Kevin T. Lesko
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Re: Letter of Intent for Homestake Scientific Collaboration

Dear Dr. Lesko,

I am submitting my research proposal for consideration in the use of the Homestake Mine laboratory facilities.

The purpose of this project is to develop an understanding of the complexities of long term data storage in space exploration. I propose to focus on the investigation of the effects of cosmic radiation on the magnetic and optical storage media. The concept includes a data storage lab at Dakota State University and a deep earth lab using the Homestake mine in Lead, South Dakota. This project will be designed as a start point for further investigation into storage issues and cosmic radiation effects. This evolutionary project will incorporate experts from the South Dakota School of Mines and Technology. This will be a cooperative effort to establish a research link between the two universities. This investigation will have long range benefits to the economy of South Dakota and will be of interest to government agencies, EROS Data Center has expressed a need for scientific research into long term data storage issues and have agreed to allow faculty and students the opportunity to incorporate their facility into research activities.

Problem Statement

Investigative study by this researcher has revealed a lack of knowledge in the physical effects of Cosmic Radiation on surfaces of digital storage media over extended exposure to Cosmic Radiation. Many environmental factors have been identified which effect the life of storage media including heat, humidity and light to name a few, but the effects of Cosmic Radiation is also a factor in the deterioration rates of digital and other forms of magnetic storage. The project will address the differences in deterioration rates in an above ground lab with the results of a deep Earth lab. This will be an extrapolation of short term results to a long term projected solution which will form the basis for further research into the viability of deep Earth storage environments for secure long term storage of digital media.

Purpose of the Study

Currently digital storage on hard disks and containerized tape media represent the bulk of government and industrial long-term information storage. Environmental issues have been addressed pertaining to heat, moisture and light exposure and accepted standards have been applied. Security issues focusing on natural disasters and terrorist attacks have evolved into bunker storage configurations for information security.

The evolution of new surface storage technologies on metallic disks has extended the lifespan of storage media creating new problems including software conversions that are scalable to conform to evolving software languages. This extended life has also created an expectation for extended storage life of information contained on the optical or magnetic devices. The long-term exposure to Cosmic Radiation might have a further deterioration effect on the long-term storage if the media is not to be reviewed for extended periods of time years or decades perhaps. This study is proposed to examine if there is a risk to long-term media storage and serve as a foundation for further research into the viability of Cosmic Radiation issues and additional media storage considerations.

Research Questions

I. Does the rate of surface deterioration experience accelerated effects as a result of cosmic radiation?

II. With cooperate research, could improved storage techniques be developed using deep Earth warehousing?

III. Can longevity be improved on archival storage by removing atmospheric pressure influences?

IV. With multi-university cooperation can a research incubator be created to improve data transitions and storage techniques improving economic development in South Dakota?

V. What are the data transport issues associated with deep Earth storage? Can remote storage locations be secure from outside environmental threats and potential terrorist attacks with secure data transport media in deep Earth storage.

Project Description

This project begins with establishing a remote storage lab at Dakota State University. The incorporation of researchers from Dakota State and The South Dakota School of Mines and Technology will provide a broad experience team for research into storage requirements. The proposed research will incorporate the lab at DSU with a proposed deep earth lab in the Homestake Mine. The investigation will commence with structure analysis of storage characteristics in the DSU lab. This investigation will incorporate all variables associated with digital storage requirements. This will include security concerns, types of storage media, and establishment of control data.

The deep earth lab will be established in the Lead, South Dakota area. The materials management lab at The South Dakota School of Mines will offer the expertise to conduct surface comparison experiments on the metallic media. The two labs will compare rates of differences to ascertain if differences occur in storage located above ground and deep earth. This project establishes a start point for future research in storage extension, security and data transmission. The expected result will be the creation of economic opportunities for South Dakota and the establishment of expanded research cooperation between the two universities.

Phase I – Infrastructure Development

The mission of phase I is to develop the Cosmic Radiation Effect Storage Plan, and build-out the infrastructure in a controlled environment before implementing physical research. This means that a measurement lab, storage data center, telecommunications infrastructure, database infrastructure design, and capture procedures/techniques are planned and developed in this phase, as all future phases will leverage this infrastructure. Subsequent phases might expand or enhance this infrastructure, but phase I provides the infrastructure framework for the project. The outcome of this phase is the capability of authenticating 'test' physical storage, cyber security, and environmental security in a controlled environment using the Earth protection infrastructure to demonstrate the effectiveness of extending storage life and that procedures are established which operate effectively, and to answer the numerous research questions associated with long term storage infrastructure. Phase I will include the research team (10 students and 6 faculty) using the simulated environment to reproduce and authenticate actual below surface benefits allowing the research team the opportunity to answer research questions and work out the issues prior to engaging the physical underground environment.

