THE PROPOSAL

Microelectronics Training and Research Institute – a Center of Excellence

Our expertise and international network will help you develop a grant, execute and (if necessary) manage it. And when the fund is not enough for a Center of Excellence, we will assist to establish a world class laboratory. We serve governments, government agencies, universities and firms on all areas of microelectronics, nanotechnology, and semiconductors. Just note that any step in this proposal can be executed in isolation. We support and supply CAD, link to international foundries, train on CMOS and BICMOS technologies, and more.

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SECTION 1

PURPOSE OF THIS ROADMAP

Objective

The purpose of this proposal is to improve the quality and relevance, efficiency and equity in science and technology teaching and learning opportunities in African universities. We propose new institutes, **Microelectronics Training and Research Institute (MTRI),** and Microelectronics labs, at selected African universities towards realizing these objectives and meeting the skills requirements in Africa's evolving and dynamic information and communication technology (ICT) sector. These institutes will educate and train students (and other citizens) in the exciting field of microelectronics, and its applications to agriculture, biology, manufacturing, telecommunications, information systems and foster opportunities not only for the acquisition of new knowledge, but also the production and application of new knowledge. A new sub-program on microelectronics would be established within the schools' masters and doctorate programs in engineering while strengthening the undergraduate engineering programs. Also, certificate and diploma programs on microelectronics will be offered to the public. Enormous efforts would be made to attract small and medium enterprise to send their employees to attend the programs. Our program will provide broad-based innovative trainings, which would enhance the quality of their business processes and systems. All the schools must be required to have Business Incubation & Technology Transfer Unit (BITTU) with vibrant academic-industry relationships. We believe in models that move ideas from labs to markets. AFRIT has the capacity to help develop and structure a modern BITTU through our networks.

What is microelectronics? The term microelectronics describes a group of technologies that integrate multiple devices into a small physical area. Often these devices are made from semiconductors with a process called photolithography. Several components are available in microelectronic scale such as transistors, capacitors, inductors, resistors, diodes, insulators and conductors. The microelectronics can be divided to its subfields which in turn are connected to other micro related fields. These subfields are micro electromechanical systems (MEMS), nanoelectronics, optoelectronics and single electron devices (SED). Integrated circuits and microchips are typical microelectronic devices, which can be found in computers and mobile phones. Microelectronics can be also found for example in medical devices, toys and automobiles. Its industry, the semiconductor industry, is considered one of the most pervasive in modern history and continues to shape global commerce and industry.

These MTRI programs will provide educational opportunities for students and public interested in the emerging and interdisciplinary areas of neuromorphics, MEMS, telecommunication circuits and systems, information systems, controls, etc. There would be cross-disciplinary efforts and partnerships between African universities and international academic partners. African experts in Diasporas will be called upon to assist the local schools to help develop their programs to educate the students at international standards. AFRIT has networks of African experts across the globe which can help African institutions get started.

MTRI program is consistent with NEPAD vision of helping African nations to develop capacity in science and technology. In the next decade, courtesy of many National visioning projects from Africa to Kenya along with the explosive growth of our telecommunications sector, Africa will have enormous needs for microelectronics engineers to move up the ladder in the technology pyramid by leading the design and development of some of the electronics systems and tools that are used in Africa. AFRIT is of the opinion that now is the time to start training the students towards building a sustainable, organically grown microelectronics industry which will help improve our KEI.

The proposed program will help many African schools that already have the missions of providing technical education and training in technical and scientific areas which are critical to their respective economies. It is consistent with their research and teaching visions. Our proposed program has great potential to become a continental model not just for microelectronics programs but in other scientific fields because it brings together a cutting edge combination of local schools and foreign academic partners. They share and network on courses, laboratories, pioneer research programs and involve a global network of their respective school alumni who are in top global institutions. This program will promote the acquisition of new knowledge and the production and application of new knowledge in classrooms and laboratories, and produce highly trained and skilled graduates well qualified to move into academic, industrial or federal research positions.

Many engineering programs in African schools will surely have a high priority on establishing the proposed institute or labs considering the level of interests they have shown on this area. This is demonstrated by the extent to which education in microelectronics related fields is already taking place in the classrooms across campus. Despite lack of facilities for practical education, the theoretical aspect is well taught across many African universities.

This proposal mirrors similar initiatives which have been used by MOSIS (USA), CMC Microsystems (Canada), Europractice (Europe) - all programs supported by their respective governments or agencies towards practical oriented training and learning on microelectronics, especially at the students' level. Through MOSIS, many US students have experienced the complete life-cycle of microelectronics design and development. Over the years, these initiatives have enabled the different nations to train and develop more relevant practically oriented students for the industries. Central to our proposal is the development of a world class training and research environment (a Center of Excellence) across Africa in partnerships with leading top international universities.

PARTNER INSTITUTIONS MANDATE

A. A TOP GLOBALLY RECOGNIZED UNIVERSITY

Understanding the specialized knowledge required in microelectronics, AFRIT always recommend that universities in Africa seek Memorandum of Understanding (MoU) with a leading university abroad. This is necessary for training and capacity building. From our researches, we have noted that when MoU exists, students could go through exchanges and

conferences could be organized easily. AFRIT remains a source to connect African universities to form ties with globally recognized institutions across the globe. We have networks!

B. VIDEO TELECONFERENCE TECHNOLOGY

In our most recent grants, we have advocated the inclusion of video teleconference (e.g., Cisco Telepresense) technology. This technology will alleviate the problem of having to fly experts to Africa to lead some specialized courses. It could be Cisco or any organization with video teleconference technology. We understand that bandwidth is a major problem, but Africa is making progress there. We require inclusion of makers of these technologies like Cisco during execution of our grants as their technologies will drive future teaching models across the globe.

