UNIVERSITY OF KENTUCKY

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January 15, 2004

Dr. Michael Nietzel, Provost
University of Kentucky
Lexington, KY 40506

JAN 2 ?

Dear Dr. Nietzel:

I am requesting your approval for the creation of a new research center in the College of Engineering entitled, Center for Visualization and Virtual Environments. This Center is an outgrowth of the support the University has received from the State's Office of New Economy, which has underwritten the development of this enterprise. Subsequent to this award, Dr. Walcott, Dr. Carter and their faculty colleagues have attracted sufficient funding and interest from a diverse group of corporations and Federal agencies to assure me that this Center will have a long and vigorous life and that it will greatly enhance the use of advanced visualization to enhance the University's efforts in a plethora of fields, including, but not limited to, manufacturing, environmental protection, architecture and historic preservation, minimally invasive surgery, and the performing arts.

The University is poised to take a leadership position among universities nationally and internationally due to the cadre of outstanding faculty who have coalesced behind this effort. Currently, much of the activity is being housed in newly renovated space in the Kentucky Utilities Building in downtown Lexington. Eventually, the Center will be housed in dedicated and shared space with computer science and electrical and computer engineering in the $42 million Digital Village, currently in preliminary design and planned for a location next to the James F. Hardymon Building on Rose Street. This structure is ranked 6th among the University's capital priorities, and a $1.5 million commitment has already been received from an engineering alumnus as part of the public/private funding plan.

I am attaching a document, originally developed by Drs. Walcott and Carter, in which the mission, objectives, and funding of the Center are outlined in considerable detail. I am not requesting any additional funding from the University to support the creation of the Center. This proposal has been approved by the faculty of the College of Engineering and by copy of this letter, the proposal is being concurrently routed to Dr. Jeffrey Dembo, Senate Chair.

I trust that you will be supportive of this new initiative.

Sincerely,

Thomas W. Lester
Dean

Attachment

cc Executive Vice President Baldwin
Dr. Grulke
Dr. Walcott
Dr. Carter
Dr. Dembo

ACADEMIC ORGANIZATON AND STRUCTURE COMMITTEE REVIEW AND CONSULTATION SUMMARY SHEET

Proposal Title: Proposal to Create Center for Visualization and Virtual Environments

Proposal available at: www.engr.uky.edu/csl/viz.pdf

Name/email/phone for proposal contact: Bruce Walcott, Ph.D., Walcott@engr.uky.edu; 257-1182

Instruction: To facilitate the processing of this proposal please identify the groups or individuals reviewing the proposal, identify a contact person for each entry, provide the consequences of the review (specifically, approval, rejection, no decision and vote outcome, if any) and please attach a copy of any report or memorandum developed with comments on this proposal.

Reviewed by: (Chairs, Directors, Faculty Groups, Faculty Councils, Committees, etc)	**Contact person Name (phone/email)**	**Consequences of Review:**	**Date of Proposal Review**	**Review Summary Attached? (yes or no)**
College of Engineering Faculty	Dean Thomas Lester, Ph.D. College of Engineering 257-1687 lester@engr.uky.edu	Unanimous Vote to Approve	November 25, 2003 (full faculty meeting)	Yes (letter from Dean Lester)
Senate Committee on Academic Organization and Structure	Kate Chard, Ph.D. 257-9338 kchar0@uky.edu			

Center for Visualization and Virtual Environments

A Proposal

Presented to

Faculty of the College of Engineering
University of Kentucky
Lexington, KY 40506

By

Dr. Bruce Walcott, Associate Dean
Dr. Brad Carter, Special Assistant – New Economy
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Executive Summary

This proposal seeks to establish a Center for Visualization and Virtual Environments within the College of Engineering. Visualization can be broadly defined in terms of two categories: depiction of computer generated data of complex scientific or engineering processes and the creation and rendering of virtual environments or the recreation of remote real environments. The proposed Center for Visualization and Virtual Environments will congeal and further basic research in visualization by offering technical staff, equipment, and common test-bed facilities. The proposed center will initially be housed on the eighth floor of the KU building occupying approximately 9,000 square feet of space. Initial funding for the creation of the proposed center stems from a $5M grant from the Office of the New Economy (ONE) via the Kentucky Economic Development Finance Authority (KEDFA). Infrastructure grant opportunities such as the Kentucky EPSCoR program are being aggressively pursued with initial success to leverage these start-up funds. Since the inception of the Center for Visualization and Virtual Environments concept, approximately $2M in new federal funding has been secured for basic and applied research in the area with another $1.7M expected shortly.

Sustained funding for the operation of the center is based upon a conservative model of increased extramural funding activity and use of indirect costs savings by virtue of the proposed center being located off-campus. Core research faculty have been identified in the departments of Computer Science and Electrical and Computer Engineering with allied faculty in Mechanical Engineering, College of Education, College of Arts and Sciences, and the College of Design.

1. Introduction

The University of Kentucky College of Engineering is the Commonwealth's leading engineering institution. Since conferring the first degree in 1890, the College has sent approximately 19,000 of its graduates into all phases of the engineering and computer science profession, and into business, law, medicine, as well as a variety of related professions.

