COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./DUE DATE NSF 15-585 11/02/16	☐ Special Exception to Deadline Date Policy	FOR NSF USE ONLY NSF PROPOSAL NUMBER **1712495**
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) DUE - IUSE-Engaged Student Le: Design & Development I&II		

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
11/02/2016	1	11040000 DUE	1998	800188161	01/13/2017 3:15pm S

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN) 751305566	SHOW PREVIOUS AWARD NO. IF THIS IS ☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE University of Texas at Dallas	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE University of Texas at Dallas 800 W. Campbell Rd., AD15 Richardson, TX. 750803021
AWARDEE ORGANIZATION CODE (IF KNOWN) 0035691000	
NAME OF PRIMARY PLACE OF PERF University of Texas at Dallas	ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE University of Texas at Dallas TX ,750830688 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions) ☐ SMALL BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS | ☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: Geoscience Animation: Construction, Evaluation, and Modification of Plate Tectonic Concepts for Geosciences Education**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 199,999	36 months	06/01/17	

THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW
- ☐ BEGINNING INVESTIGATOR (GPG I.G.2)
- ☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
- ☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
- ☐ HISTORIC PLACES (GPG II.C.2.j)
- ☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date ________ PHS Animal Welfare Assurance Number ________
- ☒ FUNDING MECHANISM Research - other than RAPID or EAGER
- ☒ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number A00005412 Exemption Subsection pending or IRB App. Date ________
- ☐ INTERNATIONAL ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
- ☒ COLLABORATIVE STATUS A collaborative proposal from multiple organizations (GPG II.D.4.b)

PI/PD DEPARTMENT Center for Lithospheric Studies	PI/PD POSTAL ADDRESS P.O. Box 830688 MS/FA31 Richardson, TX 750830688 United States
PI/PD FAX NUMBER 972-883-2537	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Email Address
PI/PD NAME Robert J Stern	PhD	1979	972-883-2442	rjstern@utdallas.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

CERTIFICATION PAGE

Certification for Authorized Organizational Representative (or Equivalent) or Individual Applicant

By electronically signing and submitting this proposal, the Authorized Organizational Representative (AOR) or Individual Applicant 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 conflict of interest (when applicable), drug-free workplace, debarment and suspension, lobbying activities (see below), nondiscrimination, flood hazard insurance (when applicable), responsible conduct of research, organizational support, Federal tax obligations, unpaid Federal tax liability, and criminal convictions as set forth in the NSF Proposal & Award Policies & Procedures Guide,Part I: the Grant Proposal Guide (GPG). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U.S. Code, Title 18, Section 1001).

Certification Regarding Conflict of Interest

The AOR is required to complete certifications stating that the organization has implemented and is enforcing a written policy on conflicts of interest (COI), consistent with the provisions of AAG Chapter IV.A.; that, to the best of his/her knowledge, all financial disclosures required by the conflict of interest policy were made; and that conflicts of interest, if any, were, or prior to the organization's expenditure of any funds under the award, will be, satisfactorily managed, reduced or eliminated in accordance with the organization's conflict of interest policy. Conflicts that cannot be satisfactorily managed, reduced or eliminated and research that proceeds without the imposition of conditions or restrictions when a conflict of interest exists, must be disclosed to NSF via use of the Notifications and Requests Module in FastLane.

Drug Free Work Place Certification

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent), is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

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

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 ☒

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

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 of Lobbying Activities,'' 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.

Certification Regarding Nondiscrimination

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

Certification Regarding Responsible Conduct of Research (RCR)
(This certification is not applicable to proposals for conferences, symposia, and workshops.)

By electronically signing the Certification Pages, the Authorized Organizational Representative is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.B., the institution has a plan in place to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research.
The AOR shall require that the language of this certification be included in any award documents for all subawards at all tiers.

CERTIFICATION PAGE - CONTINUED

Certification Regarding Organizational Support

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that there is organizational support for the proposal as required by Section 526 of the America COMPETES Reauthorization Act of 2010. This support extends to the portion of the proposal developed to satisfy the Broader Impacts Review Criterion as well as the Intellectual Merit Review Criterion, and any additional review criteria specified in the solicitation. Organizational support will be made available, as described in the proposal, in order to address the broader impacts and intellectual merit activities to be undertaken.

Certification Regarding Federal Tax Obligations

When the proposal exceeds $5,000,000, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal tax obligations. By electronically signing the Certification pages, the Authorized Organizational Representative is certifying that, to the best of their knowledge and belief, the proposing organization:
(1) has filed all Federal tax returns required during the three years preceding this certification;
(2) has not been convicted of a criminal offense under the Internal Revenue Code of 1986; and
(3) has not, more than 90 days prior to this certification, been notified of any unpaid Federal tax assessment for which the liability remains unsatisfied, unless the assessment is the subject of an installment agreement or offer in compromise that has been approved by the Internal Revenue Service and is not in default, or the assessment is the subject of a non-frivolous administrative or judicial proceeding.

