INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPRISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: Joe F Thompson

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other ____________
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☐

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important tasks, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and is not a precondition of award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represendted groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPRISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: Geoffrey C Fox

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)

☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Other Pacific Islander
☒ White

Disability Status:
(Select one or more)

☐ Hearing Impairment
☐ Visual Impairment
☐ Mobility/Orthopedic Impairment
☐ Other ______________
☐ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important tasks, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and is not a precondition of award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represendted groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 00-2 **NSF 99-167** **01/06/00**	**FOR NSF USE ONLY**
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) **INFORMATION TECHNOLOGY RESEARC**	**NSF PROPOSAL NUMBER** **0077018**

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				075461814	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY?
646000819	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	YES ☐ NO ☒ IF YES, LIST ACRONYMS(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE **Mississippi State University**	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE **Sponsored Program Administration** **Post Office Box 6156** **Mississippi State, MS. 397626156**
AWARDEE ORGANIZATION CODE (IF KNOWN) **0024232000**	
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE
PERFORMING ORGANIZATION CODE (IF KNOWN)	

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.D.1 For Definitions) ☐ FOR-PROFIT ORGANIZATION ☐ SMALL BUSINESS ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS

TITLE OF PROPOSED PROJECT **ITR/ACS: An Open-Source Web-based PSE for Distributed Geometry/Mesh Generation**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PREPROPOSAL NO., IF APPLICABLE
$ **2,869,720**	**36** months	**09/01/00**	

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

- ☐ BEGINNING INVESTIGATOR (GPG 1.A.3)
- ☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.D.1)
- ☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG II.D.10)
- ☐ NATIONAL ENVIRONMENTAL POLICY ACT (GPG II.D.10)
- ☐ HISTORIC PLACES (GPG II.D.10)
- ☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.12)
- ☐ GROUP PROPOSAL (GPG II.D.12)
- ☐ VERTEBRATE ANIMALS (GPG II.D.12) IACUC App. Date ________
- ☐ HUMAN SUBJECTS (GPG II.D.12) Exemption Subsection ________ or IRB App. Date ________
- ☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES ________
- ☐ FACILITATION FOR SCIENTISTS/ENGINEERS WITH DISABILITIES (GPG V.G.)
- ☐ RESEARCH OPPORTUNITY AWARD (GPG V.H)

PI/PD DEPARTMENT **NSF Engineering Research Center**	PI/PD POSTAL ADDRESS **Box 9627** **Mississippi State, MS 39762** **United States**
PI/PD FAX NUMBER **662-325-7692**	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Joe F Thompson**	**Ph.D.**	**1971**	**662-325-8278**	**joe@erc.msstate.edu**
CO-PI/PD **Geoffrey C Fox**	**Ph.D.**	**1967**	**315-443-2163**	**gcf@cs.fsu.edu**
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

CERTIFICATION PAGE

Certification for Principal Investigators and Co-Principal Investigators:

I certify to the best of my knowledge that:

(1) the statements herein (excluding scientific hypotheses and scientific opinions) are true and complete, and
(2) the text and graphics herein as well as any accompanying publications or other documents, unless otherwise indicated, are the original work of the signatories or individuals working under their supervision. I agree to accept responsibility for the scientific conduct of the project and to provide the required progress reports if an award is made as a result of this application.

I understand that the willful provision of false information or concealing a material fact in this proposal or any other communication submitted to NSF is a criminal offense (U.S.Code, Title 18, Section 1001).

Name (Typed)	Signature	Social Security No.*	Date
PI/PD **Joe F Thompson**		SSNs are confidential and are not displayed *ON FASTLANE SUBMISSIONS*	
Co-PI/PD **Geoffrey C Fox**			
Co-PI/PD			
Co-PI/PD			
Co-PI/PD			

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding Federal debt status, debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 00-2. Willful provision of false information in this application and its supporting documents or in reports required under an ensuring award is a criminal offense (U. S. Code, Title 18, Section 1001).

In addition, if the applicant institution employs more than fifty persons, the authorized official of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of Grant Policy Manual Section 510; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflict which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Debt and Debarment Certifications

(If answer "yes" to either, please provide explanation.)

Is the organization delinquent on any Federal debt?	Yes ☐	No ☒
Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?	Yes ☐	No ☒

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure Form to Report Lobbying,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME/TITLE (TYPED) **Robert A. Altenkirch**		**01/05/00**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
662-325-7404	**robyn@spa.msstate.edu**	**662-325-3803**

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

Project Summary

A networked collaboration among computer scientists, engineers, and mathematicians – bringing together expertise in geometry/mesh generation at Mississippi State and expertise in distributed systems at Florida State – is proposed in a large–scale three–year project to develop an open–source Web–based PSE for distributed and collaborative geometry/mesh generation. This system is to be user–configurable from interacting components, allowing user customizability from a suite of objects and supporting services, to meet the differing demands of various applications, rather than being a single monolithic system.

The framework of this system will be constructed in terms of components built according to emerging distributed object and Web standards technologies. Geometry/mesh generation computational technology will be encapsulated into modular elements as open–source, allowing for continual enhancement and extension by the user community – incorporating useful components from existing systems and developing new components as needed. This system will utilize an “Object Web” approach to building distributed systems: a three–tier architecture that generalizes the traditional client–server model to become a client–broker–service model.

The project will produce novel geometry/mesh generation systems supporting two distinct distributed object paradigms. The coarse grain model will be supported by a commodity approach controlling “whole programs” as the components. This will be used for initial operational systems. In this approach, LegacyMesh, to be built from the composition of existing programs, forms the overall architecture of the new ComponentMesh system. The ComponentMesh is built in terms of Meshlets, which are built using a JavaBean framework and with compatible XML and Java interfaces.