SECTION 2

JUSTIFICATION FOR MICROELECTRONICS INSTITUTE

Information and communalization technology (ICT) is facilitating the process of socio-economic development in Africa. It has offered new ways of exchanging information, and transacting businesses, efficiently and cheaply. It has also changed the dynamic natures of financial, entertainment and communication industries and provided fluidic means of using the human and institutional capabilities of the continent in both the public and private sectors. Increasingly, ICT is rapidly moving Africa towards knowledge-based economic structures and information societies, comprising networks of individuals, firms and nations that are linked electronically and in interdependent global relationships. This remarkable success of ICT in Africa and indeed globally since the dawn of the 20th century has been enabled by the phenomenal growth of the microelectronics technology. Microelectronics is the engine that drives the information age and without its constant evolution, ICT cannot advance. Unfortunately, the microelectronics industry does not have presence in Africa despite a hugely expanding ICT sector.

Over the years, many African schools have developed and taught courses on microelectronics. However, lack of institutional capabilities, like excellent facilities, teaching and learning environments have stalled its capacity to offer practical and relevant skills needed by its students to facilitate the diffusion of microelectronics technology from bottom-up approach in Africa. At present, no sub-Sahara African university or institution has a world-class microelectronics teaching and learning environments. We understand the challenge which has affected Africa's capacity to develop world-class programs on microelectronics- the lack of adequate funding which partly affected the abilities to have the right mix of people, processes and tools. Though we teach the techniques in African schools, the students never get to practice doing them. Poor teaching and learning environments have undermined the abilities of university teachers to develop some programs with potentials to make the students technology creators, and not just technology consumers. Across the globe, a paradigm is evolving; it is educating 360- i.e. educating from design specification to product market introduction. It is *Hear it, See it, Touch it and Do* it'. This is what we envisage in all the schools and we are optimistic that availability of excellent learning environment will enable us attract African experts abroad to join local schools towards developing the industry and building Africa.

Further, because of the rapidly-growing Africa's telecommunication sector and the identification of microelectronics as a major research thrust area to help develop Made-in-Africa's infrastructure, the stage is set for any African university and its partners to develop one of the model microelectronics programs in the continent. This Made-in-Africa's products will cover the full spectrum of products, such as cell phones, microprocessors, cameras, etc. The justifications for establishing such a program are listed below:

- MTRI program will promote any African university's stature as a leader in creating and disseminating new knowledge, and in the application of new knowledge
- MTRI program will fulfill the need for cross-disciplinary training of students, and enhance recruitment with a program that will be in increasing demand. This has a major component of attracting not just male students, but female students to S&T.

- MTRI program will drive a vibrant collaboration between African schools and their foreign partners. This will enable any African school shape its program with more market relevance.
- The MTRI program will offer new field of research and application which will create increased opportunities for employment and economic growth in the nation.
- We are optimistic that having MTRI will enable us African schools request funding for researches from HP, Intel, AMD, Motorola and other semiconductor firms presently selling their products in Africa's market. Our lack of infrastructure has undermined our capacity to obtain these grants.
- MTRI will enable us hire and retain qualified Africans and other global experts to conduct researches and teach in our university. Our present effort of attracting some of our high-achieving alumni will be easier. This has the potential of improving the quality of our students and boosting Africa's technical competitiveness.
- MTRI will enable any African university to bring world-class scholars in contacts with our students through video teleconferencing like Cisco Telepresense. Telepresence refers to a set of technologies which allow a person to feel as if they were present, to give the appearance that they were present, or to have an effect, at a location other than their true location [http://en.wikipedia.org/wiki/Telepresence].
- It will help selected university have a world-class multimedia computing center, which will enable our staff, and students collaborate with other researchers globally through web technologies. The Telepresence technologies will be stationed locally and our students can take lectures/lab works administered by experts separated by distance in this center.
- Though African schools have programs on microelectronics and general semiconductor areas, the lacks of the right mix of people, processes and tools have affected our capacities to develop a world-class program. The necessary Computer Aided Design (CAD) tools, the microcontroller development platforms, test and measurement systems are not available. Also, though not obvious, we have missed opportunities to hire some doctorate graduates that studied in some prestigious US universities simply because we do not have the learning and teaching environment they requested to come on board. Consequently, some emerging areas of engineering have been suspended because of the lack of the right teaching and learning environments.

Our plan is to develop MTRI program to become a center of entrepreneurship and technology creation in Africa. It would be structured to have market impacts through training of students and participants on the most vital areas of microelectronics. The following are some of the ways AFRIT intends to offer immediate direction:

- Many African schools will join AFRIT Microelectronics Academic Network. Through this network, they will join **Cadence Academic Network**. Cadence is the computer aided design (CAD) tool which more than 85% of global microelectronics institutions use. Cadence is used at IBM, Intel, HP, Motorola and other semiconductor/microelectronics firms. Also, Cadence has expressed written interests in supporting MTRI. Tanner, another CAD vendor, has also expressed interest in helping any MTRI in Africa.

