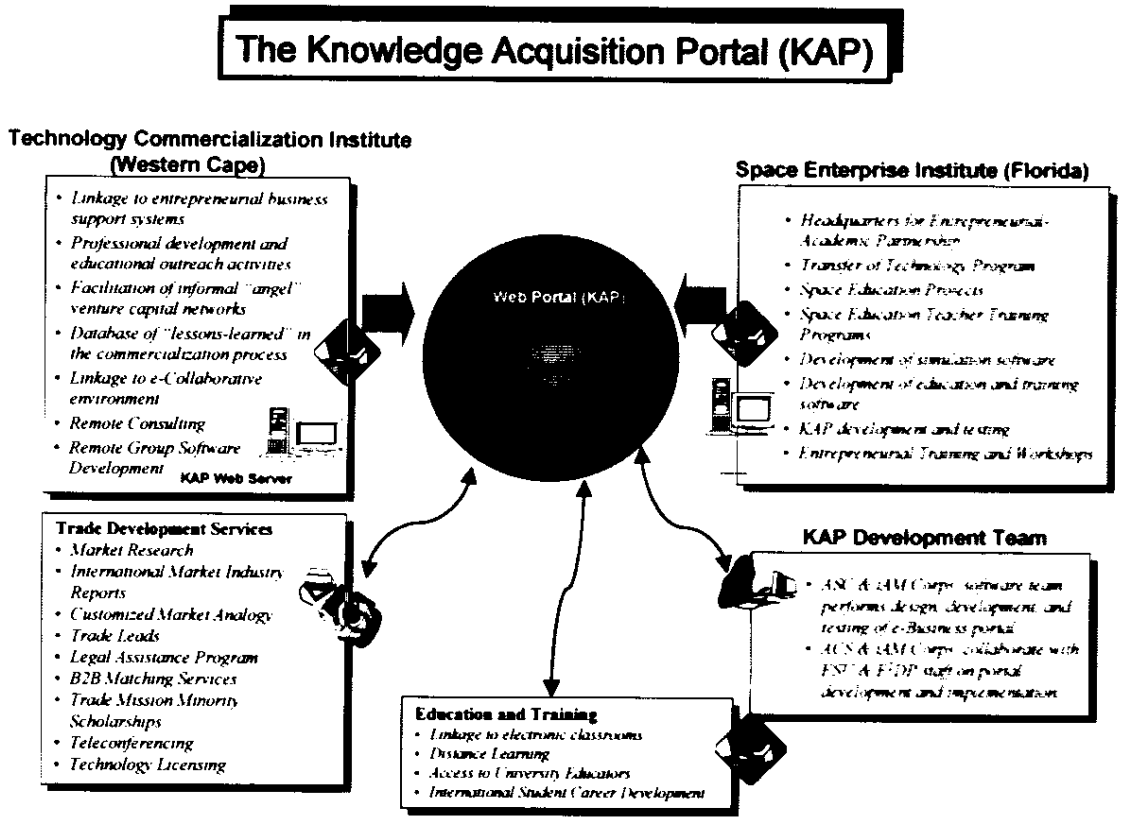
Traditional learning model	Lifelong learning
• The teacher is the source of knowledge	• Educators are [illegible]
• Learners receive knowledge from the teacher	• People learn [illegible]
• Learners work by themselves	• [illegible]
• Tests are given to prevent progress until students have completely mastered a set of skills and to ration access to further learning	• Assessment [illegible]
• All learners do the same thing	• [illegible]
• Teachers receive [illegible] training plus ad hoc in-service training	• [illegible]
• Good learners are identified and permitted to continue their education	• [illegible]

New information and communication technologies can support these changes in pedagogy and teacher training. Information technology (IT) can facilitate learning by doing (through computer simulations, for example). They can vastly increase the information resources available to learners, thereby changing the relationship between teacher and student. Further, they can facilitate collaborative learning and provide rapid feedback to learners.

However, these outcomes do not emerge simply by introducing computers into the learning setting. An appropriate policy framework is needed in which information technologies are used to tackle educational problems, significant investment is made in training teachers and managers to change their knowledge and behavior, qualified technicians and support staff are available, funding for maintenance, access to the Internet, and upgrading is sustainable. These conditions are rarely met, especially in developing countries.