Meshlets are defined hierarchically and can be as large as an aircraft or as small as a single finite element. Java is used essentially as the software to glue meshlets together and to specify those parts of the mesh that are best defined by embedded software. A mesh can in this way be considered as a set of Java objects, which could be registered and used through the Jini mechanism or displayed using Java3D. Alternatively we can map the mesh into a set of XML files that is stored in a dynamic XML database or persistently in a favorite object relational database. This XML can be translated into X3D (VRML standard expressed in XML) or other emerging XML–based graphics standards such as VML. Our use of the twin XML–Java pragmatic object Web standards allows us to take full advantage of the renderers and filters supporting them.

A key research area in this project will the general issues concerning integration of coarse grain and fine grain objects in the ComponentMesh. We will also research issues concerning scaling of client interfaces from those in hand–held devices to PCs to the CAVE. In these areas of distributed system research, we will focus on the mesh problem but draw conclusions for more general applications. Support of our new concept of meshlets, which is applicable to all grid–based applications (generation, execution and visualization), will of course be a major focus. Thus we will investigate in this specific important case the issues of mobile code and the tradeoffs between XML (data structure) and Java (programmatic) specification of information – this is a typical question underlying the different approaches to the pragmatic object Web.

This effort will address a major pacing item in computational science: the geometry/mesh generation that is inherent in computational simulation of field phenomena, i.e. the computational solution of partial differential equations. Particularly significant is that this system will be adaptable and steerable, both in dynamic coupling with the PDE solution and for the design mode in application. This large–scale software development will thus significantly enhance the infrastructure for research in computational science, both for scientific investigation and for engineering analysis and design. Finally, this effort, with its open–source user community involvement, will also serve to advance a sorely–needed set of standards for geometry/mesh generation.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

Section		Total No. of Pages in Section	Page No.* (Optional)*
Cover Sheet (NSF Form 1207 - Submit Page 2 with original proposal only)			
A	Project Summary (not to exceed 1 page)	1	
B	Table of Contents (NSF Form 1359)	1	
C	Project Description (including Results from Prior NSF Support) (not to exceed 15 pages) **(Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**	5	
D	References Cited	1	
E	Biographical Sketches (Not to exceed 2 pages each)	3	
F	Budget (NSF Form 1030, including up to 3 pages of budget justification)	2	
G	Current and Pending Support (NSF Form 1239)	0	
H	Facilities, Equipment and Other Resources (NSF Form 1363)	0	
I	Special Information/Supplementary Documentation	0	
J	Appendix (List below.) **(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**		

Appendix Items:

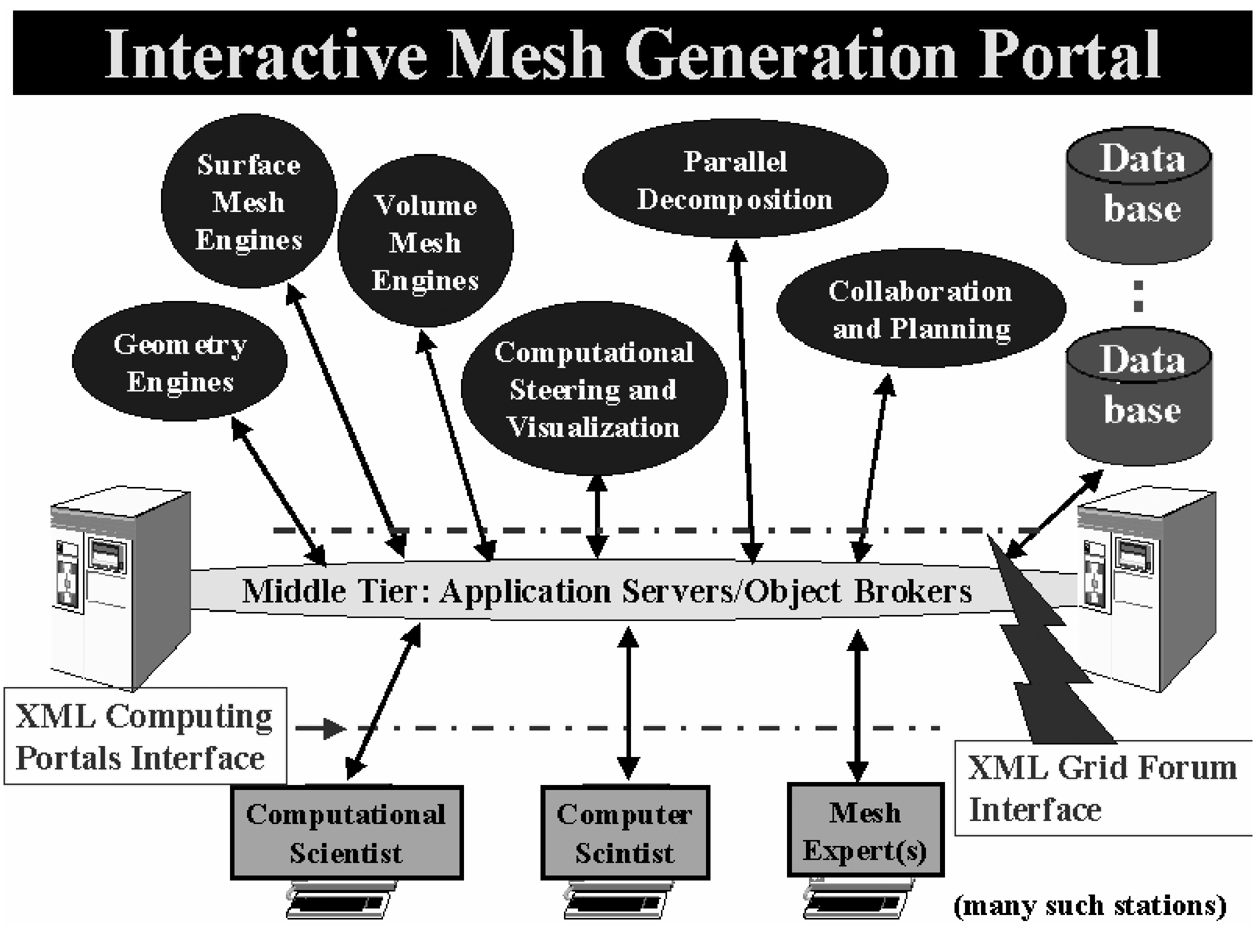
*Proposers may select any numbering mechanism for the proposal, however, the entire proposal must be paginated. Complete both columns only if the proposal is numbered consecutively.