- We will help African schools to join Europractice- this gives MTRI opportunities to collaborate with other research centers in Europe for process parameters and toolkits.. This is the most important step towards our vision of developing a world-class microelectronics institute.
- AFRIT will help bring best minds from the US and European semiconductor industry to serve as External Advisory Board of MTRI to enable the evolution of this institute to a world class status.
- MTRI will be structured with world-class teaching and learning facilities for microelectronics education. It will obtain other relevant computer aided design (CAD) tools, test and measurement tools, computing systems, etc.
- MTRI will develop new processes and systems which will be suitable for quality and practical microelectronics education. This will involve developing computer simulation models, system development platforms, and microelectronics process cycles. This proposal is not focusing on creating infrastructure, rather, to develop better systems and processes. Our present masters and doctorate programs in electrical and electronics engineering will have options for microelectronics. Also, our undergraduate education would be strengthened by this program.
- Foreign university partners will lead in developing the most relevant programs for students and participants from the industry. These programs will be designed to have the most positive impacts in diffusing the technology as well as shaping the Africa's microelectronics future. It is our knowledge that one of the key factors affecting the location and localization of some high-tech firms in Africa remains the poor state of the knowledge workers, especially the engineering components, which MTRI will address. MTRI is poised to elevate the knowledge base of our students and make them 21st century ready.
- International partners will have a complete educational package-policy, regulation, legislation, management, leadership, technology, etc. They will bring their real-life, hands-on and first-rate training skills to help develop our MTRI programs. MTRI will utilize its '*Hear it, See it, Touch it and Do* it' educational paradigm.
- MTRI, being unique, will be open to other African schools and institutions (not funded). This will enable them use the tools and learning environments for short term programs. It will also help their students get the experiences and skills necessary from our in-house team. However, they would be required to make payments.
- MTRI will engage the SME (small and medium enterprises). We understand that SME remains a key part of the success of the Africa's ICT diffusion through their *business-center* model. Through cutting-edge conferences, seminars and workshops, MTRI will help them envision opportunities in this emerging area. Providing direction and leadership, MTRI will help them leverage the opportunities to provide some customized programs which will help in faster impacts in this area.
- MTRI will work with university's Technology Transfer (TT) office to ensure that we work on researches which are relevant for the market. Also the TT office will help us license and commercialize some of our inventions and ideas. This will be a central part of our program as we want to develop students who are ready to create technology tools for Africa's market. Our students will be required to work on market oriented researches.
- Provide linkage to secondary schools to stimulate their students' interests in science

and technology as well as offer them mentoring opportunities in forms of summer works and internships. We would open opportunities to ensure that high and secondary schools in Africa are mentored.

Performance Benefits of the Institute

- This proposal will transform any African university to a world-class microelectronics training and research center. It will provide knowledge on the basic fundamentals which will enable us develop or adopt where necessary emerging technologies in the broad semiconductor industry.
- It will offer African students the best possible training on microelectronics. This has potential impacts of developing a new breed of technology leaders who can establish start-up companies and help develop the industry.
- It would enrich our research, making them, more relevant through collaborative works with our partners in the United States. It would also offer opportunities to provide an environment where Africans (in Diaspora) trained in this field can be used to pioneer developments in their native countries.
- This proposal has the potential of generating a constant pool of resources to African schools through consulting, training, and support services to SME and the governments. We hope to become the center to be consulted by investing multinational firms as they do feasibility studies in Africa.
- African university managements will learn immensely through multiple collaborations with our US partner.
- Our proposal is structured to develop programs which will have impacts in the markets. These impacts could be products or specialized skills of our students.

Innovations in Proposed Institute and our Roadmap

- Utilizing international and local collaborative networks to develop a microelectronics training and research institute that will offer world-class training and research opportunities to spectra of African university community and the SMEs. MTRI will provide platforms to help SME to adopt and diffuse the emerging technologies in Africa through consultation, training and infrastructure support. Our proposal is designed to be multi-mode with educational and research components. We envision bringing products to the market within 5^{th} year of operation to sustain organic growth after any grant fund has been exhausted. This is a requirement for any African school, ability to survive post-grant graduation.
- Entrepreneurship will form a key component of our graduates' education. Our qualified graduates, with their new ideas and innovations fostered in the university research environment will form the foundation for new startup companies and stimulate further research and development in Africa's private sector. MTRI will work hard to see that we help establish many start-up firms via our graduates. Taking our products to the market is one element of this proposal and that will influence our training philosophy.

- MTRI will provide the tools, technologies and services that make microelectronics research and development possible in select universities across Africa and this will improve our knowledge base in this area. This proposal will create value for both the participating institutions and Africa.
- Faculty members and graduate students will depend on MTRI's services to design, manufacture and test microsystems concepts for future applications in industrial sectors for products and services in microelectronics, MEMS, optoelectronics/photonics, microfluidics and embedded software.
- MTRI will enable many researchers who would not normally be able to participate in the microsystems research area if the infrastructure does not exist. MTRI is structured for quality, relevance, and practical impacts in Africa's academic and industrial spheres.
- Providing researchers with access to technical support, targeted training and networking opportunities to accelerate research efforts while decreasing time to graduation
- Availability of world-class training facility and environment will undoubtedly enrich the quality of training, learning and research. This proposal is designed to have immediate impacts and mature to sole sustainability within two years of any grant period. The program managers are composed of practicing experts who have the capacity to ensure fast start-up and implementation.
- The proposal is designed to have optimal balance between curricula reform, staff development and upgrades in facilities with positive impacts on the quality of S&T (science and technology) teaching and learning, the quality of S&T research, the relevance of the trainings and research to the labor market and enrollment of more female students in S&T based programs.
- We will utilize video teleconferencing to enable us tap a large pool of our alumni and other experts across the globe in our programs. They will lead labs and lectures at their foreign locations in real time through this technology.

How MTRI will Improve Research and Teaching

- MTRI will provide African microelectronics researchers and students with industry-caliber design resources, access to state-of-the-art prototyping technologies, tools for test and support services. This proposal will enable us acquire the facilities needed for the training and research. Also, this proposal will enable us provide the resources necessary to create technology adoption and diffusion by utilizing the expertise of African experts in Diaspora to visit the respective universities, on short term basis, to educate.
- This proposal will provide Africa University the opportunity to develop an institute which will become in future an avenue to seek grants from many multinational firms in Africa who presently are not funding researches in Africa. MTRI will showcase the readiness of Africa's educational institutions to conduct researchers for firms like Motorola, CISCO, HP, etc. This future anticipated industry supported R&D (research & development) will help develop our students, staff and management learn.
- MTRI will offer our students and staff opportunities to collaborate with global

partners in the areas of comparative technologies, especially solar technology, which we will vigorously conduct researches on. Our students will be enriched in this program.

