NATIONAL SCIENCE FOUNDATION

Computer and Computation Research
4201 Wilson Boulevard
Arlington, VA 22230

Dr. David Laidlaw
California Institute of Technology
Division of Biology 139-74
Pasadena, CA 91125

Ref.: CCR-9619649

Dear Dr. Laidlaw:

Your organization should be receiving shortly notification from the National Science Foundation (NSF) Grants Officer that a grant has been awarded with you as the principal investigator. As you know, the Foundation's programs are highly competitive, and we congratulate you on your success.

Verbatim copies of all completed reviews obtained in the processing of your proposal are enclosed. These are forwarded to the principal investigator for all NSF awards and declinations.

NSF is frequently asked to provide information to the Congress and the public regarding the projects it sponsors. As a result we would appreciate being kept informed of interesting research results you obtain during the grant period, as well as any economically significant impact of your work.

We hope that a member of our staff will be able to visit your project sometime during the period of the award. Similarly, if you are in the Washington Metropolitan area, we welcome your visit to our office.

Once again, congratulations. Please call on us if we can assist you in any manner in connection with this award.

Sincerely yours,

Richard B. Kieburtz
Division Director
Computer and Computation
Research
(703) 306-1910
rkieburt@nsf.gov

S. Kamal Abdali
Program Director
Numeric, Symbolic and Geometric
(703) 306-1912
kabdali@nsf.gov

enclosures

Attachment 1

NATIONAL SCIENCE FOUNDATION
Arlington, VA 22230

Division of Computer and Computation Research
General Information for Applicants

The Division of Computer and Computation Research (CCR) reviews in excess of 400 standard unsolicited research proposals per year. Funding is available to support approximately one-third of these proposals. The Division normally seeks advice of independent ad hoc reviewers in arriving at funding decisions.

Verbatim copies of all completed reviews obtained in the processing of your proposal are enclosed. These are forwarded to the principal investigator for all NSF awards and declinations. In reading the reviews, please keep in mind that the reviewers were addressing their comments primarily to the NSF and not necessarily to you as the proposer. Reviewers sometimes make remarks without giving detailed references or providing specific suggestions for improvements. Occasionally reviews contain irrelevant, inappropriate, or erroneous statements that the Program Officer did not use. If such comments are present, they are identified on the review.

Decisions regarding particular proposals are often very difficult. Factors other than the reviewers' comments and ratings enter into the decision. While the scientific merit of the proposal, its merit in relation to other proposals received in the same funding cycle, and the competence of the investigators are always critical, maintaining appropriate balance among subfields, the availability of other funding, the total funds available to the program, and the geographic distribution of work supported by the Foundation are also important decision factors.

Information regarding reconsideration of declined proposals is available in the NSF **Grant Policy Manual**, which should be available at your institution, normally at the office that formally submitted your proposal. Foundation policy is to accept a revised proposal for review and evaluation as a new proposal, in accordance with the designated proposal deadlines, if the reviewers' comments have been substantially addressed.

If you would like additional information about the evaluation of your proposal, please contact the Program Officer with responsibility for the area of your work.

Attachment 1

NATIONAL SCIENCE FOUNDATION
Arlington, VA 22230

Division of Computer and Computation Research
General Information for Applicants

The Division of Computer and Computation Research (CCR) reviews in excess of 400 standard unsolicited research proposals per year. Funding is available to support approximately one-third of these proposals. The Division normally seeks advice of independent ad hoc reviewers in arriving at funding decisions.

Verbatim copies of all completed reviews obtained in the processing of your proposal are enclosed. These are forwarded to the principal investigator for all NSF awards and declinations. In reading the reviews, please keep in mind that the reviewers were addressing their comments primarily to the NSF and not necessarily to you as the proposer. Reviewers sometimes make remarks without giving detailed references or providing specific suggestions for improvements. Occasionally reviews contain irrelevant, inappropriate, or erroneous statements that the Program Officer did not use. If such comments are present, they are identified on the review.

Decisions regarding particular proposals are often very difficult. Factors other than the reviewers' comments and ratings enter into the decision. While the scientific merit of the proposal, its merit in relation to other proposals received in the same funding cycle, and the competence of the investigators are always critical, maintaining appropriate balance among subfields, the availability of other funding, the total funds available to the program, and the geographic distribution of work supported by the Foundation are also important decision factors.

Information regarding reconsideration of declined proposals is available in the NSF **Grant Policy Manual**, which should be available at your institution, normally at the office that formally submitted your proposal. Foundation policy is to accept a revised proposal for review and evaluation as a new proposal, in accordance with the designated proposal deadlines, if the reviewers' comments have been substantially addressed.

If you would like additional information about the evaluation of your proposal, please contact the Program Officer with responsibility for the area of your work.

Attachment 1

NATIONAL SCIENCE FOUNDATION
Arlington, VA 22230

Division of Computer and Computation Research
General Information for Applicants

The Division of Computer and Computation Research (CCR) reviews in excess of 400 standard unsolicited research proposals per year. Funding is available to support approximately one-third of these proposals. The Division normally seeks advice of independent ad hoc reviewers in arriving at funding decisions.