ITR/ACS: An Open–Source Web–based PSE for Distributed Geometry/Mesh Generation

INTRODUCTION. Geometric representation/mesh generation is enabling technology for computational science in both scientific investigation and engineering design. This enabling computational technology, cross–cutting across mission agencies, has repeatedly been cited by industry and Federal labs as a pacing item holding back the capability of the effective application of computational simulation in investigation, analysis, and design. The computational technology of geometry/mesh generation is well advanced, but there are major software research and application issues in developing a configurable system as general enabling technology for computational science.

Geometry/mesh generation is not compute–intensive in the sense of requiring large CPU time or even the fastest CPUs available. Rather, it is more an assembly: a collection of relatively small operations on elements of a growing object, itself an aggregation of smaller objects. And these component objects are reusable and editable to form still other objects. Interactive steering and consultation among application users and those experienced in the generation process are required, because the geometry/mesh is not unique. Geometry/mesh generation is, by its very nature, a particularly good candidate for interactive distributed operation on both the server and client side: multiple servers providing specialized resources for assembly and multiple clients participating in steering and consultation, with a middle tier brokering resources.

PROPOSED EFFORT. A networked collaboration among computer scientists, engineers, and mathematicians – bringing together expertise in geometry/mesh generation at Mississippi State and expertise in distributed systems at Florida State – is proposed in a large–scale three–year project to develop an open–source Web–based PSE for distributed and collaborative geometry/mesh generation. This system is to be user–configurable from interacting components to meet the differing demands of various applications, rather than being a single monolithic system. This effort, with its open–source user community involvement, will also serve to advance a sorely–needed set of standards for geometry/mesh generation.



WEB–BASED PSE. This project will address the development of a Web–based PSE for geometry/mesh generation, allowing user customizability from a suite of objects and supporting services. The framework of this system will be constructed in terms of components built according to emerging distributed object and Web standards technologies. Geometry/mesh generation computational technology will be encapsulated into modular elements as open–source, allowing for continual enhancement and extension by the user community – incorporating useful components from existing systems and developing new components as needed.

This system will utilize an “Object Web” approach to building distributed systems: a three–tier architecture that generalizes the traditional client–server model to become a client–broker–service model. In this model, the middle tier acts as an intermediary or broker that allows diverse clients to share and choose among many different resources. The middle tier interfaces with the user through a “request for service” interface, and with service objects through a “resources” interface, with expression at these interfaces accomplished through XML technology. This architecture builds on distributed object technology, and this concept underlies the “Object Web” approach to building distributed systems.

In this Object Web architecture for geometry/mesh generation, everything is a distributed object, whether it be an elliptic mesh generation element, an unstructured front advancement element, a refinement method, a surface NURB, or a mesh quality measure element, etc, with XML and Java forms for the raw definition and operation objects themselves and the descriptions and results they produce. A single surface geometry or a volume mesh, for example, is composed of many elements, all of which will be objects.

FOUNDATIONAL EFFORT. This effort will build on the existing Gateway Architecture development (http://www.osc.edu/~kenf/theGateway/) led by Fox at Syracuse (now relocating to Florida State) as a part of the Programing Environment & Training (PET) program of the DoD High Performance Computing Modernization Program (HPCMP) and on the extensive geometry/mesh generation computational technology effort of Thompson and co–workers at Mississippi State. And this effort will build on the collaborative working relationship established between Fox and Thompson in the DoD HPCMP PET effort over the past four years.

The Gateway system creates a Web–based environment for scientists and engineers that enables secure and seamless access to high–performance resources. It comprises a multi–tier (currently three–tier) architecture. The first tier is comprised of a Web browser–based graphical user interface which assists the researcher in the selection of suitable applications, generation of input data sets, specification of resources, and the post–processing of computational results. The distributed, object–oriented middle–tier maps the user task specification onto back–end resources, which forms the third tier. The backend tier supports Globus. In this way we hide the underlying complexities of a heterogeneous computational environment, and replace it with a graphical interface through which a user can understand, define, and analyze scientific problems.

TECHNICAL APPROACH. The project will produce novel geometry/mesh generation systems supporting two distinct distributed object paradigms. The coarse grain model will be supported by a commodity approach similar to the Gateway System. This will control “whole programs” such as the components shown in the figure. This will be used for initial operational systems. In this approach, LegacyMesh, to be built from the composition of existing programs, forms the overall architecture of the new ComponentMesh system. The ComponentMesh is built in terms of Meshlets, which are built using a JavaBean framework and with compatible XML and Java interfaces.