Certification Regarding Unpaid Federal Tax Liability

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal Tax Liability:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has no unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

Certification Regarding Criminal Convictions

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Criminal Convictions:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has not been convicted of a felony criminal violation under any Federal law within the 24 months preceding the date on which the certification is signed.

Certification Dual Use Research of Concern

By electronically signing the certification pages, the Authorized Organizational Representative is certifying that the organization will be or is in compliance with all aspects of the United States Government Policy for Institutional Oversight of Life Sciences Dual Use Research of Concern.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME Lela Paksoy	Electronic Signature	Nov 2 2016 5:41PM

TELEPHONE NUMBER	EMAIL ADDRESS	FAX NUMBER
972-883-2041	lxp160130@utdallas.edu	

Not for distribution

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./DUE DATE	☐ Special Exception to Deadline Date Policy	FOR NSF USE ONLY
NSF 15-585 11/02/16		NSF PROPOSAL NUMBER
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) DUE - IUSE- Exploration & Design: Engaged Student Learni		1712206

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
11/02/2016	1	11040000 DUE	1998	069687242	01/13/2017 3:15pm S

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?
593102112	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE
University of South Florida	University of South Florida 3702 Spectrum Blvd. Tampa, FL. 336129446
AWARDEE ORGANIZATION CODE (IF KNOWN) 0015370000	
NAME OF PRIMARY PLACE OF PERF University of South Florida	ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE University of South Florida 3702 Spectrum Blvd Tampa ,FL ,336129446 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS
☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT: **Collaborative Research: Geoscience Animations: Construction, Evaluation and Modification of Plate Tectonic Concepts for Geoscience Education**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 99,982	36 months	06/01/17	

THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW
☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date ____
PHS Animal Welfare Assurance Number ____
☒ FUNDING MECHANISM Research - other than RAPID or EAGER
☒ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number ____
Exemption Subsection pending or IRB App. Date ____
☐ INTERNATIONAL ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
☒ COLLABORATIVE STATUS
A collaborative proposal from multiple organizations (GPG II.D.4.b)

PI/PD DEPARTMENT	PI/PD POSTAL ADDRESS
Department of Geology	4202 East Fowler Avenue SCA 528 Tampa, FL 33620 United States
PI/PD FAX NUMBER 813-974-2654	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Email Address
PI/PD NAME Jeffrey G Ryan	PhD	1989	813-974-1598	ryan@mail.usf.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

CERTIFICATION PAGE

Certification for Authorized Organizational Representative (or Equivalent) or Individual Applicant

By electronically signing and submitting this proposal, the Authorized Organizational Representative (AOR) or Individual Applicant 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 conflict of interest (when applicable), drug-free workplace, debarment and suspension, lobbying activities (see below), nondiscrimination, flood hazard insurance (when applicable), responsible conduct of research, organizational support, Federal tax obligations, unpaid Federal tax liability, and criminal convictions as set forth in the NSF Proposal & Award Policies & Procedures Guide,Part I: the Grant Proposal Guide (GPG). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U.S. Code, Title 18, Section 1001).

Certification Regarding Conflict of Interest

The AOR is required to complete certifications stating that the organization has implemented and is enforcing a written policy on conflicts of interest (COI), consistent with the provisions of AAG Chapter IV.A.; that, to the best of his/her knowledge, all financial disclosures required by the conflict of interest policy were made; and that conflicts of interest, if any, were, or prior to the organization's expenditure of any funds under the award, will be, satisfactorily managed, reduced or eliminated in accordance with the organization's conflict of interest policy. Conflicts that cannot be satisfactorily managed, reduced or eliminated and research that proceeds without the imposition of conditions or restrictions when a conflict of interest exists, must be disclosed to NSF via use of the Notifications and Requests Module in FastLane.

Drug Free Work Place Certification

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent), is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

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

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 ☒

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

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 of Lobbying Activities,'' 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.

Certification Regarding Nondiscrimination

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:
(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:
(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

Certification Regarding Responsible Conduct of Research (RCR)
(This certification is not applicable to proposals for conferences, symposia, and workshops.)

By electronically signing the Certification Pages, the Authorized Organizational Representative is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.B., the institution has a plan in place to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research.
The AOR shall require that the language of this certification be included in any award documents for all subawards at all tiers.

CERTIFICATION PAGE - CONTINUED

Certification Regarding Organizational Support

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that there is organizational support for the proposal as required by Section 526 of the America COMPETES Reauthorization Act of 2010. This support extends to the portion of the proposal developed to satisfy the Broader Impacts Review Criterion as well as the Intellectual Merit Review Criterion, and any additional review criteria specified in the solicitation. Organizational support will be made available, as described in the proposal, in order to address the broader impacts and intellectual merit activities to be undertaken.