Engineering plays a significant role in the University of Kentucky's land grant mission. The college currently has five research centers (the Kentucky Transportation Center, Center for Aluminum Technology, the Center for Micro-Magnetic and Electronic Devices, Electron Microscopy Center, and the Center for Manufacturing Systems) and three research consortia (the Consortium for Fossil Fuel Science, the Painting Technology Consortium, and the Vibro-Acoustics Consortium). College of Engineering academic faculty in these centers and consortia as well as research staff have played a critical role in the creation of new engineering science and the transference of this knowledge into applications and products.

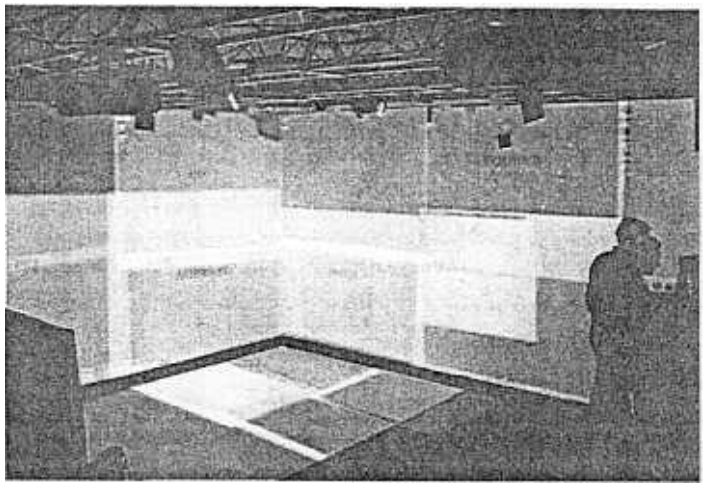
This proposal seeks to establish a sixth research center within the College of Engineering: the Center for Visualization and Virtual Environments. Visualization can be broadly defined in terms of two categories: depiction of computer generated data of complex scientific or engineering processes and the creation and rendering of virtual environments or the recreation of remote real environments. The center will serve to not only attract talented faculty and students in the area of visualization and immersive environments, the knowledge created by the center's faculty and staff will enhance the ability of faculty to perform research across the UK campus.

The intent of the proposed Center for Visualization and Virtual Environments is to build on existing capabilities in the area of visualization. The scope of the proposed Center for Visualization and Virtual Environments will encompass the core research in visualization technologies, sensor technologies and vision science as well as collaborative research in application areas (training, scientific inquiry, medical, assisted living, etc.). Researchers in the proposed Center for Visualization and Virtual Environments will consist of a mix of faculty, post-doctoral associates, graduate students, undergraduate students, and research staff. Programs are being planned to ensure students are well integrated into the research. Education will be an important component of the center and, in addition to the offering of credit and non-credit courses, faculty are considering professional certificates, undergraduate minors, graduate certificates, and master's degrees in visualization.

2. Center for Visualization and Virtual Environments Background

The first round of funding from the Office of the New Economy helped to spur activity in a variety of areas. Specifically, six key focus areas were identified for investment during the 2003-2004 Kentucky FY. These focus areas are:

- Center for Visualization and Virtual Environments and Advanced Manufacturing
- Energy and Environmental Consortium
  Safety and Security
- Natural Products Center
  Center for Circulatory Assist Devices
- Rural New Economy Business Building



The first of these six initiatives, the Center for Visualization and Virtual Environments, is located primarily in the College of Engineering. A total of $5,000,000 in funding from the Kentucky Economic Development Finance Authority (KEDFA) has been committed to this and other related New Economy projects.

While the visualization initiative within the College of Engineering has generated over $1M in directly supporting federal dollars, the initiative is most attractive due to its enabling effect. In fact, applications of visualization research and development are nearly infinite. The biomedical field is benefiting from advances in this technology in a multitude of ways: from scientific visualization of biomedical data and simulations to the miracle of telemedicine where noted specialists can not only train but actually perform complicated medical procedures remotely.

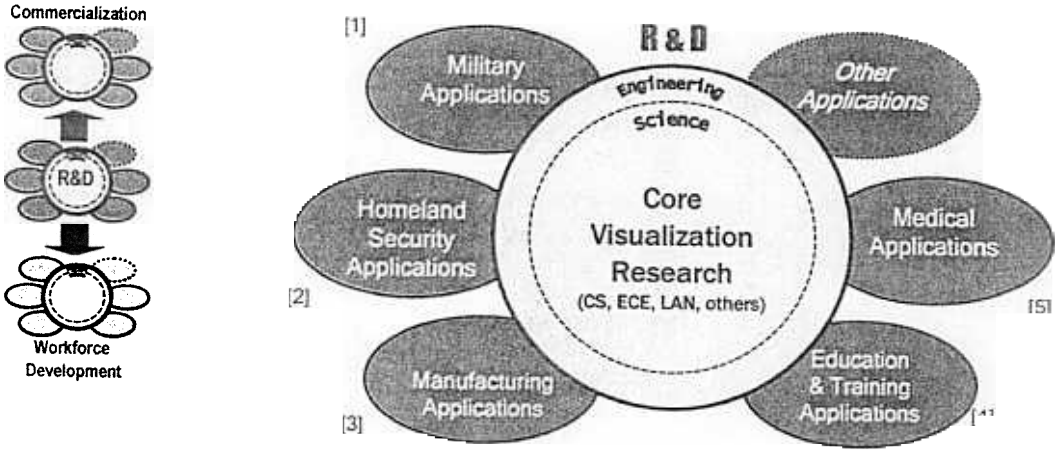
Clearly, investment in visualization is important to the future of current businesses within the Commonwealth as well as critical to fueling the types of economic development outlined in the New Economy Initiative. The following is a partial list of some of the prominent Kentucky industries that would greatly benefit from investment in visualization research as well as state-of-the-art visualization facilities:

Manufacturing
Education and Training
Agriculture

- Medical and Pharmaceutical
- Architecture/Real Estate
- Athletics/Sport
- Military/Security

However, the primary reason for the creation of a Center for Visualization and Virtual Environments is to further the basic research in the area of visualization and immersive

environments. Use of common test-bed shared facilities will encourage such advancement and establish a critical mass of researchers in the area. Once this critical mass is established, applications and commercialization opportunities can be aggressively pursued. The best means of conveying this strategy is via the following illustration:



Interfaces to applications:
[1] Fort Knox; NIMA, other DoD connections
[2] EKU Public Safety and Security Institute for Technology (PSI TEK); UK Agrosecurity Initiative
[3] Center for Manufacturing; Painting Consortium; Toyota; Lexmark
[4] UK College of Ed; Fayette/Floyd/Morgan Co Project; College Support (CFD); other (re Bruce Walcott)
[5] Center for Minimally Invasive Surgery; other UK Med School entities

Figure 1 –Relationship Between Research and Applications/Commercialization

Figure 1 illustrates that the proposed Center for Visualization and Virtual Environments will have a main, core research purpose of advancing and creating new knowledge in visualization and related areas. the which participating researchers contribute. Such a center is envisioned here, with a mission to enable new technologies and advance the art of immersive visualization by addressing the scientific and engineering challenges related to visual simulations and virtual environments.

3. Center for Visualization and Virtual Environments Mission and Goals

An initial planning committee comprised of the Associate Dean for Research, the Chair of the Department of Electrical and Computer Engineering, the Chair of the Department of Computer Science, the Director of the Center for Manufacturing Systems, the Director of the proposed Center for Visualization and Virtual Environments, and the Associate Dean for Economic Development and Innovations Management met during the Spring and Summer of 2003. This committee outlined a ***vision for the future*** of the proposed Center for Visualization and Virtual Environments at the University of Kentucky. By 2010, the committee envisions a Center for Visualization and Virtual Environments that is:

Widely recognized for excellence in core visualization research
Actively seeking and maintaining research collaborations with leading national and international visualization facilities and centers
Supporting a broad mix of educational programs with focus on visualization and visualization applications
Offering expertise in visualization to industrial organizations
Developing intellectual property in visualization and spawning start-up companies
Attracting the best faculty and professional staff
Attracting outstanding graduate and undergraduate students
Providing professional development programs that are highly valued for the quality and are attracting significant numbers of trainees
Sought as a partner of choice by major academic, industrial and government organizations
Actively involved in attracting new companies to Kentucky
Recognized as a major contributor to economic development and innovation in Kentucky

The planning committee also adopted the following mission statement for the proposed Center for Visualization and Virtual Environments:

Mission Statement

The mission of the proposed Center for Visualization and Virtual Environments is to enable new technologies and advance the art of immersive visualization by addressing the scientific and engineering challenges related to visual simulations and virtual environments.

A lesson learned from the NSF Engineering Research Centers program is the importance of unifying test-beds to support a focused research program. Integration of the various research efforts into common test-beds facilitate the leveraging of research results from different research teams—a critical issue in virtual environments, particularly as the research evolves toward sentient and ambient environments.

4. Organization

The proposed center will be administratively led by a Director who will report to the Associate Dean for Economic Development and Innovations Management in the College of Engineering at the University of Kentucky. The proposed Center for Visualization and Virtual Environments will be overseen by Steering Committee comprised of the (Associate Dean for Research, the Chair of the Department of Electrical and Computer Engineering, the Chair of the Department of Computer Science, the Director of the Center for Manufacturing Systems, the Director of the proposed Center for Visualization and Virtual Environments, and the Associate Dean for Economic Development and Innovations Management. Once approved, the proposed Center for Visualization and Virtual Environments will establish an external advisory board(s) which will meet regularly to review the Center's progress and advise on future direction.

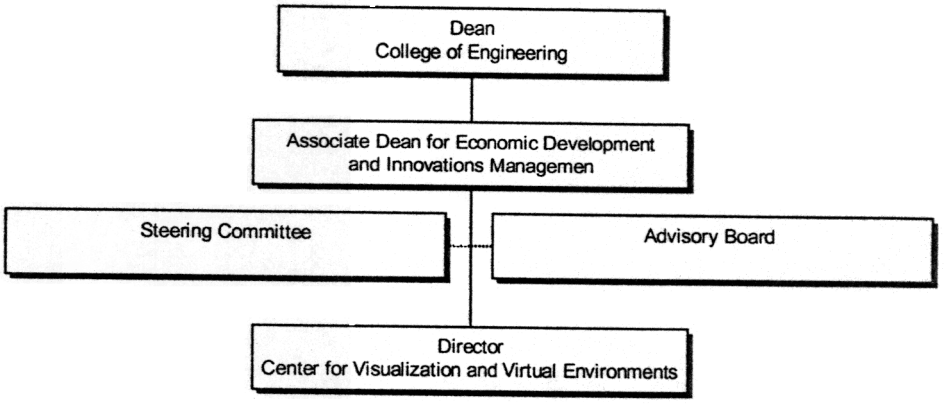


Figure 2 – Organization Chart for Proposed Center for Visualization and Virtual Environments

5. Facilities

The Center for Visualization and Virtual Environments will be housed mainly on the eighth floor of the Kentucky Utilities Building at One Quality Street in downtown Lexington. Some research lab space currently resides in the Hardymon Building on the corner of Rose and Maxwell Streets. At the present time, all of the 9,000 square feet at the KU Building has been committed to existing or future faculty. Currently, the remainder of the eighth floor of the KU Building is occupied by Lexington Community College (LCC). LCC is using the remaining space to teach night classes. With the current discussions regarding the independence of LCC, it is expected that the remainder of the eighth floor will be available sometime in the future.