Meshlets are defined hierarchically and can be as large as an aircraft or as small as a single finite element. Java is used essentially as the software to glue meshlets together and to specify those parts of the mesh that are best defined by embedded software. The latter includes handlers to define refinement strategies and interpolation schemes. A mesh can in this way be considered as a set of Java objects, which could be registered and used through the Jini mechanism or displayed using Java3D. Alternatively we can map the mesh into a set of XML files that is stored in a dynamic XML database or persistently in a favorite object relational database. This XML can be translated into X3D (VRML standard expressed in XML) or other emerging XML–based graphics standards such as VML. Our use of the twin XML–Java pragmatic object Web standards allows us to take full advantage of the renderers and filters supporting them. For instance, the collaborative white board could immediately display the Java representation if projected by a filter into two dimensions.

In the ComponentMesh, one can either define a mesh conventionally as a set of nodal points and elements or in terms of the software needed to generate the same or, most interestingly, as a combination thereof. The implicit software–based definition is the most efficient and flexible approach, and one would use this where possible with meshlets representing user–generated points at any level of the mesh hierarchy. The software specification will allow particularly efficient algorithms for associated tools like parallel decomposition and visualization.

Whereas the current Gateway approach using CORBA is sufficient for high performance implementation of the LegacyMesh, a different lighter–weight Web object model is needed. The situation is rapidly changing, but currently two attractive distributed Java object models are Ninja from an impressive group at UC Berkeley and the very recent E–Speak system from Hewlett–Packard. These provide infrastructure supporting (to differing degrees) necessary services such as security, fault tolerance, and naming (registration and lookup). Ninja has also clearly addressed scaling to a very large number of heterogeneous clients. We plan on evaluating these and other possible base object Web systems during the next few months so that we will be ready to go if this project is funded. In particular, we will set up multiple PC or workstation clusters (at FSU and MSU) as the distributed redundant home base infrastructure to support persistent storage. MSU has an established relationship with Sun – with a 64–node Sun Ultra HPC 10000, a new 16node/64processor Sun cluster, and an earlier 8node/32processor Sun cluster utilizing MSU's own wormhole router design.

The figure shows two key interfaces — middle tier–backend and client–middle tier — whose systematic use allows modular design as shown in our Gateway project. It has already allowed us to straightforwardly change the original Gateway custom Java Server middle tier to the current CORBA–based solution with XML specifications being mapped dynamically into CORBA IDL. We have defined coarse grain component and event models for Gateway which can, if appropriate, be migrated to either the new CORBA proposals in this area or to Enterprise JavaBean solutions as offered in commercial solutions like i–Planet from Sun.

We note two community activities devoted to establishing appropriate standards for generic computing portals. The Grid Forum (www.gridforum.org) is setting key resource standards for computing, network and software resources. This is complemented by the Computing Portals group (www.computingportals.org) whose preliminary abstract task definition has been adopted in Gateway. We will continue our active involvement in these projects, monitoring commercial products and incorporating their results in this project as appropriate.

Our project will contribute understanding both from the new ComponentMesh system and from a new model of geometry/mesh generation involving geographically distributed collaboration between computational scientists, computer scientists, and mesh experts. This collaboration is an archetype of general research collaboration and a particularly good case to study, as it is well known that high quality meshes often require expert user intervention. Such mesh expertise is often absent at a given location, and our proposed distributed solution seems the most practical approach. We will initiate this part of our project with the LegacyMesh, where we will use existing mesh technology to build a prototype interactive mesh portal. This will exchange data streams using XML–based data structures, which will be a prototype of those to be used in the ComponentMesh.

We have studied existing collaborative systems and have extensive experience with two – Habanero and TangoInteractive – used by the NSF Alliance and DoD PET projects. Technology has changed so rapidly that it is not interesting to re–use these systems, but rather we intend to design a new system whose internal design will be built on the ideas of the Collaborative Web Portal (CWP) recently proposed by Fox. This design also uses ideas from other projects and architecture designs such as those described in [7] and [8]. Rather than the custom servers and protocols of the earlier systems, we will build on the emerging distributed software infrastructure discussed above. Again, Ninja from UC Berkeley seems attractive, as the second generation version available in early 2000 has excellent support for robust distribution and queuing of events which is needed by the shared event models of collaboration.

CWP integrates shared event and shared display models by supporting "all events" from user actions (mouse motion etc.), programmatic state changes and pixel changes in a display. This allows us to immediately share all applications with the shared display mode of collaboration and where necessary augment with the more powerful shared event model which can require nontrivial changes to the application. We will further integrate asynchronous and synchronous collaboration models by using the strategy familiar from pagers where either mode is driven from an event (message) queue, which also plays the role of session archive. The situation in digital audio–video conferencing is changing rapidly and again we will monitor and choose from systems such as the Access Grid (from the NCSA Alliance), Buena Vista from TangoInteractive, as well as commercial approaches such as White Pine (CUSeeMe) and Microsoft Netmeeting.

RESEARCH ISSUES. For this project, a key research area will the general issues concerning integration of coarse grain and fine grain objects in the ComponentMesh – can one still achieve the needed performance, security and robustness goals that we demonstrated in Gateway. Note that the mesh generation application has the interesting feature that changes in the fine grain structure (adding new Meshlets) is associated with user input, and so has performance goals that are important but not as severe as those associated with processing existing components. This feature will be shared with other applications such as general computational steering. The more difficult problem of high performance execution of relatively fine grain software components is being tackled by the DoE CCA (Common Component Architecture) activity and we will follow this work closely. For some portal applications, scaling to many users is important, but that will not be a key problem for the mesh generation problem.

