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EFRI - EFRI RESEARCH PROJECTS		1037968

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TITLE OF PROPOSED PROJECT **EFRI-SEED: Adaptive Autonomous Performance in a Sensitive and Integrative System (AAPSIS) for a Telemedicine Unit**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 2,068,430	48 months	07/01/10	1009060

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

- ☐ BEGINNING INVESTIGATOR (GPG I.G.2)
- ☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
- ☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
- ☐ HISTORIC PLACES (GPG II.C.2.j)
- ☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
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Electronic Signature

EFRI-SEED: ***Adaptive Autonomous Performance in a Sensitive and Integrative System (AAPSIS) for a Telemedicine Unit***

PI, Pierre A. Deymier, (Engineering) U. of Arizona. Co-PIs (all from U. of Arizona): Álvaro Malo (Architecture), Ana M. López (Medicine), Eniko T. Enikov (Engineering), Mary A. Peterson (Psychology).

Native American populations have urgent need and limited access to health care. The University of Arizona's Telemedicine program is an efficient means of delivering clinical, diagnostic and continuing education for the Indian Health Services system. However, the current telemedicine systems lack facilities that can adapt to variable physiographical settings and functional needs, that are culturally competent and user-friendly, and that have sufficient autonomy in off-grid remote locations. The goals and challenges of the proposed research will focus on the integrative design and realization of an efficient and competent Telemedicine Unit that will require the following attributes: (1) Adaptive to variable programmatic needs, climatic conditions, and cultural settings; (2) Autonomous, self-sufficient of energy and resources in off-grid remote locations; (3) Sensitive to human physiology, material propensities, and environmental factors; (4) Integrative of aesthetic socio-cultural, and ecological systems; and, (5) Sustainable prospect of use and regeneration of natural resources : air, water, light, energy and land. The Telemedicine Unit will be located in Sells, Pima County, AZ., The research and design process will be carried out with the integral participation of the Tohono O'odham Nation (TON) and the Tucson Area Indian Health Services (IHS).

The objective of the proposed research is therefore to develop the fundamental scientific, engineering, technical, aesthetic, social and cultural principles required to initiate a paradigm shift in the design, development and operation of energy/resource efficient and sensitive sustainable buildings. We propose the development of advanced and innovative concepts, which using interactive modeling and simulation, apply fundamental scientific and technical principles in the architectural design, engineering, testing, and construction of a Telemedicine Unit. This transformative paradigm is based on an efficient and graceful interface between buildings as operating "hardware" and human beings as sensible, sensitive, and culturally evolving "software." Cultural competence of this facility requires that special attention be paid to both the performance of clinical functions as well as to integrative aesthetic perceptual feedback loops. Integrative aesthetics includes measurable human sensory responses related to the buildings environmental conditions, which affect human comfort and well being and provide the common sense of an immanent aesthetic.

Intellectual merit:

The proposed research introduces a new paradigm in built environments: autonomous, sustainable, adaptive and sensitive building. The research on pneumatic envelopes with automorphic and phototropic properties will provide key insights into the engineering, technical and materials aspects of adaptive building. Insight gained from the study of energy production and energy storage by integrating flexible photovoltaic cells and compressed air storage within the building envelope will help establish the principle of *autonomy*. Thus, we will explore the application of high efficiency dual use compressor/motor systems in enabling operation of the unit as well as for energy storage and recovery. The integration of new micro and macro sensor technologies into the building that can respond to environmental, structural and human factors will enable the design of a *sensitive* building. The development of model-based *multi-paradigm simulations* for real-time management of the complex interactions between flow of resources and human occupant establishes the foundation for *integrative modeling* of architectural design, engineering systems, operational building needs, human physiological and psychological comfort, and cultural sensitivity.

Broad impact:

The Arizona Telemedicine Program was founded by the state legislature in 1996. To date, over 1,000,000 teleconsultations have been conducted resulting in enhanced clinical care for Arizona's population. The initial 8 vanguard sites have expanded to over 100 sites statewide. The principles derived from this research in model-based multiparadigm simulation will be transferable to numerous IHS renovation projects and other medical facilities. Teleconsultations enhance the readily accessible clinical services. Services provided in group settings would benefit from an *adaptive* structure. Nonclinical benefits would include enhancing the technical, business and sustainability expertise of the community. The *integrative aesthetics* and "feel" for the structure will be developed with guidance of and in response to community needs and priorities. Ideally, the structure itself should be able to *sense* and *respond* to human needs. For example, the smart building may sense the rapid heart rate of an individual who is nervous and fine-tune the lights and sound to create a more comforting atmosphere — a place where people will feel "at home" and welcome. The multidisciplinary research team that will conduct the research will provide a unique goal-oriented educational environment for graduate and undergraduate students.

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Appendix Items:

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

B. Vision and Goals:

We propose the development of advanced and innovative concepts, which using modeling and simulation interactive environments, apply fundamental scientific and technical principles in the architectural design, engineering, testing, and construction of a Telemedicine Unit (TMU). This transformative paradigm must be based on an efficient and graceful interface between buildings as operating “hardware” and human beings as sensible, sensitive, and culturally evolving “software.” Cultural sensitivity toward users (patients) of this facility requires that special attention be paid to both the performance of clinical functions as well as to integrative aesthetic perceptual feedback loops. Integrative aesthetics includes measurable human sensory responses related to the buildings environmental conditions that affect human comfort and well-being and that provide the common sense of an immanent aesthetic.

More specifically, we envision a building-environment system that possesses the following attributes:

- Adaptive to variable programmatic needs, climatic conditions, and cultural settings
- Autonomous, self-sufficient of energy and resources in off-grid remote locations
- Performative efficiency regarding daylight, acoustics, energy balance and building physics
- Sensitive to human physiology, material propensities, and environmental factors
- Integrative of aesthetic (i.e. visual, acoustic, thermal, haptic, ergonomic, etc.), socio-cultural, and ecological systems
- Systematic thermodynamic prospect of use and regeneration of natural resources (i.e. air, water, light, energy, land, etc.)

We therefore propose research that will establish the foundations of a broader spectrum of ecological understanding of scientific, technical, architectural, engineering, social and cultural principles that are required to initiate a paradigm shift in the design, construction, operation and recycling of efficient, sensitive and sustainable buildings.

Specific research goals will include:

1. Discovery of a science and technology of adaptive sustainable buildings with dynamic morphing properties (e.g. automorphic structure, phototropic envelope, ergonomic adaptation).
2. Integration of new sensor technologies responsive to environmental factors, structural adaptation, and human physiology and behavior.
3. Creation of virtual environments for modeling and simulation of human responses to sensory stimuli in adaptive spatial environments.
4. Development of a model-based computational control system for real-time management of the complex interactions between flow of renewable resources and human occupant needs in adaptive structures
5. Establishment of architectural design and engineering principles derived from a scientific understanding of the operational energy needs of the building and the thermodynamic thresholds of human physiological comfort
6. Fine tuning of adaptive material spatial morphologies responsive to perceptual well-being.

These goals will be attained by conducting research within a philosophical framework emphasizing the exchange of ideas and expertise through experiential interaction with many disciplines including engineering, architecture, psychology, medicine. This project will serve as a vehicle to promote scientific, technical, social and cultural multi-linguism to enhance community’s understanding of the role of knowledge integration, transfer and creation in the field of sustainable energy efficient and environmentally and culturally competent buildings.

C. Approach and Methodology: The proposed research program, inclusive of all relevant thrusts, approaches and methodologies, is described schematically in the flow chart shown below (Fig. 1):

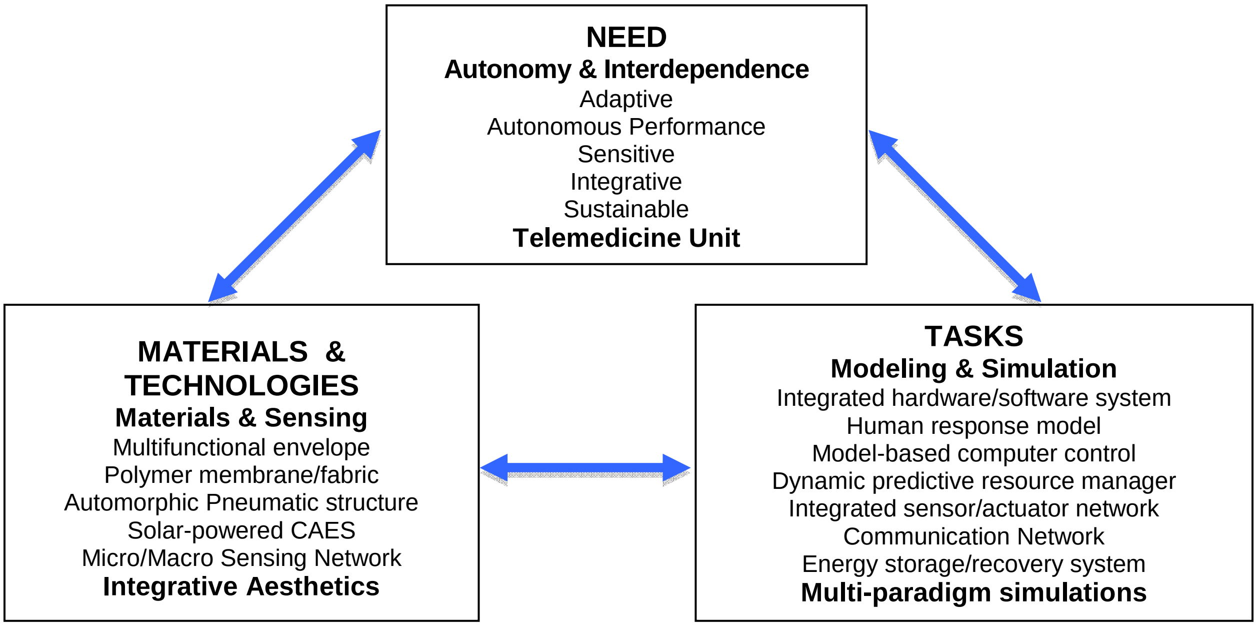


Figure 1: Flow chart of new paradigm systematic relationships between Needs, Tasks, and Material Technologies.

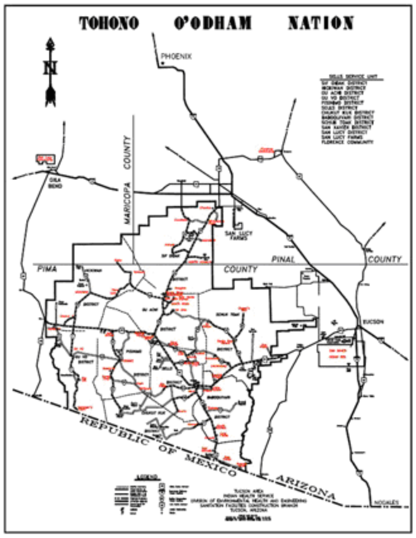
D. Needs and Requirements (UA Telemedicine Program and Tucson Area Indian Health Services): The TMU will be located in Sells, Pima County, AZ. Capital of the Tohono O'odham Nation (TON). The proposed TMU must be culturally competent as well as provide adequate spacing for patient consultation. Because of patient privacy issues and Health Insurance Portability and Accountability Act (HIPAA) compliance, the Sells Service Unit (SSU) TMU must be large enough to provide Joint Commission on Accreditation of Health Care Organizations (JCAHO) standard clinical services. The TMU must provide space for telemedicine consultations, community meetings, public health preventive programs, and national public health programs. Utilizing spacing parameters based upon normal clinical program areas, it is recommended that the proposed TMU at a minimum provide the following areas for patient care.

- Telemedicine training room area is about 16 feet by 13 feet.
- Telemedicine program coordinator and patient waiting area cubicles about 12 feet by 9 feet each.
- Physician review/consult room is about 16 feet by 10 feet.

It is recommended that the proposed TMU have the ability function as public health conference room modality with adequate spacing for 10-20 participants. The two 65 inch screens of the Tandberg system will serve as a Tele-health conference audio-visual modality. In collaboration with the TON and the Arizona Telemedicine Program, the Tucson Area Indian Health Service is committed to enhance the clinical services provided to patients by increasing the Telemedicine capabilities. The impact of the proposed TMU will be a significant advancement in the clinical services we provide the patients. The telemedicine program will need the services of a trained full time Telemedicine consult coordinator. The telemedicine consult coordinator will be the gatekeeper or bridge between the patients care and provider consult scheduling. The needs and enhancements to the telemedicine clinical services were discussed with the Arizona Telemedicine Program and Tucson Area 40+SSU providers. The providers were shown the multiple telemedicine programs available to the staff and patients.
The SSU clinical staff identified the following Tele-health program needs as having the most significant impact on their day-to-day care of the patient population:

- Tele-Cardiology, providing real-time ECHO and Ultrasound
- Tele-Pain Clinic, providing pain management consultations
- Tele-Health educational programs (HHS/IHS or CDC community programs, Arizona Dept of Health collaborative programs, U of A grand rounds)
- Tele-Psychology, providing live family or personal behavioral consultations

- Tele-Dermatology, providing store and forward or live dermatology consultations
- Tele-Rheumatology, providing the patients with increased real time rheumatology consultations



Although this list does not completely address all patient needs, it does reveal the SSU clinical staffs desire to improve patient care. A site has been identified on the grounds of the Sells hospital by IHS and the Tohono O'odham nation for the proposed TMU. This site permits hook up to city water and sewer systems.