Certification Regarding Federal Tax Obligations

When the proposal exceeds $5,000,000, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal tax obligations.
By electronically signing the Certification pages, the Authorized Organizational Representative is certifying that, to the best of their knowledge and belief, the proposing organization:
(1) has filed all Federal tax returns required during the three years preceding this certification;
(2) has not been convicted of a criminal offense under the Internal Revenue Code of 1986; and
(3) has not, more than 90 days prior to this certification, been notified of any unpaid Federal tax assessment for which the liability remains unsatisfied, unless the assessment is the subject of an installment agreement or offer in compromise that has been approved by the Internal Revenue Service and is not in default, or the assessment is the subject of a non-frivolous administrative or judicial proceeding.

Certification Regarding Unpaid Federal Tax Liability

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal Tax Liability:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has no unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

Certification Regarding Criminal Convictions

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Criminal Convictions:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has not been convicted of a felony criminal violation under any Federal law within the 24 months preceding the date on which the certification is signed.

Certification Dual Use Research of Concern

By electronically signing the certification pages, the Authorized Organizational Representative is certifying that the organization will be or is in compliance with all aspects of the United States Government Policy for Institutional Oversight of Life Sciences Dual Use Research of Concern.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Kelley Schuler**	**Electronic Signature**	**Nov 2 2016 1:51PM**

TELEPHONE NUMBER	EMAIL ADDRESS	FAX NUMBER
	kschuler@usf.edu	

NATIONAL SCIENCE FOUNDATION
Division of Undergraduate Education

NSF FORM 1295: PROJECT DATA FORM

The instructions and codes to be used in completing this form are provided in Appendix II.

1. **Program-track** to which the Proposal is submitted: **IUSE-Engaged Student Le: Design & Development I&II**
2. Name of **Principal Investigator/Project Director** (as shown on the Cover Sheet):
   Stern, Robert
3. Name of submitting **Institution** (as shown on Cover Sheet):
   University of Texas at Dallas
4. **Other Institutions** involved in the project's operation:
   U S. Florida
   Collin College

Project Data:

A. Major Discipline Code: **42**
B. Academic Focus Level of Project: **BO**
C. Highest Degree Code: **D**
D. Category Code: **--**
E. Business/Industry Participation Code: **NA**
F. Audience Code: __ __ __ __ __ __ __ __
G. Institution Code: **PUBL**
H. Strategic Area Code: _____
I. Project Features: __ __ __ __ __

Estimated number in each of the following categories to be directly affected by the activities of the project during its operation:

J. Undergraduate Students: **500**
K. Pre-college Students: **0**
L. College Faculty: **10**
M. Pre-college Teachers: **0**
N. Graduate Students: **2**

NATIONAL SCIENCE FOUNDATION
Division of Undergraduate Education

NSF FORM 1295: PROJECT DATA FORM

The instructions and codes to be used in completing this form are provided in Appendix II.

1. **Program-track** to which the Proposal is submitted: **IUSE- Exploration & Design: Engaged Student Learni**
2. Name of **Principal Investigator/Project Director** (as shown on the Cover Sheet):
   Ryan, Jeffrey
3. Name of submitting **Institution** (as shown on Cover Sheet):
   University of South Florida
4. **Other Institutions** involved in the project's operation:

Project Data:

A. Major Discipline Code: **42**

B. Academic Focus Level of Project: **BO**

C. Highest Degree Code: **D**

D. Category Code: **--**

E. Business/Industry Participation Code: **NA**

F. Audience Code: __ __ __ __ __ __ __ __

G. Institution Code: **PUBL**

H. Strategic Area Code: _____

I. Project Features: **3** __ __ __ __

Estimated number in each of the following categories to be directly affected by the activities of the project during its operation:

J. Undergraduate Students: **100**

K. Pre-college Students: **0**

L. College Faculty: **5**

M. Pre-college Teachers: **0**

N. Graduate Students: **1**

PROJECT SUMMARY

Overview:

Geoscience students in both upper and lower level undergraduate courses can benefit from more accurate and effective animations of deeply-hidden Earth processes. We will generate, assess, and disseminate two sets of new animations about fundamental tectonic processes such as continental rifting, continental collision, transform faulting, or planetary tectonics. Technically talented undergraduates from the UTD School of Arts, Technology, and Emerging Communication will work closely with UTD geoscientists to generate ~5-10 minute annotated animations for both lower- and upper-level undergraduate audiences, which will then be refined by a professional animator. These will be formatively reviewed in courses at two large universities and a community college, and refined for wide dissemination and use.