- MTRI will post some educational podcasts on our website for the general learning and education of the public. This will be followed with Internet Virtual Classroom and Labs (IVCL) to enable other African students benefit from our programs irrespective of distance.
- MTRI is designed to be academic, market and industry centric- this positions it to deliver programs to the needs of the academia, market and industry towards producing students with world-class skills.

SECTION 3

EXECUTION STEPS FOR ESTABLISHING MTRI

The following Activities will be undertaken to establish MTRI in any typical African university.

Activity 1: MTRI Program Administrative Structure

A. Executive Committee.

The Executive Committee is responsible for establishing policy and procedures for the MTRI Program, approving revisions of the curriculum and other procedures for diplomas, certificates and serving as arbiter of faculty or student complaints. The Committee chair will rotate among the Committee members. The Chair's term normally will be two years. The Chair is responsible for calling meetings of the Executive Committee at least twice/year and more frequently as needed. The Director (to be described later) reports to the Chair who is also responsible for carrying out a yearly performance evaluation of the Director and the program, in consultation with the Executive Committee.

The External Advisory Board will assist the Executive Committee by providing broader oversight and recommendations regarding how the program could be improved. This Board will include people drawn from a wide range of firms and institutions:

B. Director.

The Executive Committee will appoint the Director of the MTRI program, with the following qualifications: a full time faculty of the university and in one of the participating departments and active research agenda in microelectronics. This individual will serve as Director with some release time from established teaching responsibilities, and will report to the Executive Committee and will be paid via university fund (not this grant). The Director will oversee among others the following via a secretary:

- Maintain student records from applications to graduations,
- Post graduation career follow-ups;
- Monitor and report on students' progress toward degree status;
- Answer inquiries from prospective and current students, faculty and the public;
- Maintain MTRI partnerships
- Coordinate outreach activities;
- Respond to faculty requests;
- Report to the Executive Committee
- Develop new partnerships and source for funds

PROJECT IMPLEMENTATION TEAM

Technical

There would be local and international teams

Administrative

Local admin for rudimentary jobs

Having this administrative structure will ensure that MTRI program is constructively and carefully developed. This leadership and oversight will ensure that students receive the best possible trainings and learning experiences. It will also ensure that management focuses on important issues while identifying potential problems in time. Furthermore, students will benefit from the richness of the experiences of the external board.

Activity 2: Minor Civil Work or new Building for MTRI structure
Many African schools already have physical structures where the MTRI will be located. However, possibly, minor structural ad renovations would be done to improve its outlook for a high-tech educational and research program it would be housing. This structure will be partitioned where necessary for the different educational and research programs. This partitioning will provide Labs rooms, Test rooms, classrooms, media room, seminar rooms, and some administrative offices. In rare occasions, new structures could be built

Lab Room: The lab rooms will house about 100 computers, where the Computer Aided Design (CAD) tools will be running. This will become the major lab where students would be working. A smaller lab room with 40 computers would be provided, especially for training purposes for visitors and outsiders (for instance, SMEs and students from other schools). The idea of having this extra one is to ensure that external training does not affect students training and programs.

Test Room: Because many microelectronics test tools are fragile and expensive, we will create a different room which would be for tests and measurements. This room will house our oscilloscopes, function generator, spectrum analyzers, test chips, programming kits, FPGA hardware, etc. They will also have the usual test-benches associated with electrical labs for soldering and bread-boarding. Twenty person-spaces will be created for this room.

Media Room: This will become a world-class video-audio-test studio where we will stream some of our lectures and labs via the Internet to a larger spectrum of African students. It will have projectors, computer systems, video recorders, cameras, sound-proof system, etc.

Classrooms: All MTRI courses will be taken in MTRI 100-person capacity classrooms. There will be a small one with 40 person capacity for external training. These classrooms will serve as minor seminar and workshop rooms also. For large seminars, MTRI will use the multi-purpose auditorium.

Administrative offices: There will be some relocation of some of our key staff into the MTRI to enable better control and management of the Institute.

At the end of this activity, students will have a world-class training institute on microelectronics. It will enable our faculty members deliver courses better and that will help the students perform better.

Activity 3: Program developments: Degrees, Seminars, Workshops, Certificates and Diplomas in Microelectronics

MTRI will run many seminars and workshops for the MTRI host university community and neighboring institutions. As much as possible, we will connect with trade associations. These seminars will be to introduce their members to how MTRI can help them develop competency and invest in the area of microelectronics industry. Because we are hoping to provide a great experience for our students, we will vigorously seek partnership whereby we use our Ph.D and masters students to help them develop their programs while they pay and support the students' studies.

From our 2nd year of operation, we will start certificate (3 months) and diploma (9 months) programs to the public. We would focus on certificate and diploma programs on FPGA, Microcontroller programming and testing since there are markets for them in the telecommunication, software and emerging computer clone industries in Africa. Our feasibility studies show that this industry is dormant, but has a potential for a million-naira capacity once active. We will strengthen our masters and Ph.D programs specialization in microelectronics

At the end of this activity, students and the public will have choices on different programs in microelectronics within a world-class institute. These programs are structured and targeted for different students' levels and that will help them do better in their studies.