The reservation is the size of the state of Connecticut. Although the proposed TMU will be initially located in Sells, future expansion of the project may take place at other potential sites indicated in red as shown in Fig. 2. All these sites possess water/sewer systems but would benefit from the off-grid capability of the TMU.

Based on the needs and requirements established by the Tucson Area Indian Health Services, in conjunction with the University of Arizona Telemedicine Program, the table shown below (Fig. 3) indicates how these will be met by the design attributes selected for research and development in the TMU.

Fig. 2: Map of Tohono O'odham Nation

The design attributes of the proposed TMU that will meet the needs of the Telemedicine program and the Tohono O'Odham Nation are presented in Figure 3.

Design Attributes / Needs & Requirements	Pneumatic Building Envelope	Adaptive Morphology	Sensing	Compressed Air Energy Storage	Autonomy	Integrative Modeling System
Cultural competence and user comfort		O	O			O
Adaptive functional space	O	O				
Operation power 6-7kW			O	O		O
Off-grid				O	O	O
Mobility	O				O	
Ease of deployment	O				O	
Minimum site impact	O				O	
Low systemic ecological impact	O	O	O	O	O	O

Figure 3: Table showing correspondences between Needs & Requirements and Design Attributes.

E. Specific Research Plan: To meet the objectives of this project we will take an approach in the design of the building system that addresses several integrated functionalities. The multifunctional envelope will provide efficient energy harvesting, energy and water storage capacity, thermal storage and insulation, as well as light transmission. This envelope will be endowed with automorphic and phototropic properties to optimize its functions by adapting to environmental cyclic changes and human needs. To achieve theses functionalities, we will take advantage of technological progresses in new synthetic materials, pneumatic envelop design and microsensor technologies. We will investigate pneumatic phototropic envelopes composed of three-layered partitioned membrane systems to meet daylight, acoustics, energy balance and building physics requirements. The supporting infrastructure will incorporate materials with energetic and structural attributes, such as: (1) Flexible FRP tubing for air circulation system; (2) Flexible shielded FRP tubing for power supply system; (3) High modulus FRP for compressed air storage; and (4) Recyclable thermoplastics for water storage and circulation systems.

1. Building envelope: The choice of a multifunctional pneumatic envelope is highly compatible with the proposed Compressed Air Energy Storage (CAES) and management system, with light-weight and mobility which are consistent with the principle of autonomy, and it will require minimum site preparation for easy deployment in cases of emergency and natural disasters.
The pneumatic building envelope will be composed of a multifunctional three-layer membrane system:

- **Outer layer**, consisting of PTFE (polytetrafluoroethylene) coated glass fabric cells inflatable to 30 psi (2atm). Cells are basic elements of all systems in living nature; intensive research programs on cell-based pneumatic structures have been developing in the past 15 years in academic and industrial settings [Hensel, Menges and Weinstock, 2010]. The PTFE membrane is chosen for its high tensile strength, resistance to abrasion, atmospheric aging, corrosion and fire—it is also chemically inert. A modular array of Photovoltaic PV-Flex film will be overlaid, or encapsulated, in the PTFE fabric's southern surfaces to maximize direct incident sunlight exposure and energy generation.
- **Middle layer**, consisting of structural Kevlar reinforced tubing inflatable to 120 psi (8atm). These will be arranged on a dual-lattice to provide structural redundancy (for security) and anisotropic orientation to control morphological adaptation by pressure differential. A secondary distributed pattern of carbon fiber stays and Kevlar tendons will be considered for additional control and balance of the structural system's flexibility and stiffness.
- **Inner layer**, consisting of sound absorbing (70%NRC), low-E (infrared) coated fabric with defined light transmission and acoustical properties. This layer will be sensitive and responsive to physiological aspects of human comfort, cultural competence and integrative aesthetics: visual, acoustic, haptic and other sensorial properties—which may be capable of systematic fine-tuning. In addition, this layer will operable and manipulable directly by the users by low-tech means.

The envelope will be partitioned into individually inflatable cells that will enable it to morph (eventually automorphing via intelligent control software) and function in response to local conditions through sensing of light, pressure, and temperature. The partitioning into cells will provide a high level of stability and fault tolerance. Each pillow will contain a low-cost pressure sensor/actuator pair and a simple communication mechanism responsible for assessing the state of its neighbors [Enikov and Lazarov, 2003]. In addition, for safety reasons, the pressure sensors will enable pressure relief of the pressurized enveloped in response to variable climate and temperature changes. The response of each pillow will be controlled by a low-cost sensor/actuator printed or woven into the fabric. The principle of emergent behavior will be utilized to control the shape and function of the inflatable surface. Resultant effects include minimizing or maximizing the solar gain by local regulation of pressure in the inflated pillow leading to change in the shape of the building envelope. Similarly, regulation of light intensity inside the building will be controlled by the response of an array of autonomous apertures integrated into each pillow of the fabric. Communication between neighboring cells could be wired or wireless. Commercial solutions include using a 1-wire interface circuit as a means to serially transfer data between multiple slave nodes (sensors) and a data-logging device (master). The protocol allows a large number of sensing nodes to be attached to a single wire, which is also used to provide power to them. An alternative solution is the use of low-frequency wireless communication akin to the RFID tag technology that allows passive operation, i.e. the transponding sensor is powered by the electromagnetic field of the transmitter/receiver. Since selecting the size and power of the two coils can control the range of transmission, it is possible to fabricate transmitter/transponder pairs that operate locally between two adjacent cells, thus avoiding collision between multiple sensors. Finally, interior retractable layered partitioning will be endowed with thermal, acoustic and haptic functions using porous, air and water filled composite acoustic materials.

2. Sensing: Integrated sensors for pressure, strain, temperature, humidity, and carbon dioxide content are key to providing the adaptive function of the TMU. Additionally, a large number of low-cost wireless pressure and strain sensors integrated into the building envelope are needed in order to provide feedback from each of the pneumatic compartments comprising the envelope. Under this task, we will develop a low-cost integrated sensing module based on wireless radio frequency identification technology (RFID). An example of such sensor for measuring ambient temperature was developed by co-PI Enikov under previous NSF Support (NSE Career Award DMI-0134585 and BES-0603198) [Enikov and Seo, 2007]. This unit utilizes a 125-KHz RFID wireless sensing tag and consumes only 40 µW of power. The wireless interface is designed to measure resistance change and can be modified to measure pressure, strain, and gas concentration by replacing the thermistor with a piezo-resistive transducer. The following sensing elements will be integrated into the building envelope using the proposed RFID wireless detection scheme.

- **Embedded strain gauges for control of pneumatic inflation:** Traditional strain gauges are based on thin metal foil attached to a polymeric substrate which is subsequently bonded to the structural element whose deflection is being monitored. The main drawbacks of these sensors are their low gauge factor (about 1-2) and their relatively large size due to the low resistivity of metal films. More recently, semiconductor gauges based on poly-crystalline and amorphous Si have been demonstrated [Servati & Nathan 2005]. Their gauge factors are 20-80 times higher with much smaller dimensions (a fraction of a millimeter). One recent development by BF Goodrich has led to a hybrid solution, where Si strain gauges are heterogeneously integrated into a polymeric substrate. This type of strain gauge is particularly suitable for integration into the building envelope since it can be directly spliced onto the pneumatic cells.
- **Pressure Sensor:** Pressure sensors are now well-established tools in life-science automation. Most pressure sensors utilize a deformable membrane with integrated strain- or displacement-sensing elements. The classical Si pressure sensor was first developed by Kurtz and Goodman in the early 1970s [Kurtz & Goodman, 1974]. It is based on anisotropic etching of Si, which results in a truncated pyramid forming the cavity of the sensor. The pressure is measured by (typically) four piezo-resistive elements, placed at the location of highest stress and forming a Wheatstone bridge. These pressure sensors will be an integral part of the control system of the pneumatic envelope as well as ensuring safe pressure conditions in the CAES.
- **Humidity Sensor:** In humidity measurement (hygrometry), it is common to measure one of several interrelated parameters: relative humidity, water vapor pressure and the dew point temperature. These are interrelated. Micro-humidity sensors typically utilize an electronic or ionic (proton) conductivity change as a result of moisture absorption [Rittersma 2002] in porous ceramics or polymers. The proton-based humidity transduction mechanism utilizes the increase of conductivity due to water physisorption or capillary condensation in micro-pores [Nitta 1981, Sudo 1980], while the electronic-based humidity transduction involves donation of an electron to a n-type semiconductor through a hydrolysis step of the chemisorbed water [Seiyama et al 1983,Yamazoe & Shimizu 1986] Other technologies are based on resistive humidity sensors. Given our prior experience with water ion-exchange membranes [Enikov & Seo, 2005], and the fact that unlike semi-conductive transducers, the resistance of these membranes is not light-sensitive, we propose to integrate thin-film resistive sensors based on Nafion ion-exchange resin. Recent reports confirm the feasibility of this approach [Kuban et al 2004].
- **Temperature Sensor:** Temperature sensing is a mature field within the sensor industry. The most commonly devices are thermocouples (TC-s), resistance temperature detectors (RTD-s), thermistors, and diode temperature sensors.
- **Carbon Dioxide Sensor:** Traditionally, measurements of CO_2 is based on the use of an aqueous solution in contact with the unknown sample. Since CO_2 reacts with water to produce carbonic acid, the pH of the aqueous solution can be used to measure the amount of CO_2. The electrode based on this principle was developed by Severinghaus and Bradley [Severinghaus & Bradley, 1958]. Unfortunately, these sensors are bulky and expensive to produce and miniaturize. Recent progress in MEMS photoacoustic sensors have led to the demonstration of a novel CO_2 sensor based on photoacoustic measurements. These sensors rely on a well-known Beer-Lambert law. To detect CO_2 concentration, MEMS photo-acoustic sensors utilize a CO_2 -filled reference cavity. The decrease of IR intensity is detected via ultra-sensitive micro-machined pressure sensor (microphone) in contact with the reference cavity containing the absorbing gas (CO_2). An attempt to procure commercial product from SINTEF Inc. will be made in order to reduce the cost of this task.

3. Energy storage and management: The proposed off-grid TMU will utilize solar energy as its primary source of energy. Solar is the largest energy resource in Arizona and it can provide clean and sustainable energy. With an estimated surface area optimally exposed to sun light of approximately 100m^2, the envelope will have a targeted power production of approximately 10kW (considering a conservative estimate of flexible PV efficiency of 10%). However, solar energy is intermittent, and as such, it often cannot provide temporally consistent electricity. Furthermore, energy supply (sunshine) and energy demand do not match temporally, and the matching gap changes with seasons, Effective energy storage solutions need to be developed to supply consistent power and meet the variable energy demand of the TMU.

Some of the most established energy storage methods include compressed air, thermal storage and batteries, each offering unique ranges of response time, capacity, charge time, efficiency, uncertainty behavior, and cost. Compressed air energy storage (CAES) is a mature technology and offers design flexibility and low carbon footprint. At present, CAES offers low cost for capacity ($/kW) and for energy ($/kWh), increased hours of storage and extended life cycle as compared to batteries. CAES is an *environmentally-benign storage solution* that is geographically-unconstrained. It can be a network of decentralized, fuel-free, above-ground CAES units, whose cumulative volume is solely dependent on the number and size of these units (therefore scalable), and which can be used in conjunction with photovoltaic (PV) solar generation of energy and other storage media such as passive thermal storage and electrochemical batteries. While primarily based on CAES, the proposed TMU will also utilize a storage system based on hybrid technology for redundancy (primarily CAES complemented by thermal and electrochemical storage) [Lemofouet and Rufer, 2006]. This will provide a robust system capable of meeting the constantly varying energy demands of the TMU and offer the redundancy necessary for the critical activities of the Telemedicine program. In this context, we propose to employ solar-power driven, energy-efficient (>75%), scalable, air compressor modules that can be specifically tailored to power the envelope's functions of the TMU and provide additional compressed air energy storage to power some of the telemedicine unit appliances that can run solely on compressed air — such as water circulating system, air conditioning units or via electric energy generation. This energy storage system will be complemented by recycled lithium-ion batteries (these batteries still retain 80% of their original capacity and offer a low cost energy storage complement to CAES for system's redundancy). Water reservoirs will provide passive means of storing thermal energy that will be distributed via the CAES-driven water circulation system.

The CAES system will include a variety of components, namely high efficiency compressor modules, storage units, and energy compressed air motors/turbines for energy recovery. The compressor system will be readily scalable to operate and power the TMU by association of several modules in parallel or in series. The compressor prototype will be designed to operate as an open compression cycle system under isothermal conditions, carried out in a slow quasi-static fashion, thereby greatly reducing power consumption during compression — as compared to standard industrial air-compressors that function under adiabatic conditions [Lemofouet-Gatsi, 2006]. A low-cost, environmentally benign modular compressor unit, which can be used in conjunction with off-grid stand-alone photovoltaic cells, has already been built and tested.