Intellectual Merit:

Undergraduate students learn better if provided with high-quality, accurate animations of important Earth processes. Animations help students conceptualize complex processes, reducing their cognitive load as compared to learning situations in which the process or the procedure has to be reconstructed from text, lecture, or static pictures. However, it is unclear how much detail is optimal to include in a geoscientific animation; more accurate animations that are longer and introduce more new terms may impose too great of a cognitive load on beginning students. A pilot animation project "Plate Tectonics Basics 1" provided the means to establish a method for making attractive and accurate geoscientific animations, and effectively assessing and disseminating them. Assessment results for the pilot animation showed that while longer, more detailed animations are effective in aiding learning for upper division geoscience majors, they are less effective in introductory geoscience classes, for several possible reasons. In this project we will generate and test animations tailored to the needs of both levels of students. Diverse student cohorts in the Dallas-Fort Worth (TX) and Tampa-Orlando (FL) metropolitan areas will be targeted.

Broader Impacts:

Six main broader impacts will result from this study:
1. The produced animations will positively impact the learning and motivation to learn by many geoscience students and these are likely to help attract more students to study geoscience.
2. Working with ATEC undergraduate students to develop the draft animation will strengthen ties between two very different schools at UTD which otherwise would not have much interaction. This interaction is likely to foster future collaborations between the two schools to better show scientific concepts via animation and visualization.
3. The animations resulting from this project will be shared with NSF geoscience initiatives like GeoPRISMS and IODP to post on their "Education and Outreach" sites, increasing the impact of their research.
4. The animations will be made available to major science media outlets like Discovery Channel, National Geographic, and History Channel, in order to aid them in generating better documentaries on fundamental Earth processes.
5. Our success in both defining an efficient method for creating high-quality animations and the animations themselves may encourage others to seek top produce realistic animations of important Earth processes.
6. This work will allow a disabled geoscientist (Stern) to continue to contribute to the geosciences

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.B.2.

Appendix Items:

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

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.B.2.

Appendix Items:

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

INTELLECTUAL MERIT

1. MOTIVATION

Geoscience Animations and Learning Styles:

People learn in different ways. When asked to explain how best they learn, people commonly talk about preferring to look at pictures or videos, or listen to explanations, or do something rather than reading text. There has been a vigorous debate in the educational community about the utility of classifying students by their different styles of learning. Regardless of one's perspectives on these debates, the complex nature of solid Earth systems provides a particularly good opportunity to teach about the Earth via better visualizations. According to the Visual Teaching Alliance, approximately 65% of the US public are visual learners, but >80% of classroom education is oral or written (http://visualteachingalliance.com). Najar (1998) proposed a learning "rule of thumb": there is 3x better student recall for information that is presented visually as compared to information that is presented by lecture alone. Recall for information that is transmitted simultaneously orally and visually is 6x better! On this basis, we should recognize that visual learning is an important component of an effective teaching strategy.

Consider a "Visualization Object" (VO), which is anything an observer (a student, in this case) visually examines to assist understanding. A visualization object could be either static or moving. Static VOs include photographs, paintings, graphs, maps cross-sections, and cartoons. In contrast, motion VOs include computer simulations and animations (Phillips et al., 2010). Visualization objects foster understanding by allowing the viewer to more easily form an "Introspective Visualization". Learning happens when the viewer makes an *interpretive visualization*, when the viewer constructs meaning from the introspective visualization and integrates this interpretation into his/her evolving understanding of the system's pertinent components and processes (Braga et al., 2010). Motion VOs – referred to as animations in this proposal - are especially powerful in helping visually-oriented learners (the vast majority of all students) with explicit dynamic information that is either implicit or unavailable in static images (Lowe, 2003).

Motion VOs are especially powerful agents for enhancing student learning. A meta-analysis of 26 primary studies carried out between 1973 and 2003 found substantial advantages to animations over static pictures for learning (Höffler and Leutner, 2007). Because the Earth sciences are very visual, the value of animations for learning in this discipline is particularly large. Lin and Atkinson (2011) showed that undergraduate students who were taught basic Earth Science processes with animations were able to master these concepts in significantly less time compared to peers who were not taught with animations. There are several reasons why animations boost student learning. Animations help students conceptualize complex processes, reducing their cognitive load as compared to learning situations in which the process or the procedure has to be reconstructed from text, lecture, or static pictures (Höffler and Leutner, 2007). Furthermore, abstract signaling cues like arrows or highlights have to be interpreted in static pictures and discriminated from the pictorial information. Further benefits of integrating pertinent animations into science courses were outlined by Barak et al. (2011), who concluded that students who studied science with the use of animations developed more motivation to learn science, compared to students who studied science using only textbooks and lectures. There is no question that carefully crafted, scientifically valid animations that are thoughtfully integrated with other course materials can significantly boost undergraduate student learning of geoscientific processes, although the diversity of learning styles is best addressed by using multiple ways of presenting course materials (Pashler et al., 2008): lectures, readings, exercises, charts and graphs, and animations.