Activity 4: Revamped Academic Curricula and Library collections

We will introduce many new courses in the MTRI. African schools have many other relevant and related courses in electronics, logics, microwave, computing, etc which are complementary to these ones. The major difference is that these new courses will go further to develop critical thinking, problem solving abilities and advanced knowledge with practical components in microelectronics. These ones will be project based where the students will be required to design and develop systems which could range from controllers for solar panels to chips for water purifiers. Our team of international partners will help us develop these programs and move them ahead. Students would learn the practical design cycle of mixed signal integrated circuits with fundamental principle of semiconductor devices and their applications in medicine, robotics, telecommunications, healthcare, power generation, etc. The contents of the courses:

CAD DESIGN OF DIGITAL VLSI SYSTEMS

This an introductory course in which students- manually and through computer simulations- will design digital CMOS integrated circuits and systems at the level of transistors. The design flow covers transistor, physical, and behavioral level descriptions, using SPICE, Layout, and VerilogHD1 VLSI CAD tools. After design computer verification, students can fabricate and test their semester-long class projects.

FPGA SYNTHESIS LABORATORY

This is an advanced laboratory course in the application of FPGA technology to information processing, using VHDL synthesis methods for hardware development. The student will use commercial CAD software for VHDL simulation and synthesis, and implement their systems in programmable XILINX 20,000 gate FPGA devices. The lab will consist of a series of digital projects demonstrating VHDL design and synthesis methodology, building up to final projects at least the size of an 8-bit RISC computer. Projects will encompass such things as system clocking, flip-flop registers, state-machine control, and arithmetic. The students will learn VHDL

methods as they proceed through the lab projects, and prior experience with VHDL is not a pre-requisite.

MICROPROCESSOR LAB: This course introduces the student to the programming of computers at the machine level. General concepts relevant to microcontrollers are presented, including memory access, numerical representations, programming models, and coding techniques. A CAD will be used along with development platform like PIC, SX-48 chips.

ADVANCED ANALOG INTEGRATED CIRCUITS: Analysis and optimized design of monolithic operational amplifiers and wide-band amplifiers; methods of achieving wide-band amplification, gain-bandwidth considerations; analysis of noise in integrated circuits and low noise design. Precision passive elements, analog switches, amplifiers and comparators, voltage reference in NMOS and CMOS circuits, Serial, successive-approximation, and parallel analog-to-digital converters. Switched-capacitor and CCD filters. Applications to codecs, modems.

SEMINAR & PROJECTS ON VLSI: Research seminar devoted to current research in the engineering of large-scale integrated analog systems and project management. Topics include opamps, comparators, vision and auditory processing systems, RF circuits, etc. Group of students will work on projects.

ELECTIVES (4 FOR PH.D, 1 FOR MASTERS)

MICROFABRICATION LAB: This laboratory course is an introduction to the principles of microfabrication for microelectronics, sensors, MEMS, and other synthetic microsystems that have applications in medicine, automotive, telecoms, biology, etc. Course comprises of laboratory work and accompanying lectures that cover silicon oxidation, aluminum evaporation, photoresist deposition, photolithography, plating, etching, packaging, design and analysis CAD tools, and foundry services.

ADVANCED TOPICS IN FABRICATION AND MICROENGINEERING: This will be graduate-level course on topics that relate to microsystem integration of complex functional units across different physical scales from nano to micro and macro. Topics will include emerging fabrication technologies, micro-electromechanical systems, nanolithography, nanotechnology, soft lithography, self-assembly, and soft materials. Discussion will also include biological systems as models of microsystem integration and functional complexity.

MIXED SIGNALS MICROSYSTEMS: This is a course on the design of integrated mixed signals and domain microsystems. The emphasis is in micro-power sensor interfaces for instrumentation and automation in the life sciences. The course comprises weekly lab lectures, laboratory sessions where students make measurements on fabricated devices and circuits and CAD laboratory assignments. There will be a final group project.

ROBOT SENSORS AND ACTUATORS: Introduction to modeling and use of actuators and sensors in mechatronic design. Topics include electric motors, solenoids, micro-actuators, position sensors, and proximity sensors and how they can be designed, used in systems. This course is a full lab course with 20% devoted to lectures.

BIOSENSING AND BIOMEMS The course discusses the principles of biosensing and introduces micro- and nano-scale devices for fluidic control and molecular / cellular manipulation, measurements of biological phenomena, and clinical applications.

SEMICONDUCTOR PHYSICS: Crystal properties, symmetry and imperfections. Energy bands, electron dynamics, effective mass tensor, concept and properties of holes. Equilibrium distributions, density of states, Fermi energy and transport properties including Boltzmann's equation. Continuity equation, diffusion and drift of carriers

The students will find our library collections, such as Institute of Electrical and Electronics Engineers (IEEE) collections and Elsevier Science Direct and new books useful.

At the end of this activity, students will have world-class curricula on microelectronics. Our diploma, certificate and degree programs will become market relevant, courtesy of these new courses. It will enable our faculty members deliver courses better and that will help the students perform better.

Activity 5: Equipment and Computer Systems Purchase & Installation

The equipment and computer systems will be installed in the related rooms. This will involve some computer networking since all the systems must be networked. Some of these schools already has many computer systems which can be used for MTRI. Nonetheless, MTRI will purchase some servers and high-end computers to run some of the CADs which will be installed.

Fabrication Services: MTRI will be designing on AMI 0.5-micron CMOS process technology because of its leverage costs of fabrication. MTRI will have a cleanroom for its MEMS programs and use MOSIS (mosis.org) for the chips. Other systems which would be purchased are:

- MUMPs Cronos (Surface Micromachining)
- Rapid Prototyping Boards (Xilinx FPGA)
- DSP Platforms (PIC, SX-48 microcontrollers)
- Altium/Protel PCB CAD

Workstations: 44 high-end Linux-Windows Combo computers. These computers will have high speed and memory to enable usage of the CAD tools. Four of these computers will be used as servers for messaging/Internet proxy serve and CAD server. The other 40 will be licensed for CAD applications for design and development. While it is possible to use these schools old systems, these ones are required because of the special requirement of the CADs. These 44 machines are subsets of the 100 budgeted for lab room.