The compression module is specifically designed to, (1) be operational under isothermal conditions (stroke speed ~ 60 rpm and energy conversion efficiency of ~80%), (2) be mechanically robust, and (3) minimize energy losses due to friction. The system uses a unique chemically inert, high thermal conduction fluid piston [Muralidharan and Deymier, 2009]. The solar-energy driven compressor modules will also serve several functions: (1) permit the deployment of the pneumatic TMU, (2) maintain air pressure in the pneumatic structure during operation, and (3) store excess solar energy into additional high pressure compressed air storage tanks. The proposed units are capable of compressing air at pressures raging from 8 Atm (to inflate the envelope middle layer structural components) up to 30Atm (for higher density compressed air energy storage). It is not desirable to exceed this pressure for safety and pressurized tank regulation reasons. This upper limit enables also the use of safe and low-cost commercially available tanks. The low-pressure compressed air stored in middle layer of the pneumatic building envelope will serve as a storage buffer pressure reservoir for multistage compression at significantly higher pressure into commercially available solid storage tanks located in the footings of the unit (25m^3 minimum capacity).

An important design criterion is the energy stored in a volume V, $E = V(\frac{\gamma}{\gamma-1}P_f\left[1-(\frac{P_a}{P_f})^{\frac{\gamma-1}{\gamma}}\right])$,where γ is the polytropic index (1 for isothermal and 1.4 for adiabatic conditions), P_a is the ambient pressure and P_f is the storage pressure. For operations under adiabatic conditions; in terms of feasibility, a 25m^3 storage at 30 Atm has a maximum energy capacity of 48 kWh, which corresponds to an ideal power delivery capacity of 4.8 kW over a period of 10 hours. Isothermal conditions will provide an additional 40% in energy stored. Even assuming a loss of 40 % during recovery (due to turbine and air-regulator operations), the system enables a net power of 2.9 kW over a 10 hour period. The multistage approach involving several compressed reservoirs at intermediate pressures (low pressure middle layer envelope, high pressure tanks) enables higher efficiency in the conversion of solar energy into compressed air in the event of loss of isothermal compression conditions. The low pressure envelope (cells and middle layer) may also enable higher efficiency in multi-staging the pressure regulation for the energy recovery systems.

Indeed an important objective of the proposed research is to examine efficient energy recovery from the CAES system. We will examine the viability of our compressor prototype to function as a single-stage compressor/motor dual unit. A prime advantage of such a dual unit would be the reduction of energy losses, due to fewer moving parts/components required for the multi-stage conversion of solar-energy to compressed-air, to air-powering or electrical powering. However, we will also investigate commercially available alternative solutions to convert compressed air energy to mechanical energy and eventually to electrical energy using high efficiency commercially available turbines (e.g. 12kW recovered at 4 Atm, in the case of Quasiturbine Pneumatic turbines (Quasiturbine Inc.) with room temperature 80% pressure flow energy conversion efficiency). In this type of systems, the energy output scales approximately as the square of the pressure and would result in a recovery of 3kW at the 2Atm pressure of the air stored in the envelope's cells.

4. Integrative Modeling System: Energy demand shows long- as well as short-range temporal fluctuations in addition to requiring a range of response times. Capture of solar energy can have short-term, large-scale fluctuations (e.g. from scattered clouds) and long-term intermittency (e.g. from extended severe weather). The proposed energy storage will be part of a complex system that includes energy production and energy demand. This system involves a multiplicity of temporal scales and a variety of energy capacity, storage technologies and scales. Thus, efficient storage and energy recovery calls for a systems approach to its design and operation that accounts for all the complex interactions between energy demand, solar energy supply, energy storage technologies and factors affecting the interactions such as weather changes, season changes.

As part of the integrated software system that will drive the telemedicine unit, we propose to design an optimization model to manage PV energy supply, to control storage of energy, decide what type of storage technologies to be used and at what scale (e.g. compressed air, thermal, or electrochemical), in response to energy production and demand. The model will consider the capacity, response time and efficiency of the various storage and energy recovery systems. Several uncertainties such as the demand profile (considering the seasonality effect) and weather conditions in both the short- and long-term will be incorporated in the system design. Both energy demand and solar energy production form, mathematically, non stationary processes with fluctuations over a wide range of temporal scales. This makes the design of an energy storage system a multiscale problem. Time-frequency methods, such as wavelet based methods, will provide effective tools for analysis of multiscale data acquired from a variety of sensors (light, pressure, temperature, capacity and charge). Importantly, a dynamic version of the energy management system will update information from small- and large-scales, which will enable predictive capabilities for continuously adjusting dynamic forecast of energy demand and solar energy input forecast.

In this work, we propose a data driven, simulation-based planning and control approach as the basis for the management framework to optimize energy usage based on existing and predicted resource availability and usage requirements. In the planning phase, the simulation evaluates different control policies to govern the energy system (generators, storage units, appliances, and water systems) based on the current sensor readings (e.g. generation; weather information; demand). Once the planning stage is complete and a control policy is selected, the framework switches to the control phase, where the management framework 1) uses the control rules to make real-time decisions to coordinate among the physical components in the system, 2) compares predicted performance with actual performance from sensor data collected in real-time, and 3) adapts to the sensor data when the actual performance deviates substantially from the predicted performance and determines when to change the control policy and/or underlying models.

Furthermore, hardware-software feedback monitoring disjunctions and/or synergies between human activity and building mimesis will be accomplished via multi-paradigm simulation methodologies (system dynamic, agent-based model, dynamic system). These methodologies will be employed to develop simulation models of the key components of the proposed sustainable building, namely the environment, the power generating pressure-driven envelope, energy storage modules, water storage and circulation system, ventilation, sensor network, telemedicine appliances and facilities and human occupants. In particular, a system dynamic model will be developed to represent an environment (solar irradiance, cloud pattern, pressure, temperature, humidity, among others). Agent-based models will be developed to represent culture-specific human responses (involving synthetic cognitive model) as well as the proposed automorphic partitioned building envelope. Dynamic system models will be developed to represent energy flow, air pressure and airflow, and water in the building. An interoperable computational platform will be developed based on web service technology for integration of hybrid and distributed models. This platform will enable integration of heterogeneous simulation models, optimization engine, hardware, and autonomous systems [Rathore et al., 2005; Lee et al., 2008].

From early programming to post occupancy evaluation Building Information Models (BIM) will enable us to actualize a more robust paradigm based on collaboration and transparency. The sharing of increased amounts of information will allow effective communication to a large design team: architects, engineers and consultants, but also incorporating manufacturers, contractors and sub-contractors into the process to create more integration with the final output. Part of this process will involve generative, parametric and algorithmic design models, which will be optimized through various analyses software with real time monitoring. Digital models will facilitate our iterative prototyping/CNC fabrication process. The models will also provide the ability to analyze a building according to its systems: climate, structure, skin, services and assembly techniques. The design model will be focused on making sure that performance is optimized technically. Iterative models can be budgeted accordingly: recognizing the importance of addressing maintenance and repair costs, thermal insulation properties and life expectancy.

5. Cultural Competence and User Comfort: From a human occupant point of view, the TMU serves three functions:

1. Bringing health care to people in remote communities, specifically those living on reservation land in Arizona;
2. Teaching Native American (NA) people to serve as technical staff, thereby bringing technical knowledge and jobs to those in remote communities; and simultaneously providing staff with whom the NA patients will be familiar and more comfortable and can converse in their native tongue regarding concepts and phrases that are at best, difficult to translate
3. Interacting with those in remote communities to determine how best to maintain their long term health.

During the first 4 - 6 months of the project, we will establish a Tohono O'odham Community Advisory Group (CAG). At a minimum, the CAG will be comprised of at least one District Chairperson and two elders from the outlying, more traditional districts/communities, one representative from the Chairman's Office and one representative from the Health Department. The CAG will share equally in the interactive surveys, planning, implementation, evaluation, and results dissemination phases. Utilizing the best practices for community-based participatory processes with Native communities (Davis & Reid, 1998; Macaulay et al, 1998; Norton & Manson, 1996), we will work to balance the needs and desires of the community with those of the investigators in order to establish trust, to develop culturally competent health spaces and practices, and to empower the community to assume ownership of the process, and to utilize the results to improve their quality of life.

In order to provide adequate services, the TMU must be culturally competent. A culturally competent investigative process requires substantive and methodological insertions and adaptations designed to mesh the process with the cultural characteristics, values, beliefs and needs of the TON (Rogler, 1989). We will do this by developing a culturally informed process; by working with the CAG and the community to plan the process, share information about the collection of data, the translation of instruments, the instrument measures, and the analyses and interpretation of data. We anticipate that the cultural competence of the building will greatly affect patients' willingness to use it, personal comfort while using it, and the likelihood the patient will return and will recommend the facility to others. We expect that the patients' comfort levels will be affected by physical features of the buildings' exterior and interior spaces (e.g., dimensions and furnishings of exterior and interior spaces, temperature, light, and sound levels maintained in various parts of the building) as well as by the information they receive on the TMU and the methods by which it is delivered. In what follows, we consider both of these aspects in turn.

To determine physical design features of the TMU's exterior and interior spaces, we plan to:

1. Use CAG and community focus groups in the planning process to determine the ideal size and shape of the interior and exterior spaces, as well as the physical appearances, such as color schemes, the

presence of culturally relevant art and fixtures, photographs of culturally appropriate events to be used for medical examinations, for consultation with physicians, and for health education. Physical plant considerations will also have to respect the TON cultural need for privacy. In addition, because we are aware that human preference for particular spaces often runs counter to what would be considered optimal conditions, we will also ask the CAG and community members to provide their opinions on the temperature, light, and sound levels they would find most comfortable in the spaces used for various functions in the TMU. We plan to continue discussions with the Tohono O'odham CAG throughout the project to gather additional preference data as it emerges, and as it is needed.

2. Because people are not always conscious of the influence of temperature, light, and sound levels on their feelings of well-being, and hence, are not always able to articulate their preferences when outside those settings (or even when inside them), we plan to supplement the information, gained in numeral (1) above, with human-in-the-loop interactive surveys in the Arizona Laboratory for Immersive Visualization Enviroment (AzLIVE). These surveys will allow us to collect quasi-real human response data in a practical way [Lee and Son, 2008; Shendarkar et al., 2008]. We plan to involve NA participants of various ages (young, middle-aged, and older participants) as well as Telemedicine and HIS and Health Tribal staff in determining their comfort, stress levels, and preferences within virtual environments of various shapes and with various temperature, sound, and light levels. Some participants will be engaged at least twice, once without wearable monitors and once while wearing monitors that measure physiological indices of stress –- e.g., galvanic skin response (GSR); and heart rate variability (HRV) monitors [Phukan 2009, Teller and Crossly 2009, Bhiwapurkar et al. 2009]. These physiological indices measure participants' stress levels directly and are uncontaminated by socio-cultural factors that might affect participants' stated preferences.

A Bayesian belief network (BBN) will be employed to represent the perception of an individual within each of these groups [Lee and Son, 2008]. The BBN is a cause-and-effect network whose nodes represent the variables (e.g. environmental conditions and human responses), and whose arc directions encode the conditional dependencies and cause-effect relationship between variables. In this portion of the project, we will leverage our computational (Son) and psychophysical (Peterson) expertise to develop models of the culture-specific human responses in the proposed sustainable building. These human response models (e.g. BBN), once constructed, will be integrated with other models of the key components of the proposed sustainable building (e.g. the power generating pressure-driven envelope, energy storage modules, water storage and circulation system, ventilation, etc.) to allow us to perform what-if analyses involving alternative designs under dynamically changing environmental conditions. In addition, we can compare the responses of those who wear the monitors to those who do not to determine whether wearing the monitors changes response. These surveys will take place during the months 8 - 20 of the project (see Schedule section).

If the preliminary studies show that wearing the GSR and HRV monitors does not increase stress levels, and in consultation with CAG, we will plan to have interested visitors to the TMU wear these monitors when they come in for their medical treatments. The monitors will be interfaced with the control units in the TMU so that temperature, light and sound levels can be adjusted online to increase patients' comfort levels. It is noted that this online adaptation is innovative, which would not be possible with low-level static means. If a patient shows high stress levels, a native speaker, could then ask them if they could explore and articulate what they believe to be causing their discomfort and could then unobtrusively adjust the environmental factor(s) accordingly and the device would document and transmit whether or not the change had a positive, a negative or no effect. The continued use of the wearable monitors would allow us to continue to gather responses to the real environment throughout its lifetime so these physical properties of the TMU can be changed as seasons change, or as years pass. We will also investigate the possibility of using non-invasive sensing technologies (such as infra-red thermal sensors) to provide non-invasive means of integrating human sensitivity into the adaptive TMU system.

A Diagram of System Components discussed above and Integrative Modeling is shown below in Figure 4.