Additionally, formal education institutions need to become more flexible. Increasingly tertiary institutions are offering part-time, evening, weekend, and summer courses to meet the needs of working adults. Distance education is another way in which institutions can offer more flexible learning opportunities. Many countries use interactive radio instruction in basic education. Mexico uses television to educate about 15 percent of its lower secondary school students. In the 1900s the National Teachers Institute in Nigeria graduated more teachers through its distance learning program than all other programs in the country combined. The Internet is beginning to transform higher education and corporate training. In 1999, for example, 92 percent of large corporations in the United States piloted Web-based training programs.

In summary, more and higher-quality education and training opportunities over a lifetime are required by the global knowledge economy for citizens of Florida and the Western Cape. These provided opportunities would require increased expenditures, although resources will also need to be used more efficiently and in different ways. Also, these expenditures cannot be met solely from public sources, but a menu of options is required that is sustainable and equitable. Taking into consideration these facts and issues, the partnership will design a portal called the *Knowledge Acquisition Portal* (KAP). The figure below delineates the various services and components of KAP.



KAP Scenario

The following scenario, set within the context of a much larger example, demonstrates the ideas inherent in KAP-as-a service concept.

Alice, a native Cape Townian, after return from an *EFI South Africa Trade Mission*, decided to set up a company that offers services to Floridians who want to purchase property in South Africa. In fact, her newly developed company, with assistance from the *Technology Commercialization Institute*, currently offers two services: One provides information about available properties, while a second handles actual negotiations and purchase.

Alice's purchasing service uses other services to handle tasks such as translation, legal and financial negotiations, financing, and currency transfer, some of which are obtained via KAP. Offering these services involves specifying the terms, conditions, and form of service provision, together with the rules describing how other services will be employed. This is the know-how element of her service.

Drawn from the complete scenario, one small task concerning a legal document plays out as follows. Alice's purchasing service urgently needs to have the document translated from Afrikaans to English, which involves the following steps:

The purchasing service seeks a translation service, once again via KAP and, after negotiating the terms and conditions in consultation with the EFI Cape Town office, selects *Scribe*, the Cheapest from the four available.

Scribe, a broker that evaluates services but doesn't actually provide them, seeks an Afrikaans translation service geared to handling legal documents. From the three providers offering this service, based upon previous use history (documented in the KAP database) and satisfactory delivery (also documented in the KAP database), *Scribe* selects EZ-trans, which offers an immediate service. As it turns out EZ-trans is a small business, composed of law graduates from the University of the Western Cape, which was incubated at the *Technology Commercialization Institute*.

EZ-trans provides the translation that Alice's purchasing service requires.

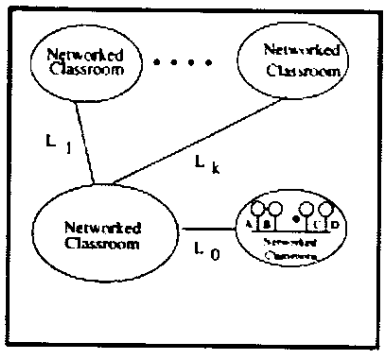
Several years later Alice's purchasing service has become a very successful small company employing 34 workers, with an eye toward expanding beyond Cape Town and Florida. She is so pleased with KAP that she often participates in a Case Study of KAP in the Business School at the University of Cape Town. EZ-trans has expanded its portfolio of languages to include: Sotho-Tswana languages; Nguni Languages; Venda; and Tsonga. EZ-trans also runs a very successful student internship with the Department of Languages at the University of the Western Cape.

➢ *Virtual Classrooms and Interactive Remote Instruction*

Over the past several years, researchers have developed the Interactive Remote Instruction (IRI) system. We present this system because it contains several key components that we intend to research for the design, develop, and implementation as virtual classrooms and interactive remote instruction for participants in the Entrepreneurial – Academic Partnership. IRI provides a virtual classroom by providing each student a multimedia workstation with group collaboration technology. IRI supports interactive hands-on apprenticeships, multimedia note taking and VCR-type replaying of classes (including images, notes, and related events). Assistance is provided to instructors in the preparation and presentation of instructional materials and in the orchestration and management of an interactive classroom.