There will be additional 10 Tape Back-Up Systems and HP storage system to backup all students' works on real time as well as store some vital Institute documents and digital infrastructure.

Test Systems: The following tools and equipment will be purchased to enable the testing and measurements of designed chips.

- 8 computers to be installed with Matlab for data collection and analyses
- Other major equipment (they would be used for chip testing and measurement)

- 3/6 GHz Signal Generators—this would be used for generating test signals
- Network Analyzers –this would be used to testing networking sequences on chip
- Logic Analyzer – this would be used to test output chip for digital signals
- Spectrum Analyzers – this will be used for noise analysis and spectrum measurement
- Function/logic generators- this will generate different signals, like sine, pulses for test purposes
- 50 GHz Sampling Scopes – these are fast oscilloscopes for signal measurement and validation
- Power Meters- this measures the power output in chips
- Probe Stations- we need the probe station for chip characterization and testing
- Microwave Probe Sets- this will be used for the RF systems testing
- SMUs test boards- these are used for easy prototyping and testing
- PCB Test Fixtures- these are used for prototyping
-High-Speed (RF) IC Test system- this test structure is designed for high RF system; good for telecoms
- NIDAC Card for data capture; this is the data acquisition card for obtaining signals from chips
- Microscopes- these are used for micro-soldering on SMU parts,
- Soldering stations- this is a high caliber soldering station
- Heat chambers- for the test of our bandgap references
- Bundles of chips for testing- there are some chips needed to test other chips; eg. ADC, DAC, etc
- each of oscilloscopes, voltage regulators, power supplies – this include the regulator, power supplie, and scopes

Design Tools:
MTRI will obtain 10 user licenses for CADENCE (cadence.com) and 40 for Tanner (tanner.com). Presently, these CADs are given at ridiculously discounted prices. While Cadence runs on Linux, Tanner runs on Windows. Other design tools to be purchased are:

High Level Synthesis (FPGA/CPLD):	Xilinx ISE
High level simulation (VHDL, Verilog, HDL:	Hamster, Xilinx III
MEMS (MEMS, design & simulation)	SUGAR, NODAS
PCB (Printed circuit board)	PCB Express/Altium

Library: Through the support of our Alumni association in the United States (many are instrumental in this proposal), we have books which can support immediate take-off of MTRI. Many of the books they donated in December 2007 are new and current for our student and program. Besides, many schools have library facilities which have books of relevance. Nonetheless, MTRI will help subscribe to Elsevier Science Direct and Institute of Electrical & Electronics Engineers (IEEE) journals to enable our researchers and students remain abreast to the state of the art publications in microelectronics. These collections are some of the best in world where the latest trends in microelectronics are published. We would ensure that we maintain Fair Use as we open the resources to other universities or institutions in Africa.

At the end of this activity, students will have a world-class training institute with state of the art facilities on microelectronics. It will enable our faculty members deliver courses better and that will help the students perform better.

Activity 6: Trainings & Equipment Trainings (plus safety training)
As a matter of priority, our staff will be trained on the safety issues on any equipment we will be using. Also, the usual trainings on the CAD, tools, equipment, where necessary will be done.

This activity will ensure that staff learn and master all the tools, CAD, equipment, etc very well towards enabling better support to students' trainings and learning. The safety component will make sure hazards are properly managed to safeguard everyone's lives and properties.

Activity 7: Introduction of MTRI to African market & online courses
MTRI will take some ads on the African news media to introduce our institutes. This will help us create awareness on the facilities and structures we have to meet the needs of the public. We will also develop web based trainings. We would offer the following services to institutions in the area of mixed signal microelectronics: circuit simulation, PCB design, VLSI design, embedded systems, power electronics, design automation, design services, and academic solutions. Our fabrication services will be available to institutions and schools, though it has to be paid and supported.

This activity is designed to showcase MTRI to the African market- what we can do and how we can partner with firms on R&D. It will also become a good way of reaching to future students and program participants.

Activity 8: Introduction of products to the African market
We understand that we need to grow and become self sustaining institute. Our plan is to introduce our first product to the market on before the 5^{th} year of operation. This product is largely going to be a power system controller which can help energy storage for batteries, solar panels, cars and motorcycles. We will work on developing better systems which can help farmers do their jobs better through system and computing power. There is a high level of activities in the Africa's Capital Market, we hope to advertise for hedge fund managers for the commercialization, support and licensing of our technologies.

Our students would be required to work on projects with potential market impacts. We will vigorously work to make products with market values. Our students and management will learn from this experience and will help everyone on the need of creating technologies for the African market. This will be a unique experience where our students will learn skills to enter into markets and succeed with their products.

Activity 9: International and local experts, technical experts, visiting professors
This activity will affect all aspects of other activities. The table shows the contributions of technical experts or visiting professors who would assist in realizing the above milestones. AFRIT will help recruit experts to assist execute the project from our international network.