Geoscientific concepts are supremely amenable to being taught with animations, particularly as compared with the other sciences. Developing more and better animations of fundamental Earth processes should be a priority for NSF in geoscience education, not only because animations generally aid learning as outlined above but also because the generation of students now moving through our educational system is by far the most visually-oriented generation that we have ever taught. These students are "digital natives" who have come through their K-12 experiences to expect to interact with high quality digital video content educationally and for other reasons (e.g. Project Tomorrow; http://www.tomorrow.org/). Unfortunately, what our science has to offer in terms of digital animations is often inaccurate, ugly, and disappointing to the audience that we need to reach. Most important global geoscience phenomena are complex processes, with multiple components, involving a range of interactions between physical, chemical, and biological processes, all of which happen simultaneously. Most of these phenomena are hidden from view, occurring high in the atmosphere or beneath the oceans, in sedimentary basins, or deeper in Earth's crust, mantle, and core. Geoscientists have had great recent success in fostering multi-disciplinary research collaborations to study these processes. For example, the NSF-funded GeoPRISMS initiative brings together geoscientists with a wide range of expertise: geochemistry, geophysics, mineralogy, mineral physics, experimental petrology and geodynamic modeling. We need to be similarly innovative in efforts to generate accurate educational visualizations and animations that present our current geoscientific understanding of key Earth processes to students at all levels, but especially undergraduates, if we are to fill the STEM pipeline with the talent that the will US need in the rest of the 21st century.

Why aren't there more high-quality animations of important Earth processes?
Given the effectiveness and desirability of video and animation as an aid to student learning, an obvious question is "Don't we already have what we need?" The answer is, unfortunately, an emphatic "No!" In the years before PI Stern embarked on the effort to generate the subduction zone animation described below, he became progressively more frustrated by the low quality of the animations available on this topic, both in terms of the science represented (content) as well as in the way that the concepts were presented. The quality is similarly poor for animations and visualizations of other plate tectonic (and other hidden) phenomena. The gap between what the scientific community understands about how the solid Earth operates and how we present this understanding to undergraduates is depressingly wide. While this assessment is anecdotal, reviewers, panelists, and program officers are invited to assess the quality of the science and presentation for plate tectonic animations on YouTube or elsewhere for themselves. While a few high quality animations of fundamental geoscience processes do exist, but they are the exception, not the norm.

In the expectation that the reader accepts this assessment, the next obvious question is "Why don't we have more good geoscientific animations designed for undergraduates?" Our explanation is that it is not easy to create high-quality geoscientific animations. The scientific expertise and motivation needed to identify and describe a global geologic process accurately, and the technical expertise needed to generate a high-quality animation, are the purviews of two very different communities of professionals. As such, developing animations involves developing teams of scientists and graphic artists, and such teams require resources to bring these disparate groups together to work toward a shared objective. The traditional professor-postdoc-grad/undergrad student "vertical structure" of modern science, while successful in advancing knowledge in discipline, does not lend itself to developing such teams; as such, these teams have to be formed outside the traditional structure of our science. Even community-driven, multidisciplinary geoscientific initiatives like the NSF GeoPRISMS initiative <http://geoprisms.org> (with which the PIs have been involved for many years) have no mechanisms for generating visualizations or animations for broader educational application of the fundamental, new and exciting science they are discovering. While all NSF GeoPRISMS and other proposals address "broader impacts", developing high quality geoscientific visualizations has been too large an undertaking for past funded projects.

Another relevant question is "Don't commercial outlets, like publishers, or Discovery Channel/National Geographic/History Channel make such animations?" Many of them have done animations, but unfortunately the gap between scientific acccuracy and "attractive" animation is large for nearly all of them. Working with publisher-hired animators often comprises receiving a call to provide feedback on a completed animation or visualization, which when provided is either ignored as too costly to implement or is implemented in ways that compromise the product's scientific accuracy, circumstances PI Ryan has experienced with several different science publishers in recent years. Media outlets often don't seek access to active NSF-funded geoscientists and/or allow them to play an active role in choosing topics for science documentaries. For example, while companies have produced many documentaries on volcanic hazards, none has put together a high-quality documentary on the more fundamental process of subduction, which is behind nearly all hazardous volcanism. A good example of this is History Channel's "Ring of Fire" video <https://www.youtube.com/watch?v=wJS7hGMr0Ws >, which includes beautiful footage of erupting volcanoes, earthquake damage, and impacts on society, but shows what is happening inside the Earth poorly. The animations of fundamental Earth processes that are needed to support a rich scientific story that can be told through these documentaries currently do not exist. Media outlets don't know how to present these important dynamic processes in motion, and they will never know unless NSF-funded geoscientists lead the way.