Verbatim copies of all completed reviews obtained in the processing of your proposal are enclosed. These are forwarded to the principal investigator for all NSF awards and declinations. In reading the reviews, please keep in mind that the reviewers were addressing their comments primarily to the NSF and not necessarily to you as the proposer. Reviewers sometimes make remarks without giving detailed references or providing specific suggestions for improvements. Occasionally reviews contain irrelevant, inappropriate, or erroneous statements that the Program Officer did not use. If such comments are present, they are identified on the review.

Decisions regarding particular proposals are often very difficult. Factors other than the reviewers' comments and ratings enter into the decision. While the scientific merit of the proposal, its merit in relation to other proposals received in the same funding cycle, and the competence of the investigators are always critical, maintaining appropriate balance among subfields, the availability of other funding, the total funds available to the program, and the geographic distribution of work supported by the Foundation are also important decision factors.

Information regarding reconsideration of declined proposals is available in the NSF **Grant Policy Manual**, which should be available at your institution, normally at the office that formally submitted your proposal. Foundation policy is to accept a revised proposal for review and evaluation as a new proposal, in accordance with the designated proposal deadlines, if the reviewers' comments have been substantially addressed.

If you would like additional information about the evaluation of your proposal, please contact the Program Officer with responsibility for the area of your work.

Propsal Id: 9619643
PI: Laidlaw
Institution: Caltech

Strengths:
Vector and tensor field visualization is an important unsolved problem. Evaluation via two very different disciplines is very good. The work is quite novel, but risky, with a very high payoff if successful.

Weaknesses:
A collaborating artist seems needed. Care must be taken to avoid showing false structures, hiding important structures and in the interactions between various stroke attributes being used simultaneously. Use of AVS, although worthwhile for prototyping, is an obstacle to dissemination. Some relevant work is not referenced, in particular, papers from the IEEE Visualization Conferences (eg Interrante, et al, 1995) and the UC Santa Cruz work of Pang et al, on "spray cans" and smart particles."

How much skill and/or training will be needed to employ these techniques effectively?

NATIONAL SCIENCE FOUNDATION

OMB NO: 3145-0060
NSF FORM 1(5/90)

PROPOSAL EVALUATION FORM

PROPOSAL NO.	INSTITUTION	PLEASE RETURN BY
96-19649	Cal. Tech.	11/22/96

PRINCIPAL INVESTIGATOR	NSF PROGRAM
D. Laidlaw	NUMER, SYMBOL & GEOMETRIC COMP

TITLE

Computer graphics tools for understanding tensor-valued volume data

Please evaluate this proposal using the criteria presented on the back of this review form. Continue on additional sheet(s) as necessary. If appropriate, please include in a separate paragraph, comments on the quality of the prior work described in the 'Results from Prior NSF Support' section.

See attached.

OVERALL RATING ☐ EXCELLENT ☐ VERY GOOD ☒ GOOD ☐ FAIR ☐ POOR

[redacted]

NSF Proposal Evaluation Form

Proposal No: 96-19649
Institution: Cal Tech
PI: David Laidlaw
NSF Program: Numer, Symbol & Geometric Comp
Title: Computer Graphics tools for understanding tensor-valued volume data

This proposal deals with a very important and unsolved problem in visualization, that of the visualization and understanding of vector-and tensor-valued volume data. The PI plan to develop visualization techniques using a painter metaphor: paints layers and brush stokes. Although this approach has been used in creating art or illustration, its application in visualization is new. The PI proposes to use AVS for the implementation, and several in-house applications in biology and flow for the evaluation. (which is a big plus). However, the proposed techniques will simultaneously display multi-valued multi-variate data using size, shape, texture, blending, color, placement and orientation of multi-layered strokes. This "messy" display might be misleading by falsely showing nonexistent structures and hidding other important structures. This is especially critical for exploring unknown data. Furthermore, the use of the commercial package of AVS, which is NOT readily available to most of the community, makes the developed techniques difficult to disseminate.

No results from prior NSF support are reported.

NATIONAL SCIENCE FOUNDATION

OMB NO: 3145-0060
NSF FORM 1(5/90)

PROPOSAL EVALUATION FORM

PROPOSAL NO.	INSTITUTION	PLEASE RETURN BY
9619649	California Institute of Technology	11/22/96

PRINCIPAL INVESTIGATOR	NSF PROGRAM
David Laidlaw	NUMER, SYMBOL & GEOMETRIC COMP

TITLE

Computer Graphics Tools for Understanding Tensor-Valued Volume Data: A Painting Metaphor

Please evaluate this proposal using the criteria presented on the back of this review form. Continue on additional sheet(s) as necessary. If appropriate, please include in a separate paragraph, comments on the quality of the prior work described in the 'Results from Prior NSF Support' section.

OVERALL RATING ☐ EXCELLENT ☒ VERY GOOD ☐ GOOD ☐ FAIR ☐ POOR

[redacted]

Proposal Number: 96-19649

Overall Evaluation:
Fatal flaw is no artist collaborator identified!