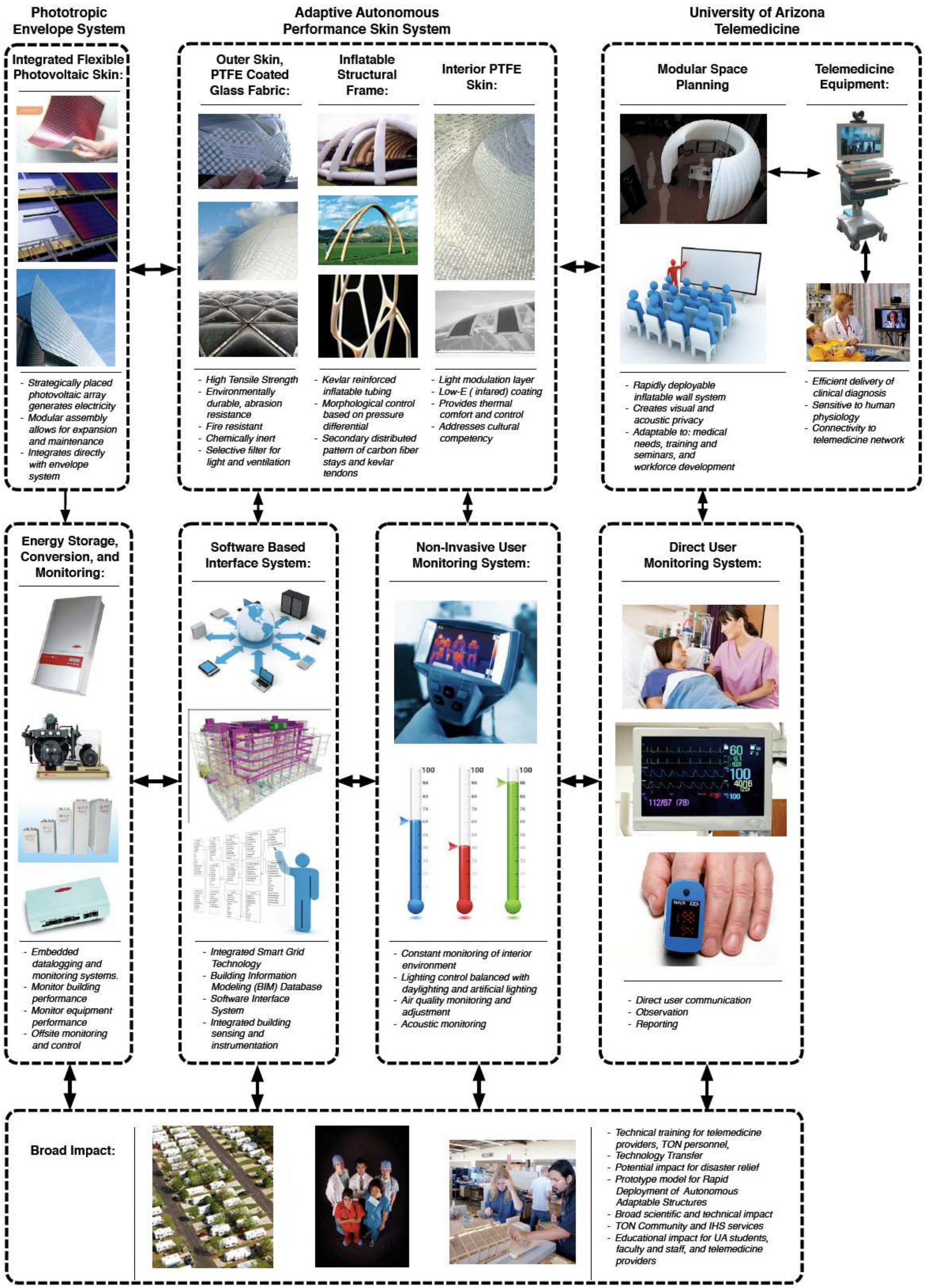


Figure 4: Diagram of System Components and Integrative Modeling

F. Impact: This project will have scientific and technical impact, impact on community and education.

1. Scientific and technical impact: The proposed research introduces a new paradigm in built environments and will serve as a catalyst for initiating a transformation in the way engineers and architects will design and operate future sustainable buildings. The advances that will result from the proposed research on autonomous, performance, adaptive and sensitive structures will not only impact the development of telemedicine buildings but also the broader field of engineered sustainable buildings. The research on pneumatic envelopes with automorphic and phototropic properties will provide key insights into the engineering, technical and materials aspects of adaptive building. Insight gained from the study of energy production and energy storage by integrating flexible photovoltaic cells and compressed air storage/hybrid storage within the building envelope will help establish the principle of *autonomy*. The integration of new micro and macro sensor technologies into the building that can respond to environmental, structural and human factors will enable the design of a *sensitive* building. The development of model-based *multi-paradigm simulations* for real-time management of the complex interactions between flow of resources and human occupant establishes the foundation for *integrative modeling* of architectural design, engineering systems, operational building needs, human physiological and psychological comfort, and cultural sensitivity.

2. Impact on community: The focus of the proposed research on telemedicine building will have a significant impact on the Native American communities as well as on its health service provider (Indian Health Service (IHS)). IHS is an agency within the Department of Health and Human Services responsible for providing federal health services to 1.9 million American Indians and Alaska Natives (AI/AN) who are members of 562 federally recognized tribes throughout the United States. The IHS is the principal federal health care provider and health advocate for Indian people and its goal is to raise their health status to the highest possible level. The proposed project will serve as a flagship in demonstrating commitment in the development of state-of-the-art sustainable energy efficient building for Native American health care. The impact of the proposed research on the IHS employees and populations served will be significant. IHS services are administered through a system of 12 Area offices and 161 IHS and tribally managed service units. 71% of the IHS' 15,676 employees are Native American. As of 2008, the distribution of those employees, among the health professions categories is approximately: 836 physicians, 2,356 nurses, 302 dentists, 533 pharmacists, 429 engineers and 299 sanitarians. The Arizona Telemedicine Program was founded by the Arizona legislature in 1996. To date, over 1,000,000 teleconsultations have been conducted resulting in enhanced clinical care for Arizona's population. The initial 8 vanguard sites have expanded to over 100 sites statewide.

3. Impact on National Needs/Grand Challenges.

In addition to its proposed programmatic use as a TMU, the autonomous adaptive sustainable structure could also serve as a prototype light-weight portable building for use by federal agencies dealing with disaster mitigation, preparedness, response and recovery planning in cases of national and international emergencies and natural disasters. Representatives of the Tohono O'Odham Nation have also indicated interest in potential extension of the development of the TMU to housing modules. The proposed technological and ecological innovations could therefore also be effectively transferred to the prefabricated and mobile home building industry segments.

We also note that the proposed research will impact at least three of the national Academy of Engineering Grand Challenges in Engineering, namely: "Make solar energy economical", "Restore and improve urban infrastructure," and "Advance health informatics."

4 Educational Impact: Management of the EFRI team will be conducted within a philosophical framework emphasizing the exchange of ideas and expertise through experiential interaction with many disciplines. This project will serve as a vehicle to promote scientific and technical multi-linguism and to enhance graduate student's understanding of the role of knowledge integration, transfer and creation. This philosophy requires that graduate students work jointly with faculty from different disciplines to form task-oriented teams reflecting the multidisciplinary nature of the challenge. This team will create a "virtual education and research unit" without departmental or individual faculty boundaries in order to better accomplish its educational and research objectives. Weekly meetings between members of the team will be institutionalized to become interactive critical design reviews during which the junior members (junior faculty, graduate students) will receive mentoring and guidance from the entire team. Each student will present an oral report as the focus of these design reviews two (2) times per semester. In addition, faculty members of the team will present synthesized activity reports to the overall team monthly. These monthly mini-workshops will be advertised and open to the entire University of Arizona, IHS and TON communities. This synergistic interaction will culminate with a national workshop to be hosted by the EFRI team in the fourth year of the program. The workshop will be open to the academic and business community as well as citizen communities and its intent is to foster dialogue on the scientific, technical, and business aspects of sustainable buildings in general and of autonomous adaptive structures in particular. Separate funding will be sought to support the development of this national workshop.

Intervention of team members in Undergraduate/Graduate level courses such as ARC 461i/561i "Materials: properties and testing" will disseminate new knowledge gained through the proposed project to a wider audience of students. We also recognize that undergraduates are the scientists, engineers, and business executives of the future, the proposed project will support the involvement of undergraduate students. Students participating in this program will be heavily recruited from under-represented groups with emphasis on individuals from the ethnically diverse population of the Tucson community. Recruiting efforts will be facilitated by the University of Arizona's strong commitment to recruitment of minority students. Towards this end, we will be assisted by and we will work closely with the Director of the Multicultural Engineering Program in the College of Engineering, the Associate Dean of the Graduate College, the Coordinator of the Multicultural Programs and the Director of the American Indian Graduate Center. Discussions have already begun between EFRI team and the TON to provide educational and technical training to students enrolled in the Tohono O'odham Community College with the aim of developing a workforce for operating and maintaining the proposed telemedecine unit as well as getting involved in potential economic development related to technological discoveries made as part of this project. We will work closely with the University of Arizona's Office of Technology Transfer and the TON to promote joint technology and economic development. Separate supplemental funding will be sought to support the research experience for undergraduate students.

G. Scheduling of Tasks and Component

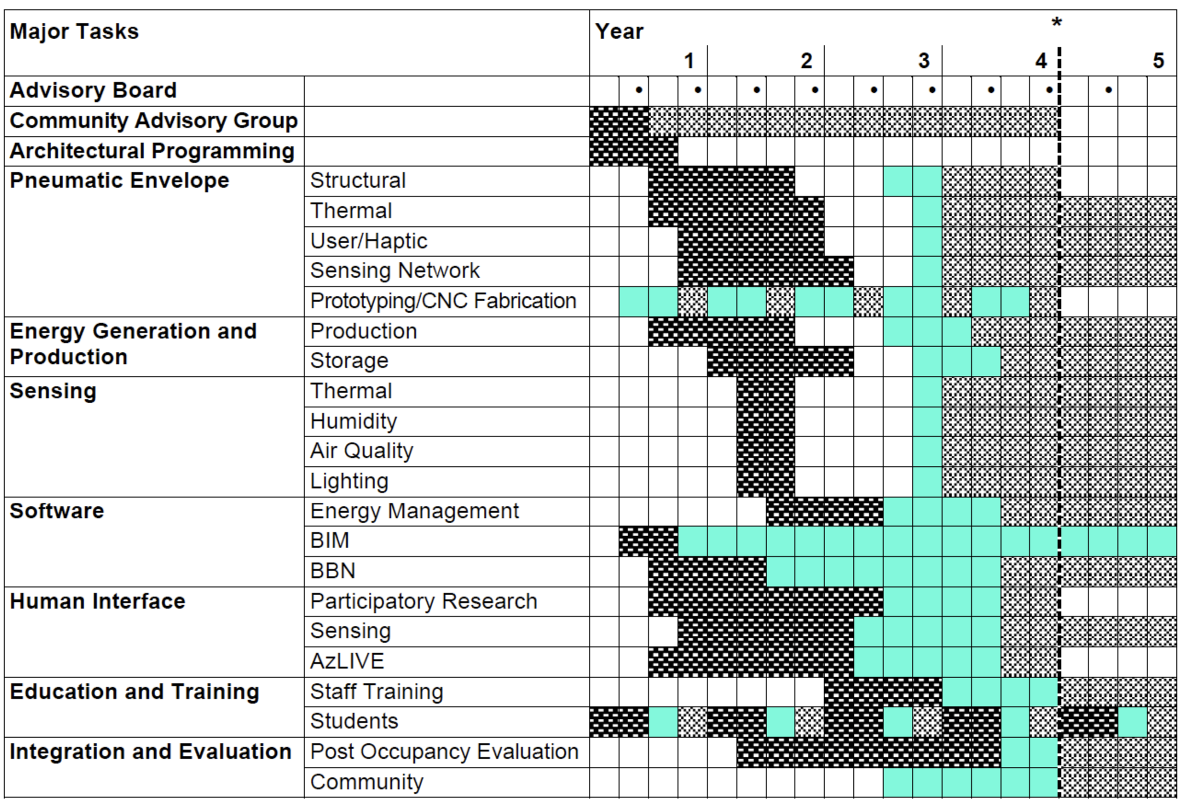
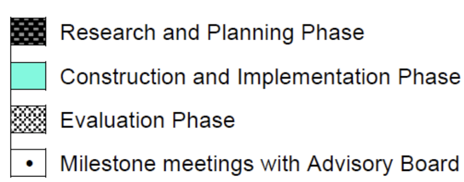


Figure 5. Schedule: Major Tasks and Distribution of Effort

* Notice: For certain tasks the schedule will extend beyond the 4 year period



G. Personnel and Management

1. List of Key Personnel and Synergies

Name	Department, School or College	Expertise
E. Brody	Medicine	Clinical Services/Native American Cardiology
P.A. Deymier	Sustainable Engineered Systems	Materials, Energy Storage, Sustainability
S. Dickinson	Architecture	Building Information Modeling (BIM)
E. Enikov	Aero. Mechanical Engineering	Sensors and sensor networks
S. Fryberg	Psychology	Cultural and Social Psychology
A.M. López	Medicine	Telemedicine
Á. Malo	Architecture	Emerging Materials Technologies in Architecture
K.Muralidharan	Materials Science and Engr.	Compressed air energy storage. Storage systems
M. A. Peterson	Psychology, Cognitive Science	Cognition and Neural Systems
Y.J. Son	Systems Industrial Engineering	Model-based multiparadigm simulations

Figure 6: Table showing list of key personnel in alphabetical order

The proposed project will be conducted by an interactive multidisciplinary team of senior and junior faculty members and graduate students from the fields of architecture, engineering (materials science, aerospace & mechanical, systems & industrial), psychology & cognitive sciences, and medicine (Telemedicine). To bring this project to a successful completion, we will integrate senior and junior faculty into task oriented subteams, namely:

(a) Subteam of architecture faculty (A. Malo (senior faculty), S. Dickinson (Junior faculty), M. Gindlesparger (Arizona Research Institute for Solar Energy (AzRISE)), P. Musters (Prototyping/CNC Materials Lab)) supervising one graduate student.

(b) Subteam of psychology and cognitive science faculty (M. Peterson (senior faculty), S. Fryberg (junior faculty)) supervising a psychology graduate student,

(c) Subteam of engineering faculty (P. Deymier (senior faculty), E. Enikov (mid career faculty), K. Muralidharan (junior faculty) and Y.J. Son (mid career faculty)) supervising three graduate students.