Phase I affords researchers the opportunity to develop and validate the model, and to work out the implementation issues around the new model in a safe, controlled environment. The underground storage model deployed would be monitored carefully by the researchers to understand possible issues and improvements

Scope:

I. Research will be conducted to understand what the requirements are for all phases of the project, including performance requirements which the project will be measured against.

II. Dakota State researchers will work with researchers at South Dakota School of Mines to identify and select the equipment that will be used for the research project. Further, the expertise from South Dakota State University will also be leveraged, as the South Dakota State University has experience with electronic measurement in its research operations. The weather conditions of the state will be considered when selecting the research times and locations. Researchers will plan and build out the lab to test equipment before rollout into the physical investigative infrastructure. Further, this lab will house all the development work necessary to support the integration of future investigations into Cosmic Radiation issues.

III. Central to the project is the database design and implementation of the physical data warehouse. Phase I will include a systematic database design effort to ensure the confidentiality, integrity, and availability of the storage is maintained. The database design will consider performance expectations for physical, cyber, and transactional security with a focus on the radiation effects on the deterioration of the physical media.

IV. A fully secure data center will be established to house the data warehouse lab. Processes must be established to ensure the confidentiality, integrity, and availability of the stored data. Single points of failure must be eliminated to ensure availability, confidentiality and integrity. Student researchers must be trained on these processes, and technology must be deployed to manage the center, including (but not limited to) access control methods, environmental control systems, and scalable software. Backup power supply must be made available to ensure the system meets availability requirements.

V. Dakota State does not currently have a fully functional research lab which would satisfy the needs for this research therefore decisions need to be made concerning which technologies should be used to plan and build-out necessary infrastructure. The lab infrastructure must be designed and tested to insure that conditions can be replicated and monitored from a distance.

VI. Development and testing of the environment and radiation capture procedures must be performed on site to investigate the difference in surface conditions at DSU versus underground conditions at the physical lab site. Vital to the application of this research in both public and private sector settings is the safe, secure, and reliable capture of surface and subsurface deterioration rates for storage media in a secure environment. Phase I will research the alternatives to storage techniques, and develop and implement the selected procedures for use in future research.

VII. Design and develop the systems management capabilities to manage the investigative environments, including reports, control, and administrative features to provide a tools to manage the secure lab structure.

VIII. Perform observations of research participants (i.e., research team) using the infrastructure in the control lab and the underground lab, and conduct focus group interviews of the same participants to determine the level of student and faculty acceptance, satisfaction, and impact of the research progression.

IX. A model will be developed by identifying the satisfaction level, attitudinal acceptance of underground security and effects on storage, and social interaction of the actors involved in the development of the underground storage environment.

Outcomes/Measurements:

1. A fully operational underground research infrastructure, including technology, process, and training components.	• Signed off deliverables include a requirements document, a lab equipment plan, a database infrastructure design document, and a network infrastructure design document. • Consultations with South Dakota School of Mines and South Dakota State University. • Development lab is operational with modeling equipment, a development environment, a data warehouse, network security, and physical security access to enter the lab. • Data center lab is developed with surface lab environment, uninterruptible power supply, layered network security, and biometric physical security access to enter the lab. • Research team successfully utilizes the technology and policy/procedure infrastructure in the surface lab to authenticate and manage physical, cyber, and transactional environmental stages for six months.
2. Completed research observations and focus group(s).	• Documented approach to address social and psychological research questions, including instrument(s) to be used to gather information. • One documented research report outlining researcher observations and focus group interviews.
3. Prototype of the deep Earth model.	• Successful use of the surface model with the research team.

8.2 Phase II- To be determined

8.3 Phase III – Product Evaluation Pilot- To be determined

The preservation of the electronic data in the storage media is essential to business and government. Storage on digital optical media has the advantage of large capacity, fast access rate and lossless information transfer however the lifetime of this storage media is limited because of chemical and physical deterioration as well as the obsolescence of the format and playback technology. I propose to determine the life expectancy of various digital data storage discs as an application guideline for data preservation of the digital storage media and other types of storage media. My proposal suggests a direct relationship between exposure to space radiation and storage media deterioration. The current storage processes are addressing environmental surrounding including moisture and temperature, however the requirement for longer storage life has created new opportunity for further investigation,

Sincerely,

Bill Figg , Ph.D.
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Cc: Dr. Dan Farrington