As for research space necessary for the expansion and growth of the proposed Center for Visualization and Virtual Environments, the Executive Vice President for Finance and Administration has guaranteed that the future vacated space will be offered to support the proposed Center for Visualization and Virtual Environments. In terms of basic infrastructure, the initial seed funding of the proposed Center for Visualization and Virtual Environments will be applied in the following manner:

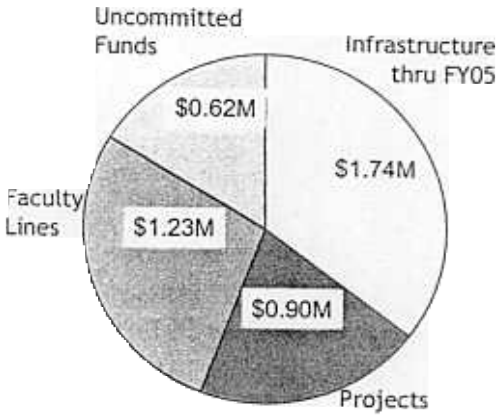


Figure 3 –Use of Initial Seed Funding From ONE/KEDFA

6. Faculty

While applications of the research generated from the proposed Center for Visualization and Virtual Environments will touch many UK faculty members, at the time of the writing of this proposal, the following visualization core research faculty have been identified:

- Hank Dietz, Professor of Electrical and Computer Engineering. Research: Parallel Processing, Hardware Architectures and Networking, Operating Systems, Imaging and Visualization
- Kevin Donohue, Associate Professor of Electrical and Computer Engineering. Research: Medical Imaging, Ultrasonic Non-Destructive Testing, Statistical Signal Processing, Audio Signals and Systems

  Etienne Grossman, Assistant Research Professor of Computer Science. Research: Computer Vision, 3-D Reconstruction, Machine Learning
- Laurence Hassebrook, Associate Professor of Electrical and Computer Engineering. Research: 2-D and 3-D Data Acquisition and Processing, Pattern Recognition, Morphological Transformation
- Christopher Jaynes, Assistant Professor of Computer Science. Research: Multi-View Calibration, Reconstruction, Appearance Modeling, Video Surveillance, Virtual Environments, Telepresence, Image-Based Rendering and Encoding, Biomedical Visualization

  Daniel Lau, Assistant Professor of Electrical and Computer Engineering. Research: Image Processing, Digital Halftoning, Medical Imaging, Human-Computer Interfacing, Visual Perception

Doreen Maloney, Assistant Professor of Digital Media. Research: Electronic Media, Digital Video, CD-ROM Authoring, Animation, Sound Design, Web Mastering

Joan Mazur, Associate Professor of Curriculum and Instruction (Instructional Systems Design). Research: Instructional Design, User Evaluation, Interface Design, Educational Uses of Interactive Multimedia

Brent Seales, Associate Professor of Computer Science. Research: Image Processing, Graphics, Medical Applications

- Ruigang Yang, Assistant Professor of Computer Science. Research: Image-Based Modeling and Rendering, View Synthesis, 3D Modeling, Real-Time Vision (stereo, tracking, etc), Video Teleconferencing, Automatic Meeting Management, HCI, Real-Time Image Processing

The following figure best illustrates the relationship between the various areas of expertise represented by these core faculty members:

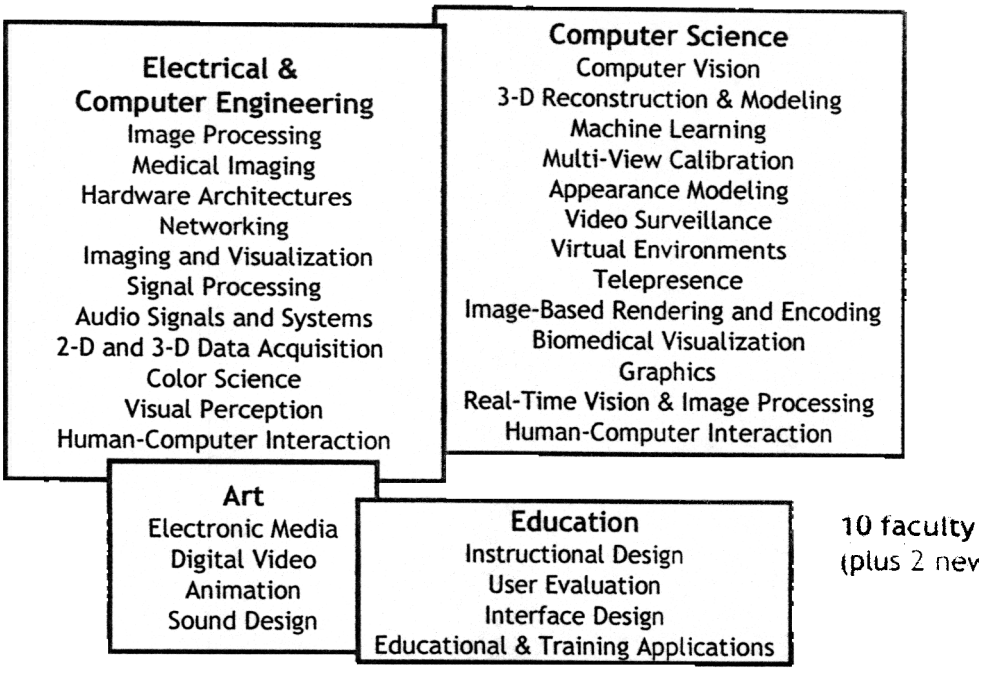


Figure 4 – Relationship Between Research Areas of Core Visualization Faculty

In terms of current goals for the number of faculty, staff and students directly involved in with the proposed Center for Visualization and Virtual Environments, Figure 5 depicts a conservative estimate of the growth of faculty/staff/student involvement based upon experience at an NSF ERC Visualization Research Center.

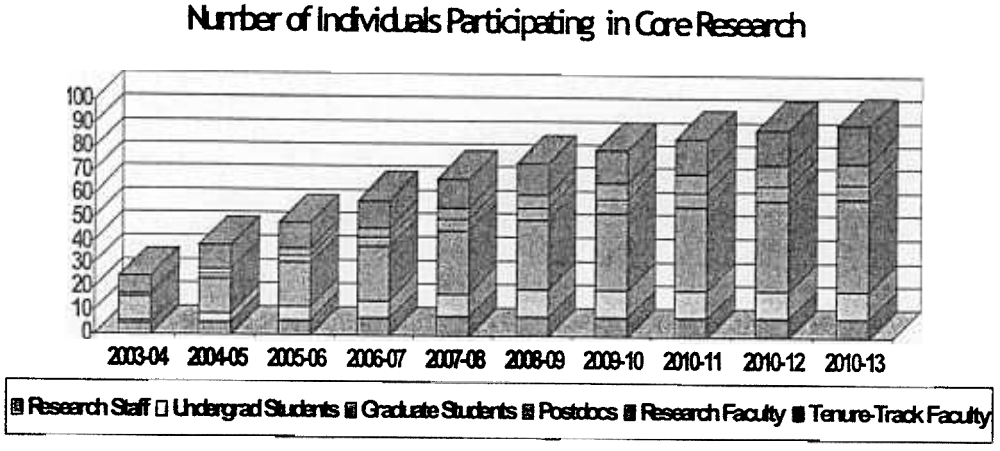


Figure 5 – Relationship Between Research Areas of Core Visualization Faculty

7. Future Research Directions

The recently submitted NSF-EPSCoR proposal for infrastructure support authored by Principal Investigator Dr. Chris Jaynes and Co-Principal Investigator, Dr. Kevin Donohue posposed two new research thrust areas in visualization. The first of the two areas concentrates on sentient and ambient visualization environments while the second focuses on the preservation of the full dimension of those environments for review and application. This section is a reprint of the NSF-EPSCoR proposal.

7.1 Ambient Visualization Environments

The barrier between the physical spaces in which we live, work, and collaborate and the virtual spaces where we store information, communicate with one another, compute, and visualize scientific phenomenon is becoming more transparent. This is evident in the wireless devices that we carry, the ubiquity of computation in our environment, the popularity of large-scale sensor networks, and the current trend of location-specific services. Examples include wearable computing devices that are capable of overlaying information about a person/place/thing as it is encountered by the user and mobile networks that deliver information to users that the move through environments in which the information is likely to be important. For example, entering the airport may trigger the delivery of flight status and weather information to a user's cell phone for browsing.

Significant research is underway related to the building of systems, the computational problems, and the networking issues related to distributed, location-aware service delivery, but there has been little focus on the problem of visualizing in a natural, non-intrusive, and seamless way.

Users are forced to utilize small, embedded displays, such as those on a cell phone or PDA, in order to access information on demand and on location. Moore's law certainly

has held true for most aspects of computing, and systems research has largely been successful in delivering incredible computational power to users in the physical environment (e.g., wireless devices, etc.).

At the same time, display technologies have been remarkably static. Users have access to nearly the same resolution, field-of-view, and color depth as they had in the 1980s. As a result, the utility of location-aware computing, collaborative and ubiquitous environments, sentient environments, and "intelligent spaces" is limited. Users often prefer to access information in their office or home where larger and higher-resolution displays are available.

One area of future research for the faculty and staff of the proposed Center for Visualization and Virtual Environments is to develop display infrastructure that is seamlessly integrated into our everyday lives. We will investigate the scientific and engineering challenges related to building interactive, self-configuring displays that are seamless components in the physical world. Users will make use of these displays through intuitive and natural ways utilizing natural gestures, voice commands, and touch to control the behavior of both the display infrastructure and a particular display. In addition, displays will observe the environment, classify its state, and anticipate user needs for display. These Ambient Visualization Environments will turn our physical environment into an interactive display that can provide us with seamless and natural access to information on demand and in context.

The proposed work builds on successes of the Metaverse Project, a five-year research program in building and deploying self-configuring immersive environments. The goal of that program was to remove the cost, maintenance, and usability barriers associated with high-end visualization environments by integrating cameras and computer vision algorithms into the display system.