(d) Telemedicine needs are represented by a senior faculty member of the College of Medicine and Director of the Arizona Telemedicine program, A.M. Lopez and E. Brody (mid career faculty) with an advisory role in telemedicine.

The project will be conducted through horizontal integration of experience (student, junior and senior faculty) but also vertical integration of expertise to address individual aspect of the project and attribute of the proposed TMU, namely:

1. Research on pneumatic envelopes with automorphic and phototropic properties for *adaptive* building (Malo, Enikov, Deymier, Lopez)
2. Energy production and energy storage to establish the principle of *autonomy* (Deymier, Enikov, Malo, Dickinson, Muralidharan, Son)
3. Integration of new micro and macro sensor technologies as components of the design of *sensitive* building. (Enikov, Peterson, Son)
4. Model-based multi-paradigm simulations for building control for *integrative modeling* (Son, Peterson, Fryberg, Dickinson, Lopez)
5. Participatory community design (Malo, Brody, Fryberg and CAG/IHS)

2. Management structure and organization

EFRI-AAPSIS research will be led by the PI and Co-PIs who bring expertise managing large research projects, managing multidisciplinary teams of researchers and scientists, identifying and organizing multidisciplinary collaborations, interacting with communities and community leaders and as well as developing innovative educational initiatives. The PI, with assistance from the Co-PIs, will oversee the research and education activities through periodical interactions with the participating faculty, students and staff. The PI will have as one of the primary responsibility overseeing interactions between the research sub-teams and collaborating institutions such as IHS, AzRISE. The PI and Co-PIs are also responsible for maintaining relations between the EFRI team and the Tohono-O'odham community. An advisory board will provide bi-annual input to the team as to the progress and direction of the project. The

Advisory board will be composed of leading representative of the constituencies with direct interest in the success of the project. The Advisory board will assist the research team in the following:

- To advise and assist EFRI-AAPSIS in meeting its objectives and goals.
- To provide a continuing source of information and insight on scientific, technical, cultural and educational challenges and opportunities.
- Help EFRI-AAPSIS adapt its strategies and if necessary its goals.
- Advise EFRI-AAPSIS in the assessment of its progress.

Through consultation with Tribal leaders, leaders of IHS and industry leaders, we have identified the following core members of the Advisory Board:

- Gary Quinn, Executive Director- Dept. health and Human Services, Tohono O'odham Nation
- Dorothy Dupree, IHS/TUC Director, or alternate George Bearpaw, IHS/TUC Executive Officer
- Ardeth Barnhart, Co-Director, Arizona Research Institute for Solar Energy (AzRISE)
- Nick Goldsmith, Senior Principal FTL Design Engineering Studio
- Buro Happold Consulting Engineers/Los Angeles
- Steve Turcotte, President Advanced Ceramics Manufacturing (ACM), a Tohono O'odham majority owned enterprise located in the TON-San Xavier Reservation

This EFRI organizational and management structure is summarized in the figure below. It includes details of the University of Arizona disciplines and institutes supporting this project as well as the facilities and industries that will support the proposed research.

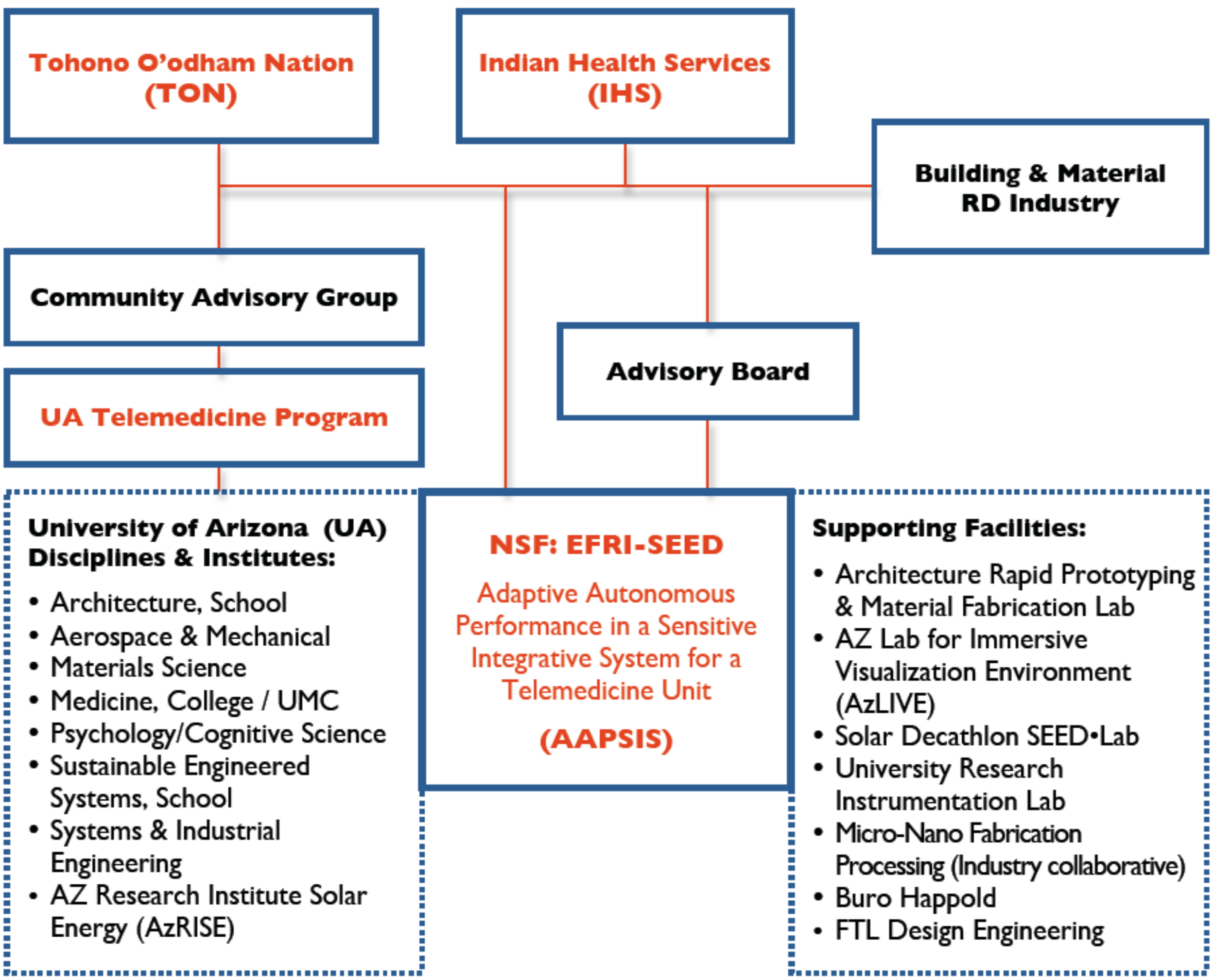


Figure 7: Organization and Management flow-chart

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A. EDUCATION

- July 1982: Engineer Degree, Materials Science, Institut des Sciences de l'Ingenieur, Université des Sciences et Techniques du Languedoc, Montpellier, France
- July 1985: Ph.D., Ceramics, Massachusetts Institute of technology, Cambridge, MA, Dissertation title: Molecular Dynamics of Grain Boundary Phase Equilibria, Dissertation Advisor: G. Kalonji

B. APPOINTMENTS

- Aug. 2009, Director, School of Sustainable Engineered Systems
- Jan. 2006, Member of the BIO5 Institute, the Univ. of Arizona
- Jan. 2001-Aug. 2009: Associate department head, Department of Materials Science and Engr., University of Arizona, Tucson, AZ
- Aug. 1997-to date: Professor, Department of Materials Science and Engr., University of Arizona, Tucson, AZ
- Aug. 1991-Aug. 1997: Associate professor, Department of Materials Science and Engr., University of Arizona, Tucson, AZ
- Aug. 1985-Aug 1991: Assistant professor, Department of Materials Science and Engr., University of Arizona, Tucson AZ
- Sept. 1995-Aug. 1996: Invited Professor, Université des Sciences et techniques de Lille I, Laboratoire de Structure et Dynamique des Matériaux Moléculaires, Lille, France
- May 1989-July 1989: Invited "Maitre de Conférences," Université des Sciences et Techniques de Lille I, Laboratoire de Dynamique des Cristaux Moléculaires, Lille, France
- May 1988-July 1988: Visiting professor, Université des Sciences et Techniques de Lille 1, Laboratoire de Dynamique des Cristaux Moléculaires, Lille, France
- June 1986: Visiting professor, Massachusetts Institute of Technology, Department of Materials Science and Engineering, Cambridge, Massachusetts
- July 1984-Jan. 1985: Invited scientist, Max Planck Institut fur Metallforschung, Institut fur Werstoffwissenschaften, Stuttgart, Germany

C. PUBLICATIONS

116 refereed journal articles out of > 130 publications.

Five most closely related publications

1. K. Muralidharan, P.A. Deymier, C. Deymier, D. Villela, S. de Valle, « High efficiency compressed air energy storage module « Invention Disclosure, University of Arizona 2009.
2. J. Bucay, E. Roussel, J.O. Vasseur, P.A. Deymier, Y. Pennec, A-C. Hladky-Hennion, Krishna Muralidharan, and B. Djafari-Rouhani, "Positive, Negative, Zero Refraction and Beam Splitting in a Solid/air Phononic Crystal: a theoretical and experimental study," Phys. Rev. B 79, 214305 (2009)
3. A. Sukhovich, B. Merheb, , K. Muralidharan, J.O. Vasseur, Y. Pennec, and P.A. Deymier, J. Page "Experimental and theoretical evidence for subwavelength imaging in phononic crystal, " Phys. Rev. Lett. 102, 154301 (2009)
4. J.-F. Robillard, O. Bou Matar, J. O. Vasseur, P. A. Deymier, M. Stippinger, A.-C. Hladky-Hennion, Y. Pennec, and B. Djafari-Rouhani, "Tunable magnetoelastic phononic crystals," Appl. Phys. Lett. 45, 124104 (2009)
5. J.O. Vasseur, P.A. Deymier, B. Chenni, B. Djafari-Rouhani, L. Dobrzynski and D. Prevost, "Experimental and theoretical evidences for the existence of absolute acoustic band gaps in two-dimensional solid phononic crystals," *Phys. Rev. Lett.* 86, 3012 (2001).

Five other significant publications

1.Javier S. Castro, Bartosz Trzaskowski , Pierre A. Deymier, Jaim Bucay, Ludwik Adamowicz, and James H. Hoying, "Binding Affinity of Fluorochromes and Fluorescent Proteins to Taxol Crystals," Mat. Sci. Engr. C. 29, 1609 (2009)
2.B. Traskowski, L. Adamowicz and P.A. Deymier, "A theoretical study of zinc(II) interactions with amino acid models and peptide fragments," J. Inorg. Biol. Chem., 13,133 (2008).
3. J.O. Vasseur, A-C. Hladky-Hennion, B. Djafari-Rouhani, F. Duval, B. Dubus Y. Pennec and P.A. Deymier, "Waveguiding in two-dimensional piezoelectric phononic crystal plates," J. Appl. Phys.10, 114904 (2007).
4. Xinya Zhang, T. Jackson, E. Lafond, P. Deymier and J. Vasseur, "Evidence of Surface Acoustic Wave Bandgaps in Phononic Crystals created on Thin Plates," Applied Phys. Lett. 88, 041911 (2006).
5. J.O. Vasseur, P.A. Deymier, M. Beaugeois, Y. Pennec, B. Djafari-Rouhani, and D. Prevost, "Experimental observation of resonant filtering in a two-dimensional phononic crystal waveguide," *Zeischrift for Krystallography* 220, 829-835 (2005).

D. SYNERGISTIC ACTIVITIES

As part of the educational component of a NSF-NIRT program I emphasize the revolutionary and interdisciplinary nature of the nanotechnology paradigm through creation of the NanoTechnology Track (NTT) of study. Through collaboration between the College of Engineering and Mines and the University of Arizona' Eller College of management, the NTT attempts to integrate the scientific, engineering and business aspects of nanotechnology into a program that emphasizes the transition between research ideas and consumer products.

E. COLLABORATORS

US Collaborators

J. Hoying[1], S. Raghavan[2], G. Frantziskonis[2], W. Beck[2], J.H. Simmons[2], K. Muralidharan[2], K. Runge[3]

1 University of Louisville; 2 University of Arizona; 3 University of Florida, Gainesville.

Graduate Advisees

J. Harris, J. Weinberg, H. Evans, R. Harrison, E. Amavisca, C.Y. Lee, G.E. Jabbour, V. Iyer, I. Vasquez, V. Campos, Ki-dong Oh, F.J. Cherne III, H. Chandra, T. Lin, Krishna Muralidharan, Vivek Kapila, Greg Martin, Y. Yang, M. Jabbour, J.S. Castro.