Proposal Evaluation Criteria:

1. Research performance competence
1.1 Capability of the investigators

No artist collaborators are indicated. Fatal flaw in my opinion.

1.2 Technical soundness of the proposed approach

No references from the Visualization conference series! Art books felt "thrown-in" for effect. I would have liked to have seen a review of how the artists do it as a precursor to how to do it in graphics.

The idea of using AVS as a foundation is sound.

Well thought out and presented proposal

1.3 Adequacy of the institutional resources available

Adequate

1.4 Comments on recent research performance

Has published in the area of visualization of the types of data proposed to be used as test applications in this work.

2. Intrinsic merit of the research. (Likelihood that research will lead to new discoveries or fundamental advances within its field of science or engineering or have substantial impact on progress in that field or in other scientific and engineering fields).

I believe that it is time to look to the artists for understanding of how to represent multiple parameters. Some preliminary results, Interrante (Viz '96), are encouraging. This will be a process of developing a new set of metaphors and getting them to the place they are "standard" so that they have a shared meaning. Then there is the task of teaching the metaphors to the users and insuring that they understand the intended meanings.

This stuff is a little weird, but I think it may pay off sometime.

3. Utility or relevance of the research. (Likelihood that research can contribute to the achievement of a goal that is extrinsic or in addition to that of the research field itself, and thereby serve as the basis for new or improved technology or assist in the solution of societal problems).

It may be a while. There may be resistance to any representation which appears more abstract than the abstraction we currently say is looking at the "real data".

4. Effect of the research on the infrastructure of science and engineering (Potential of the proposed research to contribute to better understanding or improvement of the quality, distribution or effectiveness of the Nation's scientific and engineering research, education, and human resources base).

Might, but it will be like getting doctors to use 3D imaging or color...it will be an academic generation before it would be used...after it is developed.

NATIONAL SCIENCE FOUNDATION

OMB NO: 3145-0060
NSF FORM 1(5/90)

PROPOSAL EVALUATION FORM

PROPOSAL NO.	INSTITUTION	PLEASE RETURN BY
96-19649	California Institute of Technology	11/22/96

PRINCIPAL INVESTIGATOR	NSF PROGRAM
David Laidlaw	NUMER, SYMBOL & GEOMETRIC COMP

TITLE

Computer Graphics Tools for Understanding Tensor-Valued Volume Data: A Painting Metaphor

Please evaluate this proposal using the criteria presented on the back of this review form. Continue on additional sheet(s) as necessary. If appropriate, please include in a separate paragraph, comments on the quality of the prior work described in the 'Results from Prior NSF Support' section.

OVERALL RATING ☐ EXCELLENT ☑ VERY GOOD ☐ GOOD ☐ FAIR ☐ POOR

[redacted]

Computer Graphics Tools for Understanding Tensor-Valued Volume Data:
A Painting Approach

David Laidlaw
California Institute of Technology

1. Research performance competence:

CalTech obviously has adequate institutional resources for this project and the letters of support from others, particularly Fraser and Dimotakis, indicate that the resources will be made available for this particular project. David Laidlaw received his PhD only recently and still has a substantial research publication record. His recent SIGGRAPH contribution is of high quality as well as useful.

The proposed approach is a novel method for visualization, applied to a recognized problem for which few other methods have been proposed and none are widely used. The only vaguely related work I know that is not mentioned in section 2.5 is the "spray can" and "smart particle" work done by a group at UC Santa Cruz. That work does not address tensor-valued data and only lightly touches vectors. Laidlaw's proposed work is quite different, in both the many aspects of brush strokes and the notions of where the strokes will be placed and how multiple sets of strokes may interact. The method is interesting; I can not predict how successful it will be. I am pleased, therefore, to see the emphasis on evaluation based on usé in several real applications.

There are two issues that may impact the success of these methods that were not directly addressed in the proposal. The first issue is that several parameters of brush strokes are likely to interact with each other, limiting the possibility of using all the parameters together through their full ranges of values. For example, color becomes less useful as a stroke becomes more transparent and shape is less distinguishable as strokes become very small. The second issue has to do with variation between individuals. How much skill or training may be needed to employ the tools effectively? How much skill, training or explanation may be needed to interpret results accurately? I believe these questions can be addressed in the course of the research as it is proposed.

2. Intrinsic merit of the research:

If the tools developed are completely successful, it will have a very significant impact in scientific visualization, as well as in those disciplines in which tensor-valued data is important. Even if the tools developed are only moderately useful, the stimulation to the field from such a different approach is important.

3. Utility or relevance of the research:

As with all the best scientific visualization work, the results are designed to be useful to users outside the field. In this case two biological applications and one application that bridges from physics to aeronautics are to be used in evaluations which will guide the course of the work. Several engineering disciplines would find better tensor visualization tools very helpful.

Because of the reduced budget and period of effort, the scope of the project will be modified as follows:

1. The research proposed in Section 4.1 be carried out as described.

2. The research proposed in Sections 4.2 will be done if time and funds permit.

3. The research proposed in Sections 4.3 will not be attempted.