Summary of Challenges and Opportunities

It is clear that we need better animations of fundamental plate tectonic processes aimed at undergraduates, and there are reasons why we don't have them now. This proposal aims to begin rectifying this problem by first engaging scientist-educators, because this is where the fundamental expertise resides. A range of stakeholders can help identify topics that should be animated, but the scientist-educator – ideally, research-active university professors - should ultimately decide on topics and sequence, and involve the animation talent.

Such an effort is too much work for most NSF-funded Earth scientists as part of their required "broader impacts". PIs are more likely to use their research results in their courses in simple ways or involve undergraduates in the research experience but are largely unable to commit to the team-building and effort of generating high-quality animations as a product of their research. Doing so requires research scientists motivated to assemble and lead a cross-disciplinary team of scientists and graphic arts specialists.

This proposal builds on an initial "proof of concept" effort that generated a high-quality, informative animation of basic plate tectonics concepts, and pilot tested it with undergraduates at 2-year and 4-year institutions. Below we present the strategy that led to the successful development of the pilot animation. We intend to build on this success and generate a series of new geoscientific animations for undergraduate audiences. These animations will be disseminated broadly, to solicit expert feedback on the quality of the science, and will be assessed to understand how each animation affects student understanding. The animations will be revised for lower division and community college students based on these findings.

Results of Previous NSF Support: R. J. Stern

PI Stern received a small 1-year NSF-EHR-DUE grant (DUE-1444954; $49,939) which supported the development of a pilot geoscientific animation aimed at university undergraduate and community college student audiences. This small project allowed us to build a team as well as demonstrate both our process and our product. ***Intellectual Merits*** The 9 minute digital video "Plate Tectonic Basics 1: Construction and Destruction of Oceanic Lithosphere" took ~1 year to develop. The animation is narrated and provides many visual cues (labels, arrows, scale bars) to show and explain how oceanic lithosphere is created at divergent plate margins (spreading ridges) and is destroyed in subduction zones. The process began in summer 2014 with the development of a storyboard (sketched sequence of processes to be animated, largely based on Stern (1997, 2002). ***Broader Impacts:*** Geoscientists Stern and Lieu worked with students recruited from undergraduate majors in the School of Arts, Technology, and Emerging Communications (ATEC) at UTD < http://www.utdallas.edu/atec/ >. Geoscientists met weekly with two ATEC undergraduates to create a draft animation and accompanying narration until April 2015. In early summer 2015 we established a new collaboration with professional animator Windler (Archistration, llc) to generate the final animation, which was completed in September 2015. The final animation is freely available via the internet and segments of it are being evaluated for use as a supplement for McGraw-Hill textbooks in oceanography, physical geology, Earth science, geography, historical geology, natural hazards, and natural resources Michael Ivanov, pers. comm., 9/16). The video is posted on YouTube at https://www.youtube.com/watch?v=6wJBOk9xjto . A summary of this effort was presented at 2015 GSA Annual Meeting (Stern et al., 2015a) and at 2015 Fall AGU (Stern et al. 2015b). A manuscript submitted to the peer-reviewed journal Geosphere is under review (Stern et al., submitted).

2. ASSESSMENT OF PILOT PROJECT ANIMATION:

We did two kinds of assessments of the animation: A) content validation by national and international experts in the science, and B) learning assessments on students in a sampling of geosciences courses at two institutions (U Texas at Dallas and Richland Community College, Richardson TX). Learning assessments of three groups of students were carried out: lower division students at UTD and the community college and upper division students at UTD.

Procedure

The following simple assessment exercise was designed for students viewing "Plate Tectonic Basics 1". After plate tectonics was presented in lecture as done normally, about 30 minutes of class time was set aside for "Plate Tectonics Basics 1" viewing and assessment.

Before the class watched and listened to the animation, students were asked to make one sketch each of divergent (mid-ocean ridge) and convergent (subduction zone) plate boundaries, using pencils to sketch on gridded and scaled template shown in Fig. 1. Geoscientific processes are well suited for capturing students' mental representations via sketching (Jee et al., 2014) and are an efficient and authentic means of assessment (Johnson and Reynolds, 2005). Five minutes were allowed for each sketch. The class then watched and listened to the animation, then sketched the two sections again, again taking 5 minutes each. These sketches were collected and returned to UTD, where they were scored by Stern and Lieu according to the below rubric.