Graduate Advisor

G. Kalonji, UC Santa Cruz.

BIOGRAPHICAL SKETCH
Eniko T. Enikov, Ph.D.
Associate Professor

Aerospace and Mechanical Engineering Department	tel: 520-621-4506
University of Arizona	fax: 520-621-8191
1130 N. Mountain	e-mail: *enikov@engr.arizona.edu*
Tucson, Arizona 85721-0119	

Professional Preparation

Technical University of Budapest	Mechanical Engineering	BS,MS, 1992-93
University of Illinois at Chicago	Mechanical Engineering	Ph.D. 1998
University of Minnesota	MEMS	Postdoctoral 1999-2000

Appointments

08/06 – Present	Associate Professor, Univ. of Arizona, Aerospace and Mechanical Engineering
08/07-12/07	Guest Professor, Budapest University of Technology and Economics, Fulbright Scholarship
01/07-05/07	Guest Professor, Swiss Federal Institute of Technology, Zurich, Institute of Robotics and Intelligent Systems.
08/00 – 08/06	Assistant Professor, Univ. of Arizona, Aerospace and Mechanical Engineering
12/98 – 08/00	Postdoctoral Associate, Dept. of Mechanical Engineering, University of Minnesota
8/94 – 12/98	Research Assistant in the Microengineering Applications Laboratory, Univ. of Illinois at Chicago
6/97 –9/97	Intern in the Hospital Products Division of Abbott Laboratories, Abbott Park, Illinois

Publications

(i) Five Publications Relevant to the Proposal

Enikov, E.T. and Makansi, T. "NanoAnalysis of nanometer vacuum gap formation in thermo-tunneling devices," *Nanotechnology*, v. 19, 2008, doi:10.1088/0957-4484/19/7/075703

Enikov, E. and Stepan, G.: Microchaotic Motion of Digitally Controlled Machines. *Journal of Vibration and Control* v.4, p. 427-443, 1998.

Stepan, G, Enikov, E., Muller, T., "Nonlinear Dynamics of Computer Controlled Machines," Romansy 11: Theory and Practice of Robots and Manipulators, Eds. Morecki, Bianchi and Rzymkowski, CISM Courses of Lectures No. 381, , Springer, p. 80-88, 1997

Stepan, G, Enikov, E., Haller, G., "Dynamics of digitally controlled machines," IUTAM Symposium on Interaction between Dynamics and Control in Advanced Mechanical Systems, Ed. Van Campen, D.H.,p.391-398, 1997

Enikov, E.T. and Palaria, "Charge writing in silicon-silicon dioxide for nano-assembly," *Nanotechnology*, Vol. 15,Issue 9, Pages 1211-1216, 2004.

(ii) Five Other Significant Publications

Palaria A and Enikov, E.T., "Experimental analysis of the stability of electrostatic bits for assisted nano-assembly," *Journal of Electrostatics*, v. 64, p. 1-9, 2006.

Enikov, E.T., Pau, S., “Capstone Design Project on Optical MEMS: A Vehicle for Interdisciplinary Research and Learning,” *Proceedings of ICEE International Conference on Engineering Education*, Sept. 3-7, 2007, Coimbra, Portugal

Vikramaditya, B., Nelson, BJ., Yang G., Enikov ET, "Microassembly of Hybrid Magnetic MEMS," *Journal of Micromechatronics*, 1(2), 2001.

Enikov. ET and Lazarov, K. V., “An optically transparent gripper for micro-assembly”, *Journal of Micromechatronics* Vol. 2, No. 2, p 121-140, 2003

Enikov. ET and Lazarov, K. V., “PCB-integrated metallic thermal micro-actuators,” *Sensors and Actuators A: Physical* vol.105,no.1,pp .76 –82, 2003.

Synergistic Activities:

Professional societies

1994 – present	American Society of Mechanical Engineers (ASME)
1994-1996	American Mathematical Society (AMS)
1999-present	International Society of Optical Engineering (SPIE)

Reviewer service:

Journal of Materials Manufacturing and Processing Science
Sensors and Materials
Journal of Micromechanics and Microengineering
Journal of Micro Electromechanical Systems
Nanotechnology Journal

Collaborators & Other Affiliations

Collaborators

Hecht, Mathias - Materials & Electrochemical Research Corporation, Tucson, Arizona
Roberts, Kenneth – University of Minnesota, Dept. of Reproductive Biology
Gonzales, Gilbert – Memorial Sloan-Kettering Cancer Center, New York
Gholam Peyman – Department of Ophthalmology, University of Arizona
Tareo Makansi – Trempronics Inc.

Graduate and Postdoctoral Advisors

Boyd, James G. - Texas A&M University (Ph.D. Thesis Advisor)
Nelson, Bradley J. –University of Minnesota (Postdoctoral Advisor)

Thesis Advisor and Postgraduate-Scholar Sponsor

Kalin Lazarov - University of Arizona
Geon Seo – University of Arizona
Deepak Agrawal - University of Arizona
Shantanu Kedar - University of Arizona
Amritanshu Palaria - University of Arizona
Kai Deng – University of Arizona
Jenny Taubert – University of Arizona
Joshua Scott - University of Arizona
Edward White - University of Arizona
Total number of graduate students advised: 9

Ana Maria López, MD, MPH, FACP
Associate Dean for Outreach and Multicultural Affairs
Professor of Medicine and Pathology
Medical Director, Arizona Telemedicine Program
alopez@azcc.arizona.edu

A. Education
1982, AB, Bryn Mawr College, Bryn Mawr, PA
1988, MD, Jefferson Medical College, Philadelphia, PA
1994, MPH, University of Arizona, Tucson, AZ

B. Positions and Honors
Positions and Employment
2003-present Associate Professor of Clinical Medicine and Pathology, University of Arizona
2007-present Associate Dean for Outreach and Multicultural Affairs, University of Arizona

Other Experience, Professional Memberships and Honors
Experience:

Research:
2000-present Member, Governor's Commission on the Health Status of Women and Families in Arizona, Phoenix, AZ
2002 Chair, Research and Policy Subcommittee
2000 Member, Access to Health Subcommittee.
2003-present Member, University of Arizona, National Centers of Excellence (CoE) in Women's Health; Co-Chair
2003-2006 Member, Steering Committee, Arizona Comprehensive Cancer Control Coalition
2003-present Member, Access to Health Subcommittee

Education:
1996-present Member, Rural Health Advisory Committee, COM, University of Arizona
1997-present Course Coordinator, 4th year Women's Health elective
2000-present Course Coordinator, 4th year- Telemedicine elective
2005 Curriculum Reviewer, 2nd Edition Reproductive Health Initiative
2005-present Gender-specific medicine curriculum threads designer –
2005-present Cancer curriculum block director

Honors:

2004-2005	Leadership Fellow, National Hispanic Medical Association (NHMA) presented by the Robert F. Wagner Graduate School of Public Service, New York University, NY City, N.Y.
2005	Award for Outstanding Contributions to the Advancement of Latino Health through Research & Education – presented by Redes En Acción, The National Latino Council on Alcohol, and The University of Utah – Huntsman Cancer Institute.
2006	Local Legends Award: Women Physicians who have changed the face of medicine in our Community. Sponsored by the AMWA and the National Library of Medicine. www.nlm.nih.gov/locallegends/Biographies
2006	Gold Award in Videoconferencing. Telehealth. "Distance Education Breast Cancer Curriculum for Promotoras in Southern AZ" US Distance Learning Association CO.
2002-2006	Best Doctors in America (Featured on cover - Tucson Lifestyle, June 2006)
2007	Selected to participate in Executive Leadership in Academic Medicine, American Association Medical Colleges, Philadelphia, PA

C. Selected peer-reviewed publications (in chronological order).
1.Anderson GL, Judd HL, Kaunitz AM, Barad DH, Beresford SAA, Pettinger MS, Liu J, McNeeley SG,

López AM. (2003). Effects of Estrogen Plus progestin on Gynecologic Cancers and Associated Diagnostic Procedures. The Women's Health Initiative Randomized Trial.*Journal of the American Medical Association* 290:#13 pp 1739-1748.
2.López, AM, Avery, D, Krupinski, E, Lazarus, S, Weinstein, RS. (2005) Increasing Access to Care Via Tele-Health: The Arizona Experience. *The Journal of Ambulatory Care Management.* Jan-March 2005. 28:1, pp 16-23.
3.Barker G, Krupinski E, NcNeely R, Holcomb MJ, **López AM**, Weinstein RS. (2005)The Arizona Telemedicine Program business model. *Journ. Of Telemedicine and Telecare* 2005; 11:397-402.
4.Thompson CA, Arendell LA, Bruhn RL, Maskarinec G, **López AM**, Wright NC, Moll CE, Aickin M, Chen Z. (2007) Pilot study of dietary influences on mammographic density in Hispanic and non-Hispanic white pre and post-menopausal women. *Menopause* 2007 Mar-Ap; 14 (243-50).
5. Aragaki A, Chen Z, Bassford T, Chlebowski R, López AM, Mouton C, Maricic M.(2007). Fracture Risk Increases after Cancer Diagnosis in Postmenopausal Women: Results from the Women's Health Initiative*. Journal of Bone and Mineral Research* Volume 22 pages 77-77 Published 2007 Article #1274.
6.Margolis KL, Rodabough RJ, Thompson C, López AM**,** McTiernan A (2007). A Prospective Study of Leukocyte Count as a Predictor of Incident Breast, Colorectal and Endometrial Cancer and Mortality in Postmenopausal Women*. Archives of Internal Medicine* 2007 September 24; 167 (17): 1837-44.
7.Weinstein R**, López AM,** Barker G, Krupinski E, Beinar S, Major J, Skinner T, Holcomb M, McNeely R (2007). Arizona Telemedicine Program Interprofessional Learning Center: Facility Design and Curriculum Development. *Journal of Interprofessional Care*, October 2007; 21 (S2): 51-63
8.Martinez ME, Nielson CM, Nagle R, **López AM**, Kim C**,** Thompson P. Breast Cancer Among Hispanic and Non-Hispanic *Women in Arizona.Journalof Health Care for the Poor and Underserved* Volume 18, Number 4, pp 130 - 145.
9.Weinstein RS. **López AM**, Krupinski EA, Beinar SJ, Holcomb M, McNeely RA, Latifi R, Barker G (2008). Integrating telemed. and Telehealth: Putting it all Together. *Stud Health Technol Infor*.2008;131:23-38.
10. Chen Z, Maricic M, Aragaki AK, Mouton C, Arendell L, **López AM,** Bassford T, Chlebowski RT. (2008) Fracture risk increases after diagnosis of breast or other cancers in postmenopausal women: results from the Women's Health Initiative. *Osteoporosis Int.* 2008 Sep 3.
11. Alberts, Davis S.; P.Y. Liu, Sharon P. Wilczynski, Mary C. Clouser, **López, AM**, David P. Michelin, Victor (2008) J. Lanzotti. Rand. Trial of Pegylated Liposomal Doxorubicin Plus Carboplatin vs. Carboplatin in Platinum-Sensitive Patients with Recurrent Epithelial Ovarian or Peritoneal Carcinoma After Failure of Initial Platinum-Based Chemotherapy, *Gynecol Oncol*. 2008 Jan; 108(1):90-4.
12. Larkey, L.K., **López, AM,** Minnal, A., Gonzalez, J. Storytelling versus Numeric Risk Communication for Promoting Colorectal Cancer Screening among Latinas. Cancer Control. January 2009.
13. Millen A, Rosenberg C, Wactawski-Wende J, Freudenheim J, Duffy C, Lane D, Langer R, McTiernan A, Rahmani Y, Kuller L, **López AM**, Pettinger M. Incident invasive breast cancer, geographic location of residence and reported average time spent outside. Cancer Epidemiology, Biomarkers & Prevention. 2009 Feb 3; 18 (2): 495-507.
14. Marman M, Moon J, Wilczynski S, **López AM**, Rowland KM, Michelin DP, Lanzotti VJ, Anderson GL, Alberts DS. Single Agent Carboplatin Versus Carboplatin plus Pegylated Liposomal Doxorubicin in Recurrent Ovarian Cancer: Final Survival Results of a SWOG (SO200) Phase 3 Randomized Trial. Gynecology Oncology. 2010 Mar:116(3):323-325.

Research Support - Ongoing Research Support
Coordinated Cancer Screening and Diagnosis Model - NIH-NCI – SBIR - Role: PI
To facilitate early colorectal cancer (CRC) detection by developing a care coordination system.
Home Centered Coordinated Cancer Care System - NNIH-SBIR - Role: PI
To develop and evaluate the benefits of a core coordination model for breast cancer.
Telenursing Model for Management - NIH /NINR - SBIR - Role: PI
To develop a proactive telenursing system for lymphoma patients.
¡Vida! Breast Cancer Education for Survivors & Health Care Providers via Telemedicine - National Susan G. Komen for the Cure Foundation – Role: PI To develop, deliver, and evaluate culturally and linguistically competent Breast Cancer education for Breast Cancer Survivors and Health Care Providers.