System Structure Figure 1 below presents the hardware architecture for the IRI system. Each workstation is equipped with a speaker, microphone and video camera. IRI currently supports two classes of video streams, a NTSC quality high frame video and a low frame rate video image. Normally the NTSC signal is used to display an image of the instructor or it can be used by the instructor to show live TV or recorded VCR signals. Initially, perhaps due to limitations in available video cards for the workstations,

the NTSC signal could be transmitted within a site over a standard analog coax cable. An encoding/decoding PC is used at each site to translate from the analog NTSC signal to a digital signal for transmission over the 10 mbs intersite links.



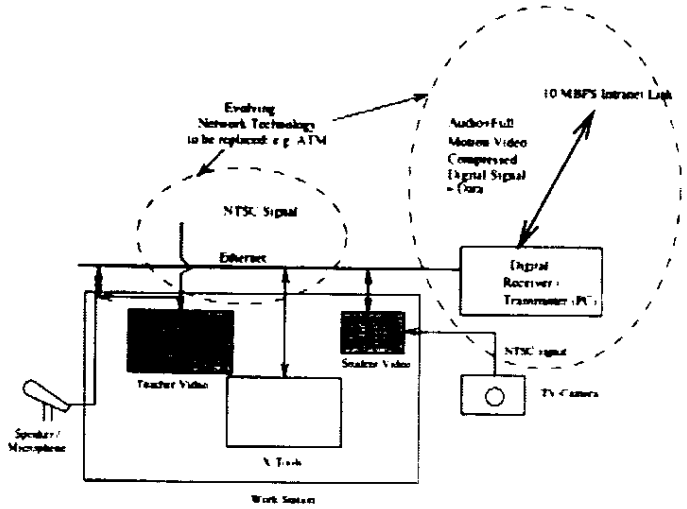
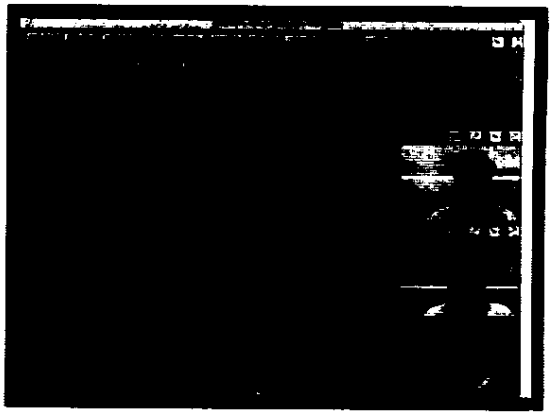


Figure 1: IRI System: Hardware Architecture

Overview of IRI Functionality The figure below shows the computer screen during lecture mode. The large video screen is a NTSC quality, high frame rate image that originates from the instructors workstation. This image can be switched to any NTSC video source including VCR tape, TV signal or laptop display.



In addition to the traditional video sources of instructional material, the instructor can use IRI shared tools or off the shelf X tools for classroom presentations. There are several underlying collaboration engine that could be used by IRI. For example, in Figure 2 AUTOCAD is

used to display an engineering drawing of the space shuttle. Any student can operate any tool used by the instructor. A student requesting the tool is given the tool's token, which allows that student to manipulate the tool. All changes to the state of the tools are broadcast to the other workstations. Students can request attention or be selected by the instructor to participate in a discussion. IRI supports both audio-only and video/audio student participation. As shown in the figures, up to two student videos can be shown to all workstations (the second and third video image down on the right in figure 2). An instructor selectable site image is shown in the bottom video image.

Figure 2: User Interface Screen with AUTOCAD running

Since any student can take control and demonstrate using the shared tool, IRI distinguishes between the instructor role and the presenter role. Presentation can be done at any site, but overall management of the class is under the instructor's control. Thus the instructor can call on a student, take control of a tool away from a student and can initiate start up of a tool.

In addition to off the shelf X tools, a set of shared tools has been developed, which takes advantage of the IRI architecture to improve performance and interactivity in the classroom. An efficient slide presentation tool has also been built, which downloads all slide materials to the site file servers before the class starts to reduce network traffic during class. This package allows random or sequential forward or backward access to the presenter's slides. It supports multiple slide groups (so that any material prepared previously by the students can be made available for presentation). This tool supports the snapping of images from the computer screen into a white board, annotation (the ability to highlight the slide using a selectable color, free hand drawing mode) and a pointer to focus the viewer's attention.