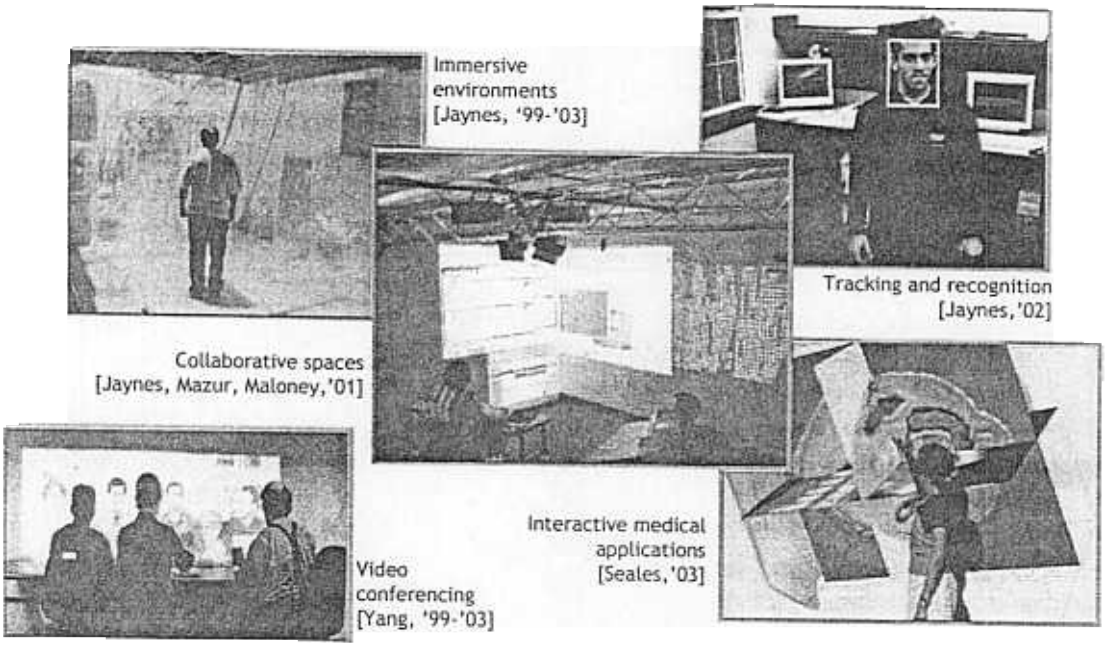


Figure 6 – Research Projects in Ambient Visualization Environments

Using techniques developed in the project, very-high resolution, large-format displays were deployed both for research and production environments. These displays were capable of automatic calibration using display cameras, seamless intensity blending, dynamic detection of projector failure and motion, and even detection and correction of transient artifacts on the display such as shadows cast by users. This earlier work demonstrated that self-monitoring and correction using camera-based methods can dramatically improve the quality, scalability, and utility of visualization systems while reducing costs. These same principles of self-configuration and monitoring can be applied to sense the environment, react to user needs and behaviors, and automatically present information to users within the environment in a useful and meaningful way. A major focus of the research, then, will be to move the capabilities of visualization facilities, centers, and artifacts into our everyday lives.

Ambient visualization environments should support the following example scenarios: Colleagues who begin an unplanned discussion in a hallway decide to access geophysical data stored on a central machine for display. Either through voice request or interaction via a wireless PDA the colleagues request display of the data. The ambient visualization environment has been tracking the two users, and based on their current location and pose, selects where to display the data. Given the resolution of the data, availability of resources that are co-located with the users (i.e., number and type of projector frustums that are in the line of sight of the users) the environment automatically configures, calibrates, and blends several display components into a seamless display intended to support the request. The system exploits available display surfaces in the physical environment (walls, desk surfaces, and even floors). Users are free to roam throughout the ambient space while critical information is continuously displayed at real-time rates in their field of view.

Although there are significant systems-related questions that must be addressed to actually deploy such a system, a simple test-bed that supports particular types of limited interaction with the system can be constructed that is a rich enough environment to support the proposed research. In the first phases of the research, we will focus on the following issues: (1) wide-area and accurate tracking of users within the environment; (2) automatic recognition of social contexts and (3) automatic calibration and configuration of displays "on-the-fly" given user visualization needs. Milestones will be configured around these three aspects of the research.

7.2 Dynamic Environment Preservation

The vision for Dynamic Environment Preservation is to record and replay an event, object or environment with all of the ambient sensory information that contributes to a person's sense of self-awareness. This idea derives from the centuries old question: Does a tree make a sound when falling if no one is around to hear it? In our case: Can an environment be preserved without the many senses that contribute to our understanding of it? Most current visualization research focuses on problems relating to the display of data. A new and unique paradigm that will complement and broaden visualization research at the University of Kentucky is proposed as a second new research thrust.