Álvaro Malo

Registered Architect, NCARB
Director & Professor, Emerging Material Technologies Graduate Program
School of Architecture, University of Arizona, Tucson, AZ 85721-0075
Phone 520.621.6752 Fax 520.621.8700
malo@u.arizona.edu http://architecture.arizona.edu/people/faculty/node/77

EDUCATION

Degrees and Diplomas

1971 M. Arch., Louis I. Kahn's Studio University of Pennsylvania, Philadelphia, PA
1969 Post-graduate Design Diploma, Bouwcentrum, Rotterdam, Holland
1967 Professional Architect's Diploma, Arquitectura, Universidad de Cuenca, Ecuador

Continuing Education

1990 Graduate Seminar on Aesthetics, Philosophy Columbia University, New York, NY
1989 Graduate Seminar on Criticism, Columbia University, Philosophy New York, NY
1988 Graduate Seminar on Aesthetics, Columbia University, Philosophy New York, NY

AWARDS & HONORS

2003 Association of Collegiate Schools of Architecture, Service Award
1998 Distinguished Public Service Award, City of Miami Beach, Florida
1969-1971 Fulbright Scholarship, Graduate Architecture, U. of Pennsylvania, Philadelphia, PA
1969-1971 University Scholarship, Graduate Architecture, U. of Pennsylvania, Philadelphia, PA
1969 Netherlands Government Fellowship, Postgraduate, Bouwcentrum, Rotterdam, Holland
1967 Decoration, Casa de la Cultura, Ecuador
1967 Decoration, best graduating architecture student, Universidad de Cuenca, Ecuador
1965 Sponsored Architectural travel in the USA, Department of State, USA

ACADEMIC APPOINTMENTS

2006-date Professor, Emerging Material Technologies, Architecture, U. of Arizona, Tucson, AZ
1998-2006 Professor, Director, School of Architecture, U. of Arizona, Tucson, AZ
1994-1998 Associate Professor, Director, Miami Architecture Research Center, U. Florida, Miami, FL
1990-1993 Associate Professor, Architecture, University of Pennsylvania, Philadelphia, PA
1986-1990 Associate Professor, Architecture, Columbia University, New York City, NY
1979-1986 Assistant Professor, Architecture, SUNY at Buffalo, Buffalo, NY
1976-1979 Assistant Professor, Architecture, Director CCD, U. of Colorado, Denver, CO

TEACHING

1998-date **University Arizona**
Materials: Modeling, 2007-date
Materials: Properties & Tests, 2006-date
Emerging Material Technologies Design Lab, 2005-date
Capstone Project, 1999-date

RESEARCH

Sponsored Projects

2010 "Autonomous Adaptive Performance in a Sensitive and Integrative System (AAPSIS) for a Telemedicine Unit, UA matching federal funds earmark. Value $1,200,000; Co-PI's: Á. Malo (Architecture); P. Deymier (Sustainable Engineered Systems); A.M. López (Medicine); E. Enikov (Aerospace & Mechanical Engineering); M. Peterson (Psychology).

2010 "Autonomous Adaptive Performance in a Sensitive and Integrative System (AAPSIS) for a Telemedicine Unit," Final Proposal. Value $2,068,430 over 4 years; NSF/EFRI Co-PI's: Á. Malo (Architecture); P. Deymier (Sustainable Engineered Systems); A.M. López (Medicine); E. Enikov (Aerospace & Mechanical Engineering); M. Peterson (Psychology).

2008 "Solar Decathlon '09." Dates: 01/08-06/09. Value $100,000;US Department of Energy/National Renewable Energy Laboratory. CoPI's: J. Simmons, D. Clifford, Á. Malo, L. Medlin, J. Vollen.

2008 "Solar Decathlon '09." Dates: 01/08-06/09. Value $100,000; funding matching AzRISE. CoPI's: J. Simmons, D. Clifford, Á. Malo, L. Medlin, J. Vollen.

2003 «International Design Symposium on Urban Design in Arid Zones." Dates: 05/25/03. Value $ 5,000; Vice Provost Research, U. of Arizona. Co-PI's: Á. Malo and I. San Martin.

2001 "Rio Nuevo MFD: Graduate and/or Married Student Urban Housing." Dates 08/24/01-12/14/01. Value $21,048.22; funding, City of Tucson. Co-PI's: Á. Malo and I. San Martin.

2001 "Rio Nuevo MFD: Sustainable Urban Design – Outdoor Space Analysis." Dates 01/17/01-05/14/01. Value $18,195.00; City of Tucson. Co-PI's: Á. Malo and F. Matter.

2000 "Rio Nuevo Multipurpose Facilities District: Urban Design Proposals." Dates 08/29/00-12/11/00. Value $11,582; funding, City of Tucson. Co-PI's: Á. Malo and R. Hershberger.

1997 "Miami Intermodal Center (MIC): Hi-Speed Rail Terminal." Dates 09/03/96-06/28/97. Value $71,650; funding, FDOT, District VI. PI: Á. Malo.

1997 "Bayside / Arena 2 Station of the E-W S.R. 836 Multimodal Corridor." Dates: 09/03/96-06/28/97. Value $71,650; funding, FDOT District VI, PI: Á. Malo

1997 "27th Avenue Station of the E-W S.R. 836 Multimodal Corridor." Dates 09/03/96-06/28/97. Value $67,450, funding, FDOT, District VI. PI: Á. Malo.

1996 "Miami Intermodal Center / Miami International Airport," (spatial and structural design of building envelope responsive to multi-modal transportation technologies). Dates: 09/03/95-06/28/96. Value $25,830.00, funding, FDOT District VI. PI: Á. Malo.

1996 "East-West S.R.836 Multimodal Corridor," (urban elevated train structural guideway). Dates, 09/03/95-06/28/96.Value $34,755, funding, FDOT District VI. PI: Á. Malo.

PUBLICATIONS

Peer-reviewed papers

2010 "Sensitive Apertures," Third International Conference on Harmonisation Between Architecture and Nature, La Coruña, Spain, April 2010

2007 "A desert land ethic: aesthetic research," Hawaii International Conference on Arts and Humanities, Honolulu, Hawaii.

2003 "Matter and Memory," Proceedings ACSA 2003 International Conference, Helsinki, Finland.

2000 "Intermodalities of Miami: Public Transportation Projects," Proceedings ACSA 2000 International Conference, Hong Kong, China.

1996 "Intermodalities of Miami," Technical Seminar: Interactions Between Airport and Town, XIX Congress International Union of Architects, UIA 96 Barcelona, Spain

Citations

2009 J. Laver, K. Winn, "EcoCeramic Research," *Archiprix*, Rotterdam/Montevideo: 010 Publishers, 2009 http://www.archiprix.org/2009/?project=2577

2007 W. Jenski, "Porous Adaptive Membranes," *Archiprix*, Rotterdam/Shanghai: 010 Publishers, 2007, p. 114-115 http://www.archiprix.org/2009/?project=2279

2005 "Modernism Comes Home to Tucson", *Architectural Record*, November 2005, p. 69

LECTURES AND PRESENTATIONS

2009 "Emerging Materials," Declination 9º 42' – Solar Fusion 2009, AzRISE, Tucson, AZ
2008 "Perspectives: On Glass," W&W Glass/Pilkington and TriPyramid Structures,Tucson, AZ
2008 "Material Ecologies," U. South Florida, Tampa, FL
2008 "Architecture and Engineering: asymptotic paths," U Pennsylvania, Philadelphia, PA

THESIS DIRECTOR/ADVISOR

2009 B.Vander Werf, "Elastic Systems for Compliant Shading Structures"
2009 E. Hall, "Plastics and Architectural Ecologies: Polymer Trombe Wall"
2009 A. Toth, "Bamboo—Flexegrity"
2008 J. Laver, "High Performance Building Envelopes"
2008 B. McDonald, "Sensitive Apertures"
2007 W. Jenski, "Porous Adaptive Membranes: Thermostatic Composite Systems for a Self-Regulating Architecture"
2007 M. Rees, "Eco-Clean Dwelling"
2006 A. Falco, "Architecture as a New Textile: a Study of Woven Composite Construction"

PUBLIC AND INSTITUTIONAL SERVICE

2009-2010 Indian Health Services/Tohono O'odham Nation, Telemedicine building research.
2007 Fulbright Senior Specialists Program, Referee.
2006 The MacArthur Fellows Program, Nominator.
2004 The MacArthur Fellows Program, Peer Reviewer.
2003 ACSA 2002 International Conference, Topic Co-Chair: Urban Planning, Havana, Cuba.

BIOGRAPHICAL SKETCH

NAME: MARY A. PETERSON
POSITION TITLE: Professor, Department of Psychology and Research Social Scientist in Cognitive Science, University of Arizona, Tucson, AZ 85721

EDUCATION

1978 - 1984	Columbia University, Ph.D., Psychology
1968 - 1972	Marymount Manhattan College, B.A., English Literature

PROFESSIONAL EXPERIENCE

2000 – present	Professor, Department of Psychology, and Research Social Scientist in Cognitive Science, *The University of Arizona*
1995 - 2002	Director, Cognitive Psychology Program, *The University of Arizona*
1992 - 2000	Associate Professor, Department of Psychology, and Associate Research Social Scientist in Cognitive Science, *The University of Arizona*
1988 - 1992	Assistant Professor, Department of Psychology, and Assistant Research Social Scientist in Cognitive Science, *The University of Arizona*
1983 - 1988	Assistant Professor, Department of Psychology, *State University of New York at Stony Brook*
1978 - 1983	Graduate Faculty Fellow, Psychology Department, *Columbia University*

PUBLICATIONS
(i) 5 publications most closely related to the proposed project

Peterson, M. A. & Salvagio, E. (2008). Inhibitory Competition in Figure-Ground Perception: Context and Convexity. *Journal of Vision, 8(16): 4, 1-13.* http://www.journalofvision.org/8/16/4/

Peterson, M. A. (2007). The Piecemeal, Constructive, and Schematic Nature of Perception. In M. A. Peterson, B. Gillam, H. A. Sedgwick (Eds). *In the Mind's Eye: Julian Hochberg's Contributions to Our Understanding of the Perception of Pictures, Films, and the World.* Pp. 419-428. NY: Oxford University Press.

Burge, J., Peterson, M. A., Palmer, S. E. (2005). Ordinal configural cues combine with metric disparity in depth perception. *Journal of Vision, 5(6*), 534-542. http://www.journalofvision.org/5/6/5/

Peterson, M. A., & Rhodes, Gillian (2003). *Perception of Faces, Objects, and Scenes: Analytic and Holistic Processes.* New York: Oxford University Press.

Bloom, P., Peterson, M. A., Nadel. L., & Garrett, M. F. (1996). *Language and Space.* Cambridge, Mass: MIT Press.

(ii) 5 other significant publications (whether or not related to the proposed project

Gothard, K., Brooks, K., & Peterson, M. A. (2009). Multiple perceptual mechanisms of face processing in macaque monkeys. *Animal Cognition*,12 (1), 155-167.

Peterson, M. A. & Skow, E. (2008). Suppression Of Shape Properties On The Ground Side Of An Edge: Evidence For A Competitive Model Of Figure Assignment. *Journal of Experimental Psychology: Human Perception and Performance, 34 (2),* 251-267.

Kimchi, R. & Peterson, M. A. (2008). Figure-ground Segmentation Can Occur Without Attention. *Psychological Science, 19(7),* 660-668.

Behrmann, M., Peterson, M. A., Suzuki, S., & Moscovitch, M. (2006). Independent representation of parts and the relations between them: Evidence from integrative agnosia. *Journal of Experimental Psychology: Human Perception and Performance,* 32(5), 1169-1184.

Peterson, M. A. & Skow-Grant, E. (2003). Memory and learning in figure-ground perception. In B. Ross & D. Irwin (Eds.) *Cognitive Vision: Psychology of Learning and Motivation, 42,* 1-34.

SYNERGISTIC ACTIVITIES

1. *Teaching:* I am committed to training students from under-represented groups: Many of my graduate students have been women, 3 have been Mexican-American (2 M; 1 F); I serve as the Psychology Honors Advisor at the University of Arizona: 1995-present, mentoring approximately 30 honors students and advising up to 50 honors students per year (I received the Outstanding Honors Advisor Award 3 X: 2000, 2007, & 2008); I advise undergraduate students in the NSF-funded Undergraduate Biology Research Program at the University of Arizona; I integrate research into my large undergraduate class (140 students).
2. *Women in Cognitive Science:* Advisory Board Member (2003 – present)*;* Chair of the Travel Award Committee (2003 – 2006); Participant in Annual Meetings at the Psychonomics Society; Panel Moderator (2007).
3. *Vision Sciences Society*: Board of Directors (2005 – 2009)
4. *Psychonomics Society*: Chair of the Governing Board (2009); Governing Board Member (2005-2010); Chair of the Publications Committee (2008); Publications Committee Member (2005-2008).
5. *Series Co-Editor,* with Gillian Rhodes, *Advances in Visual Cognition,* Oxford University Press.