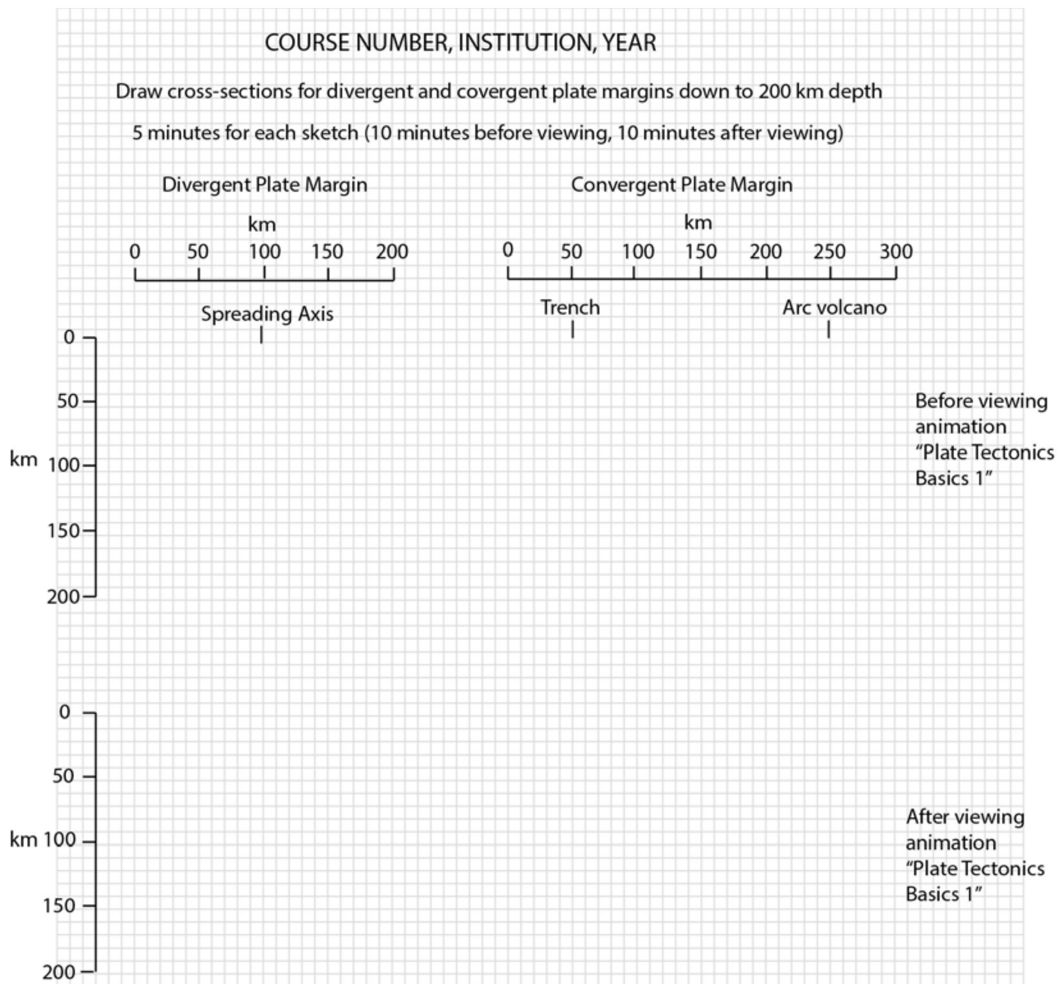

Fig. 1: Template for student sketches before and after watching and listening to animation (reduced to save space; full-size template fills an 8.5" x 11" sheet of paper).

Assessment Rubric:

This assessment was developed to evaluate whether or not and to what extent the animation "Plate Tectonic Basics 1" helps students better understand the structure and operation of divergent and convergent plate boundaries. We accomplished this by scoring each sketch on a 4-point scale for divergent plate margins (left sketches) and a 6-point scale for convergent plate margins/subduction zones (right sketches) so that there is a total of 10 points for each pair of pre- and post-viewing sketches. Points are allocated by assigning 1 point for each key conceptualization (fractional points can be given where appropriate:

FOR BOTH DIVERGENT AND CONVERGENT PLATE MARGINS/SUBDUCTION ZONES:

a) Scale and proportionality: does the student show features as they should appear in terms of their relative size and location? Does the student show the Earth's solid surface near 0 km?
b) Crust and lithosphere: does the student clearly distinguish between crust and mantle lithosphere? Is lithosphere shown thinning towards the spreading axis?
c) Lithosphere and asthenosphere: does the student distinguish between mantle lithosphere and asthenosphere?
d) Mantle flow and melting: does the student accurately depict overall flow of lithosphere and asthenosphere? Does the student show where magmas are generated?

ADDITIONALLY FOR CONVERGENT PLATE MARGINS/SUBDUCTION ZONES (right hand sketches):

e) Fluids and sediment melts from subduction zone: Does student show fluids released from subducted slab rising into overlying mantle?
f) Magma-crust interactions: Does student show magma interacting with crust beneath volcano?