We will research issues concerning scaling of client interfaces from those in hand–held devices to PCs to the CAVE (available at MSU). In these areas of distributed system research, we will focus on the mesh problem but draw conclusions for more general applications. Support of our new concept of meshlets, which is applicable to all grid–based applications (generation, execution and visualization) will of course be a major focus. Thus we will investigate in this specific important case the issues of mobile code and the tradeoffs between XML (data structure) and Java (programmatic) specification of information – this is a typical question underlying the different approaches to the pragmatic object Web.

Another major research focus will be support of the distributed collaboration between computational scientists, computer scientists and mesh experts. Here we will again focus on the special features of interactive mesh generation as we have reasonably good understanding of general collaboration tools but poor understanding as to which shared capabilities are important to support distributed computing. We will first develop a collaborative version of the interactive user–driven mesh specification and visualization tool. This will use the full shared event capabilities, as customization of the shared control of this seems certain to be important as it the vehicle for collaboration between the mesh expert and users.

This part of the project will start with the coarse grain LegacyMesh approach, and we will initiate use and evaluation of the collaborative environment by using the simple shared display version. We will follow this approach with other tools (such as specialized visualizers for the different portal engines shown in the figure) with quick evaluation using a shared display version being followed if necessary by a customized true shared event implementation. This part of the project will teach us which tools of what architecture support this mode of collaboration and how the general distributed system architecture of CPW performs. For example, what is the relative performance of the different collaborative models and will the queued event architecture lead to serious overheads?

MANAGEMENT AND EXECUTION. This three–year, large–scale effort will be managed collaboratively by Thompson and Fox, with contracting administration at Mississippi State. Co–workers will be assembled as needed and appropriate from the existing research groups at Mississippi State and Florida State. The NSF ERC at MSU has a ten–year establishment in the relevant areas of this effort, and Fox is establishing relevant expertise at FSU through focusing of existing experience and additions. Thompson and Fox have an established collaborative relationship in the DoD Programming Environment & Training contract of the DoD HPC Modernization Program (http://www.hpcmo.hpc.mil/Htdocs/PET/index.html).

In the course of this effort, a networked collaborative framework will be set up to facilitate both the research and to lead into the open–source user community sustainment and enhancement of this geometry/mesh system. The system will be in operation, including user community activity, by the end of the project. This networked framework will then serve to continue the user community involvement beyond the term of this project.

Major focus will be given to the involvement of graduate students and post–docs at both MSU and FSU throughout this effort, as is particularly appropriate with the open–source nature and user community involvement that are inherent to this effort.

BROADER ISSUES. This effort is necessarily large–scale because the deliverable is a major software system developed through close virtual collaboration among computer scientists and engineers/mathematicians with expertise in geometry/mesh computational technology. Smaller–scale effort could only serve to make incremental advances in the level of capability of geometry/mesh generation systems for computational science, and would not enable the addressing of the challenges in computer science that are the determining factors in the development of this usable and extendable system.

This large–scale project – requiring close interaction among computer science and engineering – is ideal for the cross–disciplinary education of graduate students. And the breadth of the effort requires a large number of students addressing the different aspects of the problem, but in coordinated effort. MSU has an established relationship with Jackson State University – which produces more African American CS graduates than any other university of any kind in the country – and FSU has an established relationship with Florida A&M. Both of these HBCUs will be involved in this effort.

This effort will address a major pacing item in computational science: the geometry/mesh generation that is inherent in computational simulation of field phenomena, i.e. the computational solution of partial differential equations. Particularly significant is that this system will be adaptable and steerable, both in dynamic coupling with the PDE solution and for the design mode in application. This large–scale software development will thus significantly enhance the infrastructure for research in computational science, both for scientific investigation and for engineering analysis and design.

Dissemination of results is inherent and fundamental to this open–source software effort. The computational science user community, working with interested computer scientists, will continually enhance and extend this system, as well as putting it into application.

The NSF ERC at MSU.

Initially funded by NSF in 1990 as an NSF Engineering Research Center (ERC), the ERC for Computational Field Simulation at Mississippi State is a multi–disciplinary academic research center with research funded by NSF, DoD, NASA, DoE, and industry. This ERC is thus well positioned to leverage effort across NSF and mission agencies. This Center focuses on all elements involved in the computational simulation of physical field phenomena: physical processes occurring over space and time, i.e. governed by partial differential equations – computationally intense simulations requiring access and efficient utilization of HPC facilities at the highest level.

This Center necessarily incorporates engineers, physicists, computer scientists, and mathematicians in cross–disciplinary research in geometrical representation, numerical solutions, and scientific visualization – together with the underlying parallel computing environments and mathematical foundations. This ERC is the only one of the NSF ERCs with its focus directly on high performance computing, and has been a major player in the progress of MPI. Although the Center's historical concentration has been in computational fluid dynamics, its strategic research efforts in building computational problem solving environments encompasses all areas of field physics.

The NSF ERC at Mississippi State took the leadership role in setting up a university team to join with Nichols Research of Huntsville and E–Systems of Dallas to respond to the DoD competitive solicitation for support of the four DoD HPC Major Shared Resource Centers (MSRCs) in the DoD High Performance Computing Modernization Program (HPCMP). This university team has the responsibility for the Programming Environment and Training (PET) element of this support, amounting to some $4M @ year at each of the four MSRCs. Winning this DoD competition represents something of an NSF success story, since the nucleus of the team was an NSF ERC (MSU), an NSF S&TC (CRPC–Rice), and an NSF SCC (NCSA–Illinois).

This Center has built and expanded on established nationally–recognized research effort in mesh generation at Mississippi State (recognized by the 1992 AIAA Aerodynamics Award to Thompson), and has now made major advances in unstructured mesh generation, as well as in its traditional area of block–structured mesh generation. The Center has produced the comprehensive "Handbook of Grid Generation" published by CRC Press in 1999.