Name	Credentials	Role/contribution	Length of stay

Activity 10: Constant Evaluations of program

The assessment of the proposed MTRI program will be done at the end of every semester. The MTRI program Director in consultation with the Executive Committee will establish the goals for the program and the process for assessing whether the goals are achieved. The Director through the External Advisory Board will arrange for external reviews by panels of distinguished members in the academic and research communities, and self-assessments in consultation with the various interested departments to evaluate whether the objectives for the program are being met--in terms of creating and disseminating new knowledge; educating students to prepare them for positions in academia, industry and national laboratories; and the extent to which this program is a model for other institutions to follow. Whenever possible, these reviews will be part of the student reviews and will be scheduled periodically. The External Advisory Board will also be consulted to identify the highest quality criteria and goals they believe are necessary for the MTRI program to prepare scientists for professional careers. The assessments will be performed under the supervision of the Director, and the outcomes reports will be submitted to the Executive Committee. The assessment will include the following:

- Development of new knowledge, and maintaining leadership role for MTRI: number of research grants awarded to faculty, fellowships awarded to students, publications by faculty (highlighting those coauthored with students), applications and proposals awarded for patents and trademarks, conferences attended by faculty and students, and presentations given by students and faculty.
- Application and admission records: how many students applied, their qualifications, which students (high/mid/low quality) were accepted- and which of those enrolled. This includes diploma and certificate programs for industrial participants.
- Enrollment and grade records: tracking enrollment and grades of students in the MTRI affiliated programs, and their career development activities.
- Mapping the number of students that receive graduate degrees and secure academic, industrial or federal positions in Africa, or elsewhere.
- Conducting and assessing student evaluations of each course, lecture and laboratory period as well as each instructor at the end of each semester, with the anonymous results provided to each instructor and to the MTRI program Director.
- Assessing how well the MTRI program prepares its graduates for positions in the field. The External Advisory Board may also be asked to conduct on-site assessments and report the results to the Executive Committee, with recommendations for improvement.

- Development and implementation of a formal one-on-one exit interview procedure to solicit comments, criticism, and recommendations from each program graduate before they leave campus.
- Creation of and results of a tracking program to monitor the post-graduation careers of the MTRI affiliated program graduates and to conduct periodic surveys to determine the impact that participation in the program has had on their careers, as well as on the careers of faculty participants. This would be developed alongside Lagos Business School alumni network which maintains updated records of all former and present students.
- In classes, the students' achievement of the program's learning outcomes will be assessed using: grading of homework assignments, quizzes, midterms, individual and/or group projects, research papers, and final exams.

We want to continuously access our capacities in MTRI. This will help us correct mistakes, learn and constantly develop programs which will benefit our students, participants in our programs and our management. A feedback mechanism will help us understand the needs of the students and the best ways to solve them.

Activity 11: Multimedia Computing Center with Video Telepresense

AFRIT will seek the support of Cisco or any other firm to establish a **Multimedia Computing Center** that will enable our Internet virtual classrooms and labs as well as Cisco Telepresence or other video teleconference. We will incorporate Webex technologies and other web tools as well to enable our students interact and share with their peers across the globe.

Think of a Nobel laureate of Physics teaching our semiconductor physics. This could be made possible if we have technologies, which can enable him or her to stay in his/her office anywhere on the globe to lecture our students using Telepresence. He can guide labs and classrooms in real time without the troubles of jumping in a plane. We do believe that our contents and programs will improve through better access to harness the pool of our alumni and other global experts. Within this center, we will have archival and imaging technologies, which will record our lectures towards reuse and sales where necessary.

Progress Indicators

Activity 1: MTRI Program Administrative Structure			
Progress Indicators:	Phase One*	Phase Two	Final Phase (Milestone 1)
	Constitute the Executive committee (M1**)	Appoint MTRI Director (M1)	Structure all administrator structures (M1)
Activity 2: Civil Work for MTRI structure			
Progress Indicators:	Phase One	Phase Two	Final Phase (Milestone 1)
	Quantify the work(M2)	Ask for quotes and award contracts (M2)	Complete minor civil/construction work (M3)
Activity 3: Program developments: Degrees, Seminars, Workshops, Certificates and Diplomas in Microelectronics			

Progress Indicators:	Phase One	Phase Two	Final Phase (Milestone 1)
	Develop programs structures (M2)	Integrate into university academic calendar (M2)	Integrate into university academic calendar and map out dates for seminars, workshops (M2)
Activity 4: Revamped Academic Curricula and Library collections			
Progress Indicators:	Phase One	Phase Two	Final Phase (Milestone 1)
	Develop courses for the school programs (M2)	Develop courses for industry programs (M2)	Determine library collections and purchase them (M4)
Activity 5: Equipment and Computer Systems Purchase & Installation			
Progress Indicators:	Phase One	Phase Two	Final Phase (Milestone 1)
	Ask for quotes (M2)	Make offers and award contracts(M3)	Complete equipment and computer systems purchase and installation (M4)
Activity 6: Trainings & Equipment Trainings (plus safety training)			
Progress Indicators:	Phase One	Phase Two	Final Phase (Milestone 1)
	Develop training structures (M2)	Execute trainings (M3)	Complete local trainings (M5) Complete International trainings (M6)
Activity 7: Introduction of MTRI to African market & online courses			
Progress Indicators:	Phase One	Phase Two	Final Phase (Milestone 1)
	Advertise MTRI to firms and schools (M6)	Advertise MTRI to firms and schools(M6)	Advertise MTRI to firms and schools(M6)
Activity 8: Introduction of products to the African market			
Progress Indicators:	Phase One	Phase Two	Final Phase (Milestone 1)
	Develop products for the market (M48)	Introduce the products to the market (M48)	Introduce the products to the market (M48)
Activity 9: International and local experts, technical experts, visiting professors			
Progress Indicators:	Phase One	Phase Two	Final Phase (Milestone 1)
	Use them in projects (affects all months)	Use them in projects (affects all months)	Use them in projects (affects all months)
Activity 10: Constant Evaluations of program			
Progress Indicators:	Phase One	Phase Two	Final Phase (Milestone 1)
	Monitoring, evaluation and corrections (quarterly)	Monitoring, evaluation and corrections (quarterly)	Monitoring, evaluation and corrections (quarterly)
Activity 11: Multimedia Computing Center with Cisco Telepresence			
Progress Indicators:	Phase One	Phase Two	Final Phase (Milestone 1)
	Ask for quotes (M2)	Make offers and award contracts(M3)	Complete imaging and archiving equipment, Telepresence and computer systems purchase and installation (M4)