Students can also take notes on line using a multimedia notepad. Any image on the screen can be snapped into the notepad and annotated. Text can be typed either directly on the sapped image or into a separate text window attached to the image by a hypertext marker.

One mode of interaction, which is well supported by a distributed computer-based classroom, is electronic polling. Using a survey tool, the instructor can ask a multiple-choice question to the class at any time. Responses come back (anonymously at present) to the instructor's workstation and the results are displayed as they come in. The instructor can use the results to assess the level of the class's understanding of a topic or to survey the class. The results can be broadcast back to the student workstation at the instructor's discretion.

From the student's perspective, IRI offers several irritants and many advantages. Through experience, an acceptance of remote instruction, both for it's increased availability and for the quality of the preparation of material has been found. IRI makes it possible for the student to exercise more control. This in turn requires additional training for the students. For example, the students need to learn how to be effective tele-communicators (adjusting cameras, using the microphone, using multi-media presentation material). It is also true that poor performance is not only irritating but can make the system unusable (if the actions of the students are not responded to within a reasonable period of time, they become disoriented and confused). Another advantage of IRI is the ability to take snapshots of the presented material and annotate it on-line.

Presentation Bandwidth The amount of visual information, provided by the instructor, to which the student has access at anyone time in the lecture is referred to as *presentation bandwidth*. The ability to look back at material presented earlier is important in helping the student understand the lecture. A traditional classroom with multiple blackboards can have a high bandwidth if the instructor uses all blackboards. Traditional TV classes have a very limited bandwidth due to the limited resolution of the TV screen. The modern A/V class has better projection resolution than a TV and also has the option of the blackboards for increased bandwidth of presentation. Each IRI student uses a high-resolution monitor, plus the student can capture and review previously presented material on demand. Note that bandwidth in general is a serious problem in Africa.

Robustness IRI is a complex system which must work well in real-time and in a variety of environments. To enhance the robustness of IRI, the software must be redesigned to use a given set of communicating processes. Each process takes care of one, or a related set of, functions and can be restarted, if necessary, without bringing down the entire IRI session.

Experience has demonstrated the feasibility and potential of computer supported group collaboration in the classroom. However, the IT community is just beginning to explore the opportunities that these systems offer for changing the learning experience. IRI will be considered in a true wide area environment and we will work on scaling it to an order of hundreds of simultaneous users. In summary, we intend to use computer supported group collaboration to enrich the educational experience.

Technology Commercialization Institute

The Southern Technology Council (STC) and the National Business Incubation Association (NBIA) produced a joint report entitled "*The Art and Craft of Technology Business Incubation*", which states

"Technology business incubation involves the commercialization of science and technology through newer community-instructional arrangements which can be thought of as technology venturing. It concentrates on alliances as an economic development strategy. Technology venturing is based on creative and innovative ways of linking public-sector initiatives and private-sector resources within and across regional and national boundaries for promoting economic growth.

Technology incubation can foster corporate and community collaborative efforts, while nurturing positive government-academic-business relationships. These new types of organizational alliances incorporate a dynamic private sector; a creative role for government through technology policies, initiatives and development programs; and innovative academic relationships. The science and technology policies that promote and flow from these technology alliances are redefining the role and scope of the wide variety of institutions involved in advancing economic growth through technology."

The STC and the NBIA was a benchmarking study, using more than 50 technology business incubators, which identified best practices. It is noteworthy that more than 30 of these technology business incubators were associated with universities. Thus, they will serve as models for establishing a technology incubator and commercialization center acting as catalysis for our State-to-State Partnership.

In a similar effort, the Southern Technology Council provides a report entitled, *Benchmarking Best Practices for University-Industry Technology Transfer*, describing the practices and polices that either hinder or facilitate university technology transfer to new enterprises. Key issues identified in this report include:

- *Research and Technology Match or Portfolio*
- *Mission and Goals of the University*
- *University Personnel Policies and Practices*
- *Business Support Systems*
- *Facilities and Physical Infrastructure*
- *Faculty and Organizational Culture*
- *Capital and Finance*
- *Faulty Conflict-of-Interest-Issues*
- *Technology Transfer Office Operations*

Based on recommendations from the STC report for development and implementation of a technology commercialization and entrepreneurship program, the partnership will implement the following:

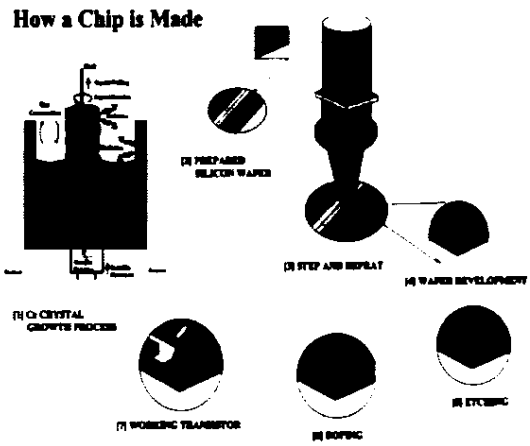
- Support academic research linked to growth opportunities in both regions;
- Expand linkages to existing entrepreneurial business support systems;

- Strengthen university entrepreneurial development programs;
- Support organizational recognition and rewards to faculty involved in technology transfer and technology based enterprises;
- Create professional development and educational outreach efforts;
- Explore approaches to expand venture capital funding

Below we give snapshot views of an interactive environment for modeling and simulating scientific and engineering problems based on partial differential equation. This software tool is currently under development as an outgrowth of Dr. Turner's award winning research in this area.

CFDPORT Invited

A Computational Fluid Dynamics Portal



Example of a CFDPORT modeling application area

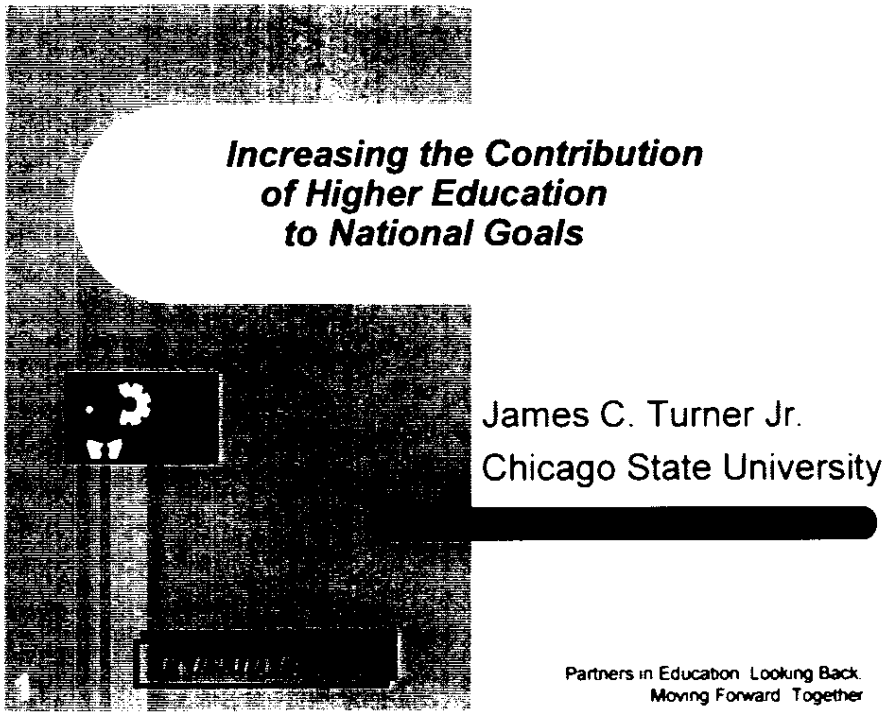
CFDPORT is an interactive environment for modeling and simulating scientific and engineering problems based on partial differential equations --- equations that are the fundamental basis for the laws of science.

KEY FEATURES

- **Interactive and user-friendly graphical user interface for all steps of the modeling process**
- **Flexible specification with multiphysics capabilities**
- **General formulations for quick and easy modeling**
- **Fully automatic and adaptive mesh generation**
- **Extensive model libraries that document and demonstrate solved examples**
- **Interactive post-processing that allows for visualizing any function of the solution variable**

Lectures

During this fiscal year, the Principal Investigator was invited to give two lectures. one in South Africa and one in Swaziland. Below we give the first slide of the PowerPoint presentations slides used in those lectures.



Learning Materials: Successful Models and Challenges

James C. Turner Jr.
Chicago State University

Partners in Education Looking Back
Moving Forward Together