REFERENCES.

1. "Using Gateway System to Provide a Desktop Access to High Performance Computational Resources", Erol Akarsu, Geoffrey Fox, Tomasz Haupt, Alexey Kalinichenko, Kang–Seok Kim, Praveen Sheethaalnath, and Choon–Han Youn, *Proceedings of HPDC–8 Conference*, Redondo Beach Ca., Aug 3–6, 1999, IEEE Press, http://neumann.computer.org/conferen/proceed/hpdc/0287/0287toc.htm

2. Ninja – http://ninja.cs.berkeley.edu/

3. E–speak – http://www.e–speak.hp.com/

4. Initial Description of CPW (Collaborative Portal on the Web) – http://www.npac.syr.edu/users/gcf/offbeatxmloct99/

5. TangoInteractive – http://www.npac.syr.edu/tango

6. Fox, G., Scavo T., Bernholdt D.,Markowski R.,McCracken N.,Podgorny M., Mitra D. and Malluhi Q., "Synchronous Learning at a Distance: Experiences with TangoInteractive", in *Proceedings of SC98*, Orlando, November 1998.

7. "A Reference Architecture for Distributed Collaborative Applications", technical report by Vassil Roussev from University of North Carolina Collaboration Bus Project, 1999. http://www.cs.unc.edu/~dewan/cb.html

8. "Collaborative Visualization", PhD Thesis by Jason Wood, University of Leeds, School of Computer Science 1998.

9. Habanero Home Page at NCSA – http://havefun.ncsa.uiuc.edu/habanero/

10. "Handbook of Grid Generation", Joe F. Thompson, Bharat K. Soni, Nigel P. Weatherill (Eds), CRC Press, 1999. http://www.crcpress.com/catalog/2687.htm

11. NSF ERC at Mississippi State – http://www.erc.msstate.edu

Joe F. Thompson
William L. Giles Distinguished Professor of Aerospace Engineering
P. O. Box 9627, NSF Engineering Research Center
Phone: 662–325–7299 Fax Number: 662 325–7692
joe@erc.msstate.edu

Education

PhD, Aerospace Engineering, Georgia Institute of Technology, 1971
MS, Aerospace Engineering, Mississippi State University, 1963
BS, Physics, Mississippi State University, 1961, "Highest Honors"

Employment

Department of Aerospace Engineering, Mississippi State University, 1964–Present
Marshall Space Flight Center, NASA, 1963–1964

Closely Related Publications

1. *Handbook for Grid Generation,* Joe F. Thompson, Bharat K. Soni, Nigel Weatherill (Eds), CRC Press, 1999.
2. *Handbook for Computer Science and Engineering* (Editorial Board, Editor for Computational Science Section), Allen Tucker (Ed.), CRC Press, 1997.
3. *Numerical Grid Generation: Foundations and Applications*, Joe F. Thompson, Z. U. A. Warsi, and C. W. Mastin, North–Holland, 1985. (Available on the Web at www.erc.msstate.edu)
4. Chrisochoides, N., Fox, G., and Thompson, J.F., "Menus–PGG: A Mapping Environment for Unstructured and Structured Numerical Parallel Grid Generation," *Contemporary Mathematics*, Volume 180, pp. 381–386, 1994.
5. "A Survey of Grid Generation Techniques and Systems with Emphasis on Recent Development," J.F. Thompson and B. Hamann, *Surveys on Mathematics for Industry,"* Chp. 6, p. 289, Springer–Verlag, 1997.

Other Significant Publications

1. Luong, P.V., Thompson, J.F., and Gatlin, B., "Solution–Adaptive and Quality–Enhancing Grid Generation," *Journal Of Aircraft*, Vol. 3, Page 2, 1993.
2. Thompson, J., "The National Grid Project," *Computing Systems in Engineering*, Vol 3, Nos. 1–4, pp. 393–399, 1992.
3. Tu, Y., and Thompson, J.F., "Three–Dimensional Solution–Adaptive Grid Generation on Composite Configurations," *AIAA Journal*, Vol. 29, No. 12, pp. 2025–2026, 1991.
4. Warsi, Z.U.A., and Thompson, J.F., "Application of Variational Methods in The Fixed and Adaptive Grid Generation," *Computers & Mathematical Applications*, Vol. 19, No. 8–9, p. 31, 1990.
5. Thompson, J.F., "A General Three–Dimensional Elliptic Grid Generation System on a Composite Block Structure," *Computer Methods in Applied Mechanics and Engineering*, Vol. 64, p. 377, 1987.

Synergistic Activities

1. Founding Director, NSF Engineering Research Center for Computational Field Simulation at Miss State University
2. Led the formation of the multi–university team that teamed with Nichols Research and Raytheon/E–Systems to win the support contracts for Programming Environment & Training (PET) at three of the four DoD HPC Major Shared Resource Centers (MSRCs) as part of the DoD HPC Modernization Program, and now leads this team for the MSRC at the Army Engineer Research & Development Center in Vicksburg, Mississippi
3. Editorial board, *Journal of Computational Physics*
4. Appointed by President Clinton to the President's Information Technology Advisory Committee (PITAC)