*Phase is used here to describe a stage/segment of an activity with a time dimension.
** M is month; M1 is Month 1 after award and upon signing grant agreement

SECTION 4
SUSTAINABILITY AND MANAGEMENT

Students and other citizens in this program are likely to come from a broad range of disciplines, such as engineering, computer science, physics and mathematics. We expect that a significant number of students will come initially from Africa. We believe that Africa's first microelectronics institute will help progress the reputation of the continent. We are optimistic that MTRI program will elevate our status of the continent and its commitment to science. As the ICT sector improves and expands, we are seeing markets for creating the infrastructure from bottom-up. This will involve supporting emerging technology applications in digital signal processing (DSP), printed circuit board (PCB) technology, microcontroller programming, developing hardware drivers, etc. Even the government research institutes across Africa will likely send their employees while many small and medium enterprises (SME) will patronize our programs to learn cutting edge skills to become competitive. Thus, the program is strategically oriented to serve the needs of current and future industrial and government sectors of Africa.

MTRI program will be consistent with any African university's goals for equitable representation of various student groups- men and women. We will vigorously work to ensure women are attracted and supported. This program has also developed a technique to use the flavors of high-tech to recruit more students into the university. Our model has avenues to enable students from high and secondary schools do internships or summer programs in our Institute. This technique, undoubtedly, will enable them have easy access to our professors, students, researchers and possibly stimulate the student's interests in S&T.

AFRIT's model will help raise female students' matriculation and graduation by 40% within the next five years. Furthermore, offering first-rate courses in microelectronics will provide us high pool of postgraduate students who will attend our programs. We estimate 100% increase in enrollment in engineering postgraduate programs, just for access to MTRI.

Because we anticipate a strong industrial and business support for the program, we are sure to attract and prepare a continuous pool of applicants from and for the industries and businesses. Aggressive recruitment strategies will be implemented to attract other potential students. Such strategies, especially for our graduate component, will include:

- Maintaining a frequently updated web page that informs the public on the organization, opportunities, accomplishments, and excitement of the program.
- Faculty presentations about the program at technical meetings (and trade associations) that are devoted to S&T education.
- Faculty visits to other institutions with potential sources of students.
- Mass mailings and e-mailings of flyers and other publicity materials about the program.
- Contact with alumni and other potential benefactors via mail and open houses.
- Governments will be challenged to offer fellowships through National Science Foundation to enable top deserving African students pursue postgraduate careers in science and technology. AFRIT is developing a program for NEPAD through which all African nations will be required to award a minimum of four years postgraduate

fellowships to 1000 students with bigger countries like Nigeria and South Africa 2000 students.

GRANT GRADUATION PATH

MTRI is designed to survive post-grant graduation, i.e., operate when the grants have been exhausted. The following operations or techniques have been identified in that regards:

- MTRI will organize workshops, seminars and conferences as revenue sources
- MTRI will introduce products in the market within the first 4 years
- Seek more sources of funding, such as grants, endowments, etc
- Generate income from patents and spin-offs
- Through university BITTU, develop consulting relationships with firms and bring products to market.

SECTION 5

ASSESSMENTS AND IMPACTS

Here are how we will access impacts and indicators for improvements and quality control in MTRI

Activity:	Expected Outcome (Result)	Indicators of Outcome (Result)	Means of measurement/Verification
International collaboration	This will expose our staff and students to more learning and training experiences	*publications * patents * exchange students * visiting professors	We expect 10% increase in our students' publications in 1st year; 20% in 2nd year. We will file at least 2 patents in 2nd year.
Entrepreneurship and start-up firms (product introduction and success of the products in the market)	We want our students to be technology creators and innovators	* start-up firms	Before our 5th year, at least 2 our students should be managing a small firm; BITTU will diversify and provide microelectronics consulting services in Kano and Lagos
Support services	We will lead in chip fabrication through our relationship with foundries under MOSIS venture	* chips fabricated	We will fabricate 10 working chips in our 1st year; 20 in our 2nd year.
Expanded research base	Our Institute will expand as we mature and get better	* obtain clean room	We will acquire full clean room in our 6th year.
Enhanced skills and equipment/tools usage proficiency	Our students will be the best microelectronics students in Africa	* admissions abroad * jobs * number of students	MTRI will increase by 100% the number of our students admitted in foreign top schools; 100% of our students will have jobs within 3 months of graduation; we will double the size of postgraduate engineering by 200%
Collaboration/training of African SMEs	We will train many African SME to new technical skills to make them better	*competency * products in market * industry diffusion	We will elevate the level of skills of SME-measurable by better products; MTRI will stimulate microelectronics industry diffusion from our 2nd year
Overall Project:	**Expected Outcome (Result)**	**Indicators of Outcome (Results)/Impact**	**Means of measurement/Verification of outcome(results)/Impact**
MTRI (this proposal)	Project will stimulate Africa's ICT. It will create diffusion and produce better ICT managers and tech creators. Will be both technical and management success	* new products * industry growth * new firms * manpower capacity	At least 3 products will come from our institute within 5 years; microelectronics industry will emerge in Africa; at least 4 firms from us or our students will be in Africa; 200 skilled microelectronics engineers will be ready for Africa's economy from our institute within 2 years.

SECTION 6

FINANCES AND BUDGETS

Total budget for MTRI is in Appendix. Please refer to section 2 for all the activities.

Please download http://fasmicro.com/Documents/appendix.pdf

We have another document that gives unit prices of all the items and where they could purchased. Upon request, we will help you with this more comprehensive excel document.

These activities can be executed in stages.