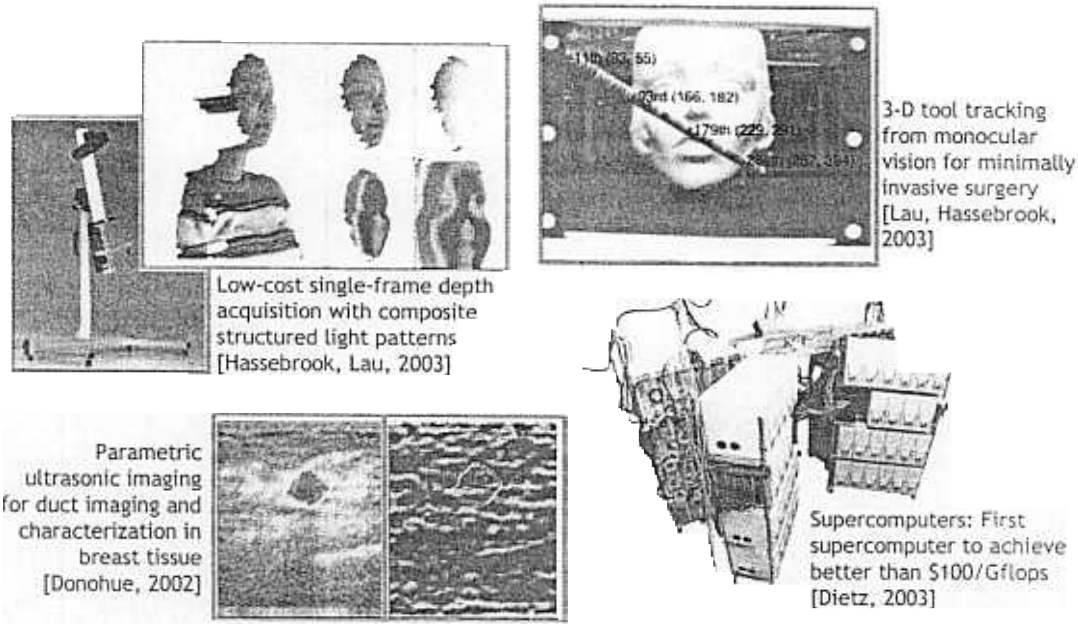


Figure 7– Research Projects in Dynamic Environmental Preservation

We plan to organize the research associated with this thrust as depicted in the table on the next page. In Dynamic Environment Acquisition and Preservation, the data acquisition

will be substantive data collection where the goal is to preserve a moment in time including an all-encompassing, multi-spectral, 3-D video record of an environment/event as well as immersive audio and tactile recordings. To a greater degree than has ever been performed previously, we will preserve an event globally and completely. Many of the necessary technologies are already part of existing research at UK.

Dynamic Environment Acquisition and Preservation	Environment Modeling, Processing, Storage, and Transmission	Interactive Environment Exploration
Motion-capture 3-D video Multi-spectral color imaging Immersive sound recording	Supercomputer clusters Audio signal processing N-channel video processing	Immersive display environments Multi-spectral displays Thin film displays

Table 1 - Research Model for Dynamic Environment Preservation

In Environment Modeling, Processing, Storage and Transmission, the goal is to translate the preserved event into a form that can be archived for later re-enactment, processed to identify specific environmental metrics, transmitted over long distances for remote re-enactment, and otherwise placed in a new form for user manipulation.

Once the acquisition and processing is complete, the Interactive Environment Exploration focuses on the re-enactment of the event with all of the ambient sensory information so important in the original recordings. As such, the re-enacted event must offer the same sense of self-awareness so that the viewers can interact and contribute to the event/environment playback just as they did in the preserved event. This implies all of the senses of sight, hearing, and touch that were implied earlier.

A portable recording and preservation studio with a playback theatre is planned as an initial test-bed for the research with applications from several domains being used to validate the research. For example, in the case of manufacturing, we can visit remote factories, create complete 3-D scans of the parts being manufactured, and preserve the essential elements of the environment. The results would then be transmitted to the display theater where they can be compared with similar results from other manufacturing facilities. In medical applications, a medical professional will be able to fully review the preserved details of treatments of multiple patients from multiple sites. A portable preservation system would make valuable contributions to students with disabilities who do not have the mobility to cross campus for multiple classes per day. A single theater could serve as their classroom with the recording system transported from class to class. Other potential applications exist in training, education, security, etc. Initial research for this thrust will focus on: (1) environment sampling, audio and video sensor placement/density for unambiguous recording of environmental features; (2) environment playback, audio and video output device placement of unambiguous playback; (3)

representation and processing of data from multiple channels and modalities; and (4) efficient display technology for multi-view of dynamic objects.

7.3 Long-Term Goal: Sentient Spaces

The ultimate goal of the proposed research thrusts in ambient visualization environments and dynamic environmental preservation is to have these areas marry or merge in the future under the heading of "Sentient Spaces". Simply put, a Sentient Space is a mixture of reality experiences with virtual environments. In other words, Sentient Spaces are actual real-world spaces where the user's perception is assisted with computer-provided experiences and services. In the future, sentient spaces could prevent security breaches from use of 3-D image capture and recognition techniques or could enable a surgeon to perform surgery in a sentient space that provides patient information, anatomical 3-D depictions, etc., on demand. Dynamic preservation research will lead to the tools and sensors needed to enable such environments while the work on-going in ambient visualization environments will provide the means to render this information useful to the user of the sentient space (see Figure 8).