Collaborators ***(DoD Programming Environment & Training Contract)***

Polly Baker, *NCSA, Illinois*
Keith Bedford, *Ohio State*
Charles Bender, *Ohio State*
David Bernholdt, *Syracuse*
Willie Brown, *Jackson State*
Shirley Browne, *Tennessee*
Graham Carey, *Texas*
Jack Dongarra, *Tennessee*
Geoffrey Fox, *Syracuse*
Richard Hanson, *Rice*
Ken Kennedy, *Rice*
Chuck Koelbel, *Rice (now NSF)*
Raghu Machiraju, *Ohio State*
Wayne Mastin, *Nichols Research Corporation*
Tinsley Oden, *Texas*
Larry Smarr, *NCSA, Illinois*
Louis Turcotte, *Army Engineer Research & Development Center*
Mary Wheeler, *Texas*

Collaborators ***(Handbook of Grid Generation)***

Michael Aftosmis, *NASA Ames*
Timothy Baker, *Princeton*
Mark Beall, *Rensselaer Polytechnic Institute*
Marsha Berger, *Courant Institute*
William Chan, *MCAT/NASA Ames*
Zheming Cheng, *Program Development Corporation*
Hugues deCougny, *Rensselaer Polytechnic Institute*
Luis Eca, *Technical University of Lisbon*
Peter Eiseman, *Program Development Corporation*
Austin Evans, *NASA Lewis*
Gerald Farin, *Arizona State*
David Ferguson, *Boeing*
Luca Formaggia, *Ecole Polytechnique Federale de Lausanne*
Timothy Gatzke, *Boeing*
Paul–Louis George, *INRIA*
Bernd Hamann, *University of California, Davis*
O. Hassan, *University of Wales Swansea*
Jochem Hauser, *CLE Salzgitter Bad*
Frederic Hecht, *INRIA*
Sergey A. Ivanenko, *Computer Center of the Russian Academy of Sciences*
Olivier–Pierre Jacquotte, *Research Directorate*
Brian Jean, *Los Alamos*
Yannis Kallinderis, *University of Texas, Austin*
O.B. Khairullina, *Urals Branch of the Russian Academy of Sciences*
Ahmed Khamayseh, *Los Alamos*
Andrew Kuprat, *Los Alamos*
Kelly Laflin, *North Carolina State*
Kunwoo Lee, *Seoul National University*
David Marcum, *Mississippi State*
C. Wayne Mastin, *Nichols Research Corporation*
D. Scott McRae, *North Carolina State*
Robert Meakin, *Army Aeroflightdynamics Directorate*
John Melton, *NASA Ames*
David Miller, *NASA Lewis*
K. Morgan, *University of Wales Swansea*
Robert O'Bara, *Rensselaer Polytechnic Institute*
Sangkun Park, *Information Technology R&D Center*
J. Peiro, *Imperial College*
J. Peraire, *MIT*
E.J. Probert, *University of Wales Swansea*
Anshuman Razdam, *Arizona State*
Robert Schneiders, *MAGMA Giessereitechnologie GmbH*
Jonathon Shaw, *Aircraft Research Association*
A.F. Sidorov, *Urals Branch of the Russian Academy of Sciences*
Mark Shephard, *Rensselaer Polytechnic Institute*
Bharat Soni, *Mississippi State*
Stefan Spekreijse, *National Aerospace Lab*
O.V. Ushakova, *Urals Branch of the Russian Academy of Sciences*
Zahir U.A. Warsi, *Mississippi State*
Nigel Weatherill, *University of Wales Swansea*
Tzu–Yi Yu, *Chaoyang University of Technology*
Paul Zegeling, *University of Utrecht*
Yang Zia, *CLE Salzgitter Bad*

Collaborators ***(President's Information Technology Advisory Committee)***

Eric Benhamou, *3Com Corporation*
Vinton Cerf, *MCI WorldCom*
Ching–Chih Chen, *Simmons College*
David Cooper, *Livermore National Lab*
Steven Dorfman, *Hughes Electronics Corporation*
David Dorman, *PointCast*
Robert Ewald, *Cray Research*
David Farber, *University of Pennsylvania*
Sherrilynne Fuller, *University of Washington*
Hector Garcia–Molina, *Stanford*
Susan Graham, *University of California, Berkeley*
James Gray, *Microsoft Research*
W. Daniel Hillis, *Walt Disney Imagineering*
Bill Joy, *Sun Microsystems*
Robert Kahn, *Corporation for National Research Initiatives*
Ken Kennedy, *Rice*
John Miller, *Montana State*
David Nagel, *AT&T Labs*
Raj Reddy, *Carnegie Mellon*
Edward Shortliffe, *Stanford School of Medicine*
Larry Smarr, *University of Illinois, Urbana–Champaign*
Leslie Vadasz, *Intel*
Andrew Viterbi, *QUALCOMM*
Steven Wallach, *CenterPoint Ventures*
Irving Wladawsky–Berger, *IBM*

Graduate Advisors

PhD, James Wu – *Retired, Georgia Tech*

MS, Joseph Cornish – *Retired, Lockheed*

Thesis Advisor

John West, *Army Engineer Research & Development Center*

29 Total PhD & MS Students

Geoffrey Charles Fox

NPAC Syracuse University, 111 College Place, Syracuse, NY 13244–4100
Phone: 315–443–2163 **Fax:** 315–443–4741
gcf@npac.syr.edu
http://www.npac.syr.edu