COLLABORATORS (Last 48 months)
Marlene Behrmann, Carnegie Mellon University
Shlomo Bentin, Hebrew University
Johannes Burge, UC Berkeley
Barbara Gillam, University of Sydney
Ruth Kimchi, University of Haifa
Morris Moscovitch, University of Toronto
Lynn Robertson, UC Berkeley
Hal Sedgwick, City University of New York
Satoru Suzuki, Northwestern University
Luca Tommasi, University of Chieti

GRADUATE ADVISOR
Julian Hochberg

THESIS ADVISOR AND POSTGRADUATE-SCHOLAR SPONSOR (other than current)
Postgraduate Scholar sponsor
Peter Gerhardstein (Associate Professor, Psychology Department, Binghamton University, SUNY)
Robert Rauschenberger (Siemens, Corporation, Princeton, NJ)
Satoru Suzuki (Associate Professor, Psychology Department, Northwestern University)

Ph.D. Thesis advisor:
Gary Chon-Wen Shyi (Professor, Psychology Department, National Chung Chen University)
Bradley S. Gibson (Associate Professor, Psychology Department, Notre Dame University)
Emily Skow Grant (Assistant Professor, Psychology Department, Simpson College)
Logan Trujillo (Post-doctoral Fellow, University of Texas, Austin)

M.A. Thesis Advisor:
Hollis Weidenbacher (Research Associate, University of Arizona)
Erin Harvey (Assistant Professor, Ophthalmology Department, University of Arizona)

Elliot Sprecher	Sabrina Geoffrion
Elizabeth P. Merikle	Jee Hyun Kim
Logan T. Trujillo	Melissa Schulz
Abrie Schroeder	Elizabeth Salvagio

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION: **University of Arizona**				FOR NSF USE ONLY	
				PROPOSAL NO.	DURATION (months): Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Pierre A Deymier**				AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Pierre A Deymier - PI	0.00	0.00	0.30	$ 5,184	$
2. Eniko T Enikov - Co-PI	0.50	0.00	0.00	5,262	
3. Other Faculty - Senior Investigators	0.00	0.00	2.50	26,310	
4. Ana Maria Lopez - Co-PI	0.00	0.00	0.25	6,006	
5. Alvaro Malo - Co-PI	0.00	0.00	0.50	6,763	
6. (1) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.50	5,662	
7. (6) TOTAL SENIOR PERSONNEL (1 - 6)	0.50	0.00	4.05	55,187	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (5) GRADUATE STUDENTS				111,185	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				166,372	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				55,760	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				222,132	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				5,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				115,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				115,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				342,132	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) MTDC (Rate: 51.5000, Base: 311445)					
TOTAL INDIRECT COSTS (F&A)				160,394	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				502,526	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 502,526	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME: **Pierre A Deymier**	FOR NSF USE ONLY		
	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*: **Mary Gerrow**	Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET COMMENTS - Year 1

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Peterson, Mary - Co-PI	0.00	0.00	0.50	5662

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION **University of Arizona**			FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Pierre A Deymier**			AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Pierre A Deymier - PI**	0.00	0.00	0.30	$ **5,340**	$
2. **Eniko T Enikov - Co-PI**	0.50	0.00	0.00	**5,421**	
3. **Other Faculty - Senior Investigators**	0.00	0.00	2.50	**27,099**	
4. **Ana Maria Lopez - Co-PI**	0.00	0.00	0.25	**6,186**	
5. **Alvaro Malo - Co-PI**	0.00	0.00	0.50	**6,966**	
6. (**1**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.50	**5,833**	
7. (**6**) TOTAL SENIOR PERSONNEL (1 - 6)	0.50	0.00	4.05	**56,845**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**5**) GRADUATE STUDENTS				**114,521**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**171,366**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**57,433**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**228,799**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**5,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**115,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**115,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**348,799**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 51.5000, Base: 317192)**					
TOTAL INDIRECT COSTS (F&A)				**163,354**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**512,153**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **512,153**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME **Pierre A Deymier**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Mary Gerrow**	Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 2

Other Senior Personnel Name - Title	Cal	Acad	Sumr	Funds Requested
Peterson, Mary - Co-PI	0.00	0.00	0.50	5833

SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION University of Arizona				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Pierre A Deymier				AWARD NO.	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Pierre A Deymier - PI	0.00	0.00	0.30	$ 5,500	$
2. Eniko T Enikov - Co-PI	0.50	0.00	0.00	5,583	
3. Other Faculty - Senior Investigators	0.00	0.00	2.50	27,912	
4. Ana Maria Lopez - Co-PI	0.00	0.00	0.25	6,372	
5. Alvaro Malo - Co-PI	0.00	0.00	0.50	7,175	
6. (1) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.50	6,007	
7. (6) TOTAL SENIOR PERSONNEL (1 - 6)	0.50	0.00	4.05	58,549	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (5) GRADUATE STUDENTS				117,956	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				176,505	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				59,156	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				235,661	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				5,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				115,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				115,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				355,661	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) MTDC (Rate: 51.5000, Base: 323105)					
TOTAL INDIRECT COSTS (F&A)				166,399	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				522,060	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 522,060	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				
PI/PD NAME Pierre A Deymier	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION				
ORG. REP. NAME* Mary Gerrow	Date Checked	Date Of Rate Sheet		Initials - ORG	

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET COMMENTS - Year 3

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Peterson, Mary - Co-PI	0.00	0.00	0.50	6007

SUMMARY PROPOSAL BUDGET

YEAR 4

ORGANIZATION **University of Arizona**				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Pierre A Deymier**				AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Pierre A Deymier - PI**	0.00	0.00	0.30	$ **5,665**	$
2. **Eniko T Enikov - Co-PI**	0.50	0.00	0.00	**5,751**	
3. **Other Faculty - Senior Investigators**	0.00	0.00	2.50	**28,749**	
4. **Ana Maria Lopez - Co-PI**	0.00	0.00	0.25	**6,563**	
5. **Alvaro Malo - Co-PI**	0.00	0.00	0.50	**7,391**	
6. (**1**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.50	**6,188**	
7. (**6**) TOTAL SENIOR PERSONNEL (1 - 6)	0.50	0.00	4.05	**60,307**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**5**) GRADUATE STUDENTS				**121,194**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**181,501**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**60,821**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**242,322**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**5,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**115,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**115,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**362,322**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 51.5000, Base: 328872)**					
TOTAL INDIRECT COSTS (F&A)				**169,369**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**531,691**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **531,691**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME **Pierre A Deymier**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Mary Gerrow**	Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Arizona

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Pierre A Deymier

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Pierre A Deymier - PI**	0.00	0.00	1.20	$ **21,689**	$
2. **Eniko T Enikov - Co-PI**	2.00	0.00	0.00	**22,017**	
3. **Other Faculty - Senior Investigators**	0.00	0.00	10.00	**110,070**	
4. **Ana Maria Lopez - Co-PI**	0.00	0.00	1.00	**25,127**	
5. **Alvaro Malo - Co-PI**	0.00	0.00	2.00	**28,295**	
6. (**1**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	2.00	**23,690**	
7. (**6**) TOTAL SENIOR PERSONNEL (1 - 6)	2.00	0.00	16.20	**230,888**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**20**) GRADUATE STUDENTS				**464,856**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**695,744**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**233,170**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**928,914**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**20,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**460,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**460,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**1,408,914**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**659,516**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**2,068,430**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **2,068,430**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Pierre A Deymier

ORG. REP. NAME*
Mary Gerrow

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Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification:

The proposed research is labor intensive and will be conducted by an interactive multidisciplinary team of senior and junior faculty members and graduate students from the fields of architecture, engineering (materials science, aerospace & mechanical, systems & industrial), psychology & cognitive sciences, and medicine (Telemedicine). To bring this project to a successful completion, we will integrate senior and junior faculty into task oriented subteams, namely (a) a subteam of architecture faculty (A. Malo (senior faculty), S. Dickinson (Junior faculty)) jointly supervising an architecture graduate student, (b) a subteam of psychology and cognitive science faculty (M. Peterson (senior faculty), S. Fryberg (junior faculty)) supervising a psychology graduate student, (c) a subteam of engineering faculty (P.Deymier (senior faculty), E. Enikov (mid career faculty), Y.J. Son (mid career faculty) and K. Muralidharan (Junior faculty)) supervision three graduate students. Telemedicine needs are represented by a senior faculty member of the College of Medicine A.M. Lopez and a Eric Brody (mid career faculty). The budget for senior personnel reflects the commitment of the faculty to this project.
Support for the five graduate students is requested. These students will work specifically on (a) architectural principles of integrative aesthetics and pneumatic adaptive envelope, (b) solar energy generation and energy storage, (c) integrated flexible sensors and sensing networks, (d) model-based multi-paradigm simulation and control, and (e) human behavior model and cultural competency. Strong interactions between the faculty and the students are anticipated.

Travel funds are requested in the amount of $5,000 to cover expenses to attend at least two domestic conferences per year and travel between University of Arizona and Indian Reservations.

The objective of the proposed research is to implement a prototype adaptive, autonomous, sensitive sustainable telemedicine building. Funds in the amount of $115,000 per year are requested to support the purchase, construction of necessary infrastructure (e.g. materials for the building envelope, materials for structure footings, flexible sensors and communication network of sensors, compressor/motor modules and energy storage units, wiring, computer system, etc.). The estimated cost of the building envelope including flexible photovoltaic is estimated at ~$200,000.

In view of the complexity but high pay-off of the project, support is requested for a period of four years.

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory: The proposed research will utilize the following facilities at the University of Arizona:
*Architecture Rapid Prototyping & Materials Fabrication Laboratory
*Solar Decathlon SEED Laboratory (i.e. 2009 Solar Powered house)

Clinical:

Animal:

Computer: Computer modeling and simulation research will be conducted on the University Information Technology Services (UITS) computer platforms and facilities. These include the AZ Laboratory for Immersive Visualization Environment (AzLIVE). Other computer platforms in the department of

Office:

Other:

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

Additional support in terms of facilities will be provided by industrial partners affiliated with this project, namely Buro Happols and FTL Design Engineering.

FACILITIES, EQUIPMENT & OTHER RESOURCES

Continuation Page:

LABORATORY FACILITIES (continued):

*University Research Instrumentation Laboratory
*Micro-Nano Fabrication Facilities in the College of Engineering (to become a University-wide NanoFabrication and Processing Facilities)
*A variety of other laboratories in the School of Sustainable Engineered Systems including Arizona Materials Laboratories, and the Compressed Air Energy Storage laboratory.

COMPUTER FACILITIES (continued):

System and Industrial Engineering will be used.

TOHONO O'ODHAM NATION

DEPARTMENT OF HEALTH AND HUMAN SERVICES

P.O. BOX 810 • SELLS, ARIZONA 85634

Office of the Executive Director
(520) 383-6000
(520) 383-3930 Fax

Division of:

Adult Protective Services
(520) 383-6250
(520) 383-5170 Fax

Behavioral Health
(520) 383-6165
(520) 383-5433 Fax

Child Welfare Services
(520) 383-6100
(520) 383-5373 Fax

Community Health
(520) 383-6200
(520) 383-8806 Fax

Family Assistance
(520) 383-6250
(520) 383-5170 Fax

Health Promotion
(520) 383-6240
(520) 383-4682 Fax

Health Transportation
(520) 383-6050
(520) 383-6065 Fax

Senior Services
(520) 383-6075
(520) 383-4776 Fax

Special Needs
(520) 383-6124
(520) 383-3930 Fax

March 16, 2010

RE: EFRI-SEED Final Proposal: Adaptive Autonomous Performance in a Sensitive and Integrative System (AAPSIS) for Telemedicine Building

University of Arizona
Dept of Materials Science & Engineering
Attn: Dr. Pierre Deymier
888 N. Euclid Ave
TUCSON, AZ 85721-0001

Dr. Deymier:

The Tohono O'odham Nation Department of Health and Human Services (TODHHS) is in support of the University of Arizona's Department of Materials Science and Engineering EFRI-SEED proposal. The proposal, Adaptive Autonomous Performance in a Sensitive and Integrative System (AAPSIS) for Telemedicine Building, has potential to address telehealth possibilities within the Tohono O'odham Nation and will support our primary health care provider, the Indian Health Service, to deliver teleheath to our community members. The focus of the proposed project will also have a significant impact as a pilot project on the Tohono O'odham Nation and have duplication potential for other Native American communities. The proposed project can serve as a needed commitment in the development of state-of-the-art sustainable energy efficient building for Native American health care.

The purpose of your telemedicine units serves three functions: (1) bringing health care to people in remote communities, specifically those living on reservation land in Arizona; (2) teaching native people to serve as technical staff, thereby bringing technical knowledge and jobs to those in remote communities; and (3) interacting with those in remote communities to determine. These functions will benefit our Nation and we look forward to being a partner in this project.

I am confident that University of Arizona's Department of Materials Science and Engineering EFRI-SEED proposal will successfully implement a culturally appropriate telehealth project and make a positive impact on the lives of members of the Tohono O'odham Nation.

Sincerely,

Gary M. Quinn, Executive Director
Tohono O'odham Nation Department of Health and Human Services

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Indian Health Service
Tucson Area Director's Office
7900 South J Stock Road
Tucson, Arizona 85746-9352

March 19, 2010

University of Arizona Telemedicine Program
& Emerging Material Technologies Graduate Program
School of Architecture,
The University of Arizona
1040 N. Olive Street
Tucson, AZ 85721-0075

RE: Telemedicine Building Letter of Support

Dear Dr. Lopez, Dr. Malo and To Whom It May Concern:

The Tucson Area Indian Health Service (TAIHS) is very pleased to provide this letter of support for a collaborative venture in developing a telemedicine building to be located at the Indian Health Service Sells Service Unit campus. This joint venture between the University, the Indian Health Service and the Tohono O'odham Nation is a wonderful example of community partnership. This collaboration will help us develop our telemedicine program and help the advancement of patient care services to the citizenry of the Tohono O'odham.

A telemedicine building will assist us in our TAIHS plans to expand medical home capacity. Through a telemedicine forum, we anticipate reducing barriers of isolated geography and health disparities along with improved access to health services.

TAIHS is committed to forming a cultural advisory board comprised of Tribal and Indian Health service members to work with the University on this project. We have committed space on the IHS Sells Service Unit campus for a telemedicine building.

We are excited to collaborate with the University of Arizona Telemedicine Program, the University of Arizona School of Architecture and the Tohono O'odham Nation in making this endeavor a success!

Sincerely,

D Dupree

Dorothy Dupree, B.S., MBA
Director, Tucson Area Indian Health Service