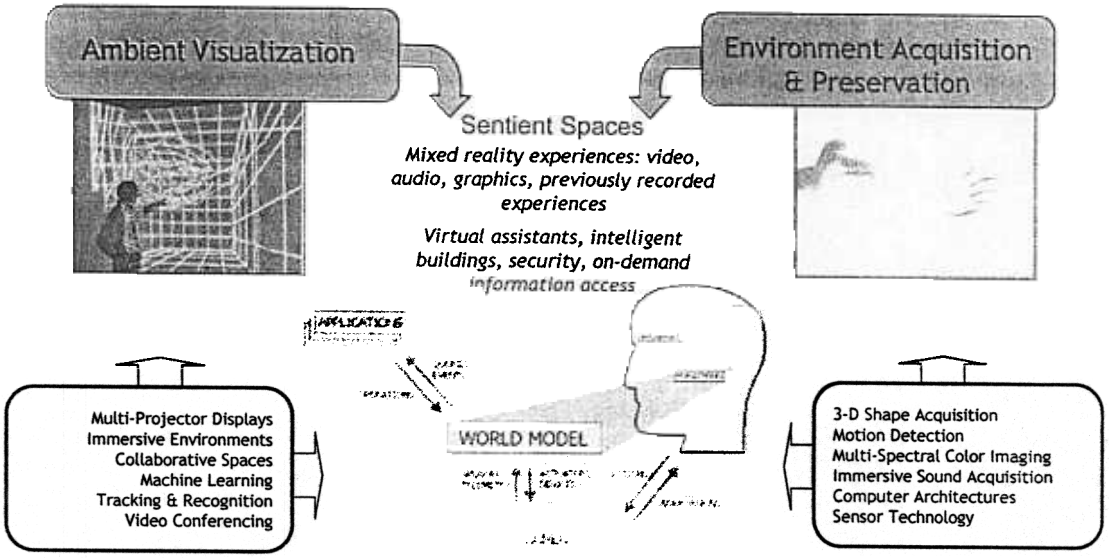


Figure 8 – Merger of Ambient Visualization and Environment Preservation

8. Budget

Colleges and Universities that attain excellence in visualization will be poised national success. Clearly, a requirement for such success is an on-going supporting infrastructure that includes state-of-the-art test-beds for conducting and integrating the research of the

participating researchers, appropriate technical and administrative staff, and operational funds. In the long run, infrastructure resources will be derived from the grants of the participating faculty and from other sources such as industrial contributions and support from UK research funds. In the short term, the initiative needs stable infrastructure funding to be successful and to reach the long-term funding goals.

Figure 3 illustrated the distribution of the initial seed capital provided by the Office of the New Economy and the Kentucky Economic Development Finance Authority. Sustained funding for the operation of the center is based upon a conservative model of increased extramural funding activity and use of indirect costs savings by virtue of the proposed center being located off-campus.

Initial infrastructure funding is approximately $450,000 per year and increases to about $850,000 in Year 10 if the growth model in Figure 8 is achieved. Figure 9 shows one very achievable funding model for sustaining the proposed center. The initial funding (KEDGA and DoD congressionally assisted funding) is in place through the first three years. The center is in the second round of the NSF EPSCoR funding that would provide additional infrastructure support through 2007-08. With the expected success of the participating faculty, it is reasonable to believe that winning an NSF MRI grant in 2006 and "center funding" from NSF or another agency beginning in 2008-09 is viable. Certainly the projected increases in individual faculty grants and from business and industry are not overly optimistic. Not reflected in the model are current efforts for additional funding from KEFDA and for long-term funding in areas of homeland security and K-12 educational applications. But even if these funding sources do not all materialize, it is reasonable to project sufficient funds to operate the center.

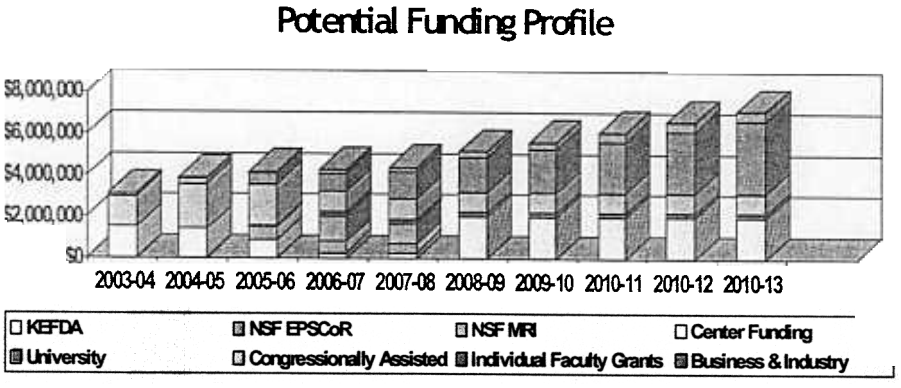


Figure 9 – Future Funding Model for Proposed Center for Visualization and Virtual Environments

As illustrated in Figure 9, the proposed Center for Visualization and Virtual Environments has identified funding through FY 2007-08. At this time, it is expected

that funding generated by the center through indirect cost returns will fill-in the gap funding illustrated by the green and white striped area.

9. Summary

This proposal has presented a plan to establish a Center for Visualization and Virtual Environments within the College of Engineering at the University of Kentucky. Initial seed for the Center has been secured and core research faculty identified. While the primary focus of the Center for Visualization and Virtual Environments will be to further the knowledge base in the area of visualization and perceptive environments, applications of this research will positively affect many researchers across the University of Kentucky campus as well as attract new researchers to the university. Clearly, the successful execution of the plan contained in this proposal will establish a nationally and internationally competitive research and education center and contribute to the "Top 20 Status" of the University of Kentucky and to the well-being of the Commonwealth of Kentucky.