Education

PhD, Theoretical Physics, Cambridge University, 1967

MS, Cambridge University, 1968

BS, Mathematics, Cambridge University, Cambridge, England, 1964

Employment

2000–	***Professor***, Computer Science, Florida State University
1990–2000	***Professor***, Computer Science, Syracuse University
1990–2000	***Professor,*** Physics, Syracuse University
1990–2000	***Director***, Northeast Parallel Architectures Center
1979–1990	***Professor***, Physics, California Institute of Technology
1986–1988	***Associate Provost***, Computing, California Institute of Technology
1983–1985	***Dean***, Educational Computing, California Institute of Technology
1981–1983	***Executive Officer***, Physics, California Institute of Technology
1974–1979	***Associate Professor***, Physics, California Institute of Technology
1971–1974	***Assistant Professor***, Physics, California Institute of Technology
1970–1971	***Millikan Research Fellow***, Theoretical Physics, Caltech
1970	***Visiting Scientist***, Brookhaven National Laboratory, Long Island
1969–1970	***Research Fellow***, Peterhouse College, Cavendish Lab.,Cambridge
1968–1969	***Research Scientist***, Lawrence Berkeley Lab., Berkeley, Calif.
1967–1968	***Member***, School of Natural Science, Inst. for Advanced Study, Princeton, New Jersey

Selected Publications

1. Fox, G.C., Messina, P., Williams, R., *Parallel Computing Works!*, Morgan Kaufmann, San Mateo, CA, 1994.

2. Akarsu, E., Fox, G.C., Furmanski, W., Haupt, T., "WebFlow – High–Level Programming Environment and Visual Authoring Toolkit for High Performance Distributed Computing," *Proceedings of Supercomputing'98*, Orlando, FL, November 1998.

3. Akarsu, E., Fox, G.C., Furmanski, W., Haupt, T., Kalinichenko, A., Kim, K.–S., Sheethaalnath, P. and Youn, C.–H., "Using Gateway System to Provide a Desktop Access to High Performance Computational Resources", *Proceedings of HPDC–8 Conference*, Redondo Beach CA, August 1999, IEEE Press.

4. Fox, G.C., Furmanski, W., "Computing on the Web, New Approaches to Parallel Processing, Petaop and Exaop Performance in the Year 2007," *IEEE Internet Computing*, Vol.1:2, p.38, 1997.

5. Fox, G.C. and Podgorny, M., "Real Time Training and Integration of Simulation and Planning using the TangoInteractive Collaborative System", Proceedings of International Test and Evaluation Workshop on High Performance Computing, Aberdeen, MD, July 1998.

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION Mississippi State University	**FOR NSF USE ONLY**		
	PROPOSAL NO.	DURATION (months)	
		Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Joe F Thompson	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-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Joe F Thompson - Distinguished Prof, ASE at MSU	2.40	0.00	0.00	$ 107,474	$
2. C.S. Assistant Professor	3.00	0.00	0.00	71,868	
3. Geoffrey C Fox - Professor, CS at FSU	0.00	0.00	0.00	0	
4. Bharat K Soni - Professor, ASE at MSU	3.00	0.00	0.00	100,616	
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (4) TOTAL SENIOR PERSONNEL (1 - 6)	8.40	0.00	0.00	279,958	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (2) POST DOCTORAL ASSOCIATES	12.00	0.00	0.00	400,526	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (6) GRADUATE STUDENTS				216,000	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				896,484	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				214,282	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				1,110,766	

D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)		
TOTAL EQUIPMENT	0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)	15,000	
2. FOREIGN	0	
F. PARTICIPANT SUPPORT COSTS		
1. STIPENDS $ 0		
2. TRAVEL 0		
3. SUBSISTENCE 0		
4. OTHER 0		
(0) TOTAL PARTICIPANT COSTS	0	
G. OTHER DIRECT COSTS		
1. MATERIALS AND SUPPLIES	1,500	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION	0	
3. CONSULTANT SERVICES	0	
4. COMPUTER SERVICES	0	
5. SUBAWARDS	1,264,470	
6. OTHER	1,500	
TOTAL OTHER DIRECT COSTS	1,267,470	
H. TOTAL DIRECT COSTS (A THROUGH G)	2,393,236	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) MTDC (Rate: 41.5000, Base: 1148156)		
TOTAL INDIRECT COSTS (F&A)	476,484	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)	2,869,720	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.D.7.j.)	0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)	$ 2,869,720	$

M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $			
PI / PD TYPED NAME & SIGNATURE* Joe F Thompson	DATE	**FOR NSF USE ONLY**		
		INDIRECT COST RATE VERIFICATION		
ORG. REP. TYPED NAME & SIGNATURE*	DATE	Date Checked	Date Of Rate Sheet	Initials - ORG

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION **Mississippi State University**	**FOR NSF USE ONLY** PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Joe F Thompson**	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-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Joe F Thompson - Distinguished Prof, ASE at MSU	2.40	0.00	0.00	$ 107,474	$
2. C.S. Assistant Professor	3.00	0.00	0.00	71,868	
3. Geoffrey C Fox - Professor, CS at FSU	0.00	0.00	0.00	0	
4. Bharat K Soni - Professor, ASE at MSU	3.00	0.00	0.00	100,616	
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (4) TOTAL SENIOR PERSONNEL (1 - 6)	8.40	0.00	0.00	279,958	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (2) POST DOCTORAL ASSOCIATES	12.00	0.00	0.00	400,526	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (6) GRADUATE STUDENTS				216,000	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				896,484	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				214,282	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				1,110,766	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)				15,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
(0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				1,500	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				1,264,470	
6. OTHER				1,500	
TOTAL OTHER DIRECT COSTS				1,267,470	
H. TOTAL DIRECT COSTS (A THROUGH G)				2,393,236	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				476,484	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				2,869,720	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.D.7.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 2,869,720	$

M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $			
PI / PD TYPED NAME & SIGNATURE* **Joe F Thompson**	DATE	**FOR NSF USE ONLY** INDIRECT COST RATE VERIFICATION		
ORG. REP. TYPED NAME & SIGNATURE*	DATE	Date Checked	Date Of Rate Sheet	Initials - ORG