Results

We received the assessment templates completed by the students from the three classes as either original hard copies or as scanned images attached to email. The forms were anonymous but tagged with information about institution and course level. For scoring, the sheets were folded so that the "before" and "after" sketches were scored independently, to minimize any bias that might arise from seeing both sets of sketches. Three groups of sketches were considered, based on student level (Table 1): Group 1 (G1) consisted of 15 UT Dallas upper-level geology majors in a junior-level petrology class; Group 2 (G2) consisted of 27 UT Dallas lower-level geology majors from an introductory Earth Science class; and Group 3 (G3) consisted of 21 Richland Community College students (non-majors and high school students) in a lower-level introductory geology class. The "mean change" values in Table 1 and in Fig. 2 documents the degree to which the three student groups improved their understanding about divergent plate margins and subduction zones after interacting with the animation; Figure 3 provides some example sketches. Given the small numbers of students at each site, we have chosen not to do involved statistical analysis of these results. However, comparisons of the mean change values to their standard deviations make it obvious that the animation offered real educational benefits to the upper-level course, but were less effective for beginning students, especially those at the 2-year college.

While the original ambition was to create an animation for use in introductory-level geoscience courses, the assessment results from our pilot effort identified benefits to an unanticipated audience (upper level students), and some challenges in its use with introductory students. A reasonable explanation for this may lie in the length and information density of the pilot animation: it is common practice in online course development efforts

Table 1: Student sketch scores, before and after viewing animation

Mean "Before viewing" score	Mean "After viewing" score	Mean change	N	Class
2.9±1.7*	6.0±2.1	3.1±1.3	15	UTD Upper Div.
2.7±2.2	5.3±2.3	2.6±2.1	27	UTD Lower Div.
1.3±1.3	2.4±1.7	1.1±1.8	21	Richland CC

*standard deviation

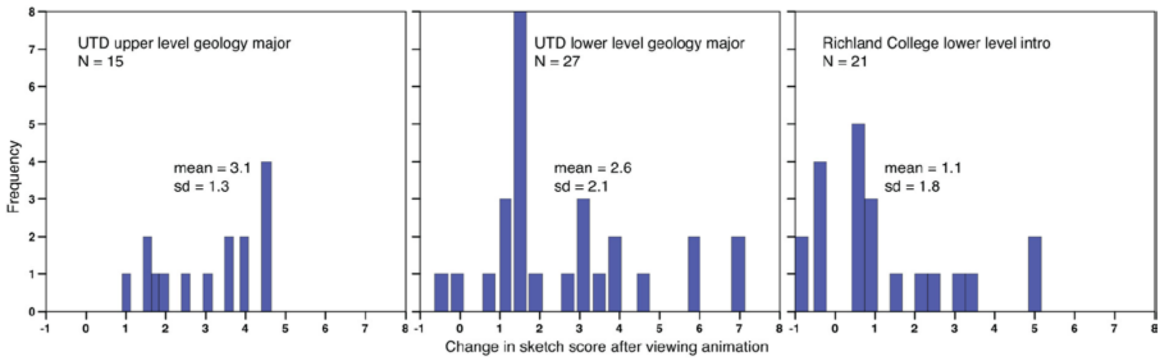

Fig. 2: Change in student understanding of divergent and convergent margin processes before and after viewing and listening to Plate Tectonic Basics 1. While students at all levels appear to have improved their understanding of fundamental plate tectonic processes after viewing the animation, upper division students benefitted more than lower division and community college students.

to keep instruction-related videos short (< 6 minutes; Hsin and Cigas, 2013), and to have them focus on a few key concepts. Our pilot video, at ~10 minutes and 36 informational call-outs, may have been both too long and too "dense" for introductory students. For example, in scoring the sketches, we noted that information about melt generation beneath spreading ridge and above subduction zones and melt-crust interaction beneath arc volcanoes was often overlooked, in both pre-viewing and post-viewing sketches. This may be a manifestation of the video being "too dense" with information for students to effectively process it on the timestep of viewing. However, after interacting with the animation, many students correctly adjusted their depictions of absolute and relative thicknesses of crust, lithosphere and asthenosphere, and their geometric depiction of subducting and overriding plates showed marked improvement, so they did gain a better understanding of other key details. Nearly four minutes of the animation time spent focused on these aspects of the phenomena, as compared with the much shorter (~1 minute long) sequence of flux-melting and the interaction of melt in the continental crust, which showed much lower improvement scores. This raises the question: are a single, long-held shots necessary to allow students time to absorb information-dense animation and narration? It is likely that the presentation of key aspects of these processes will need to be significantly expanded, both to more clearly animate them and to break down multi-step processes for more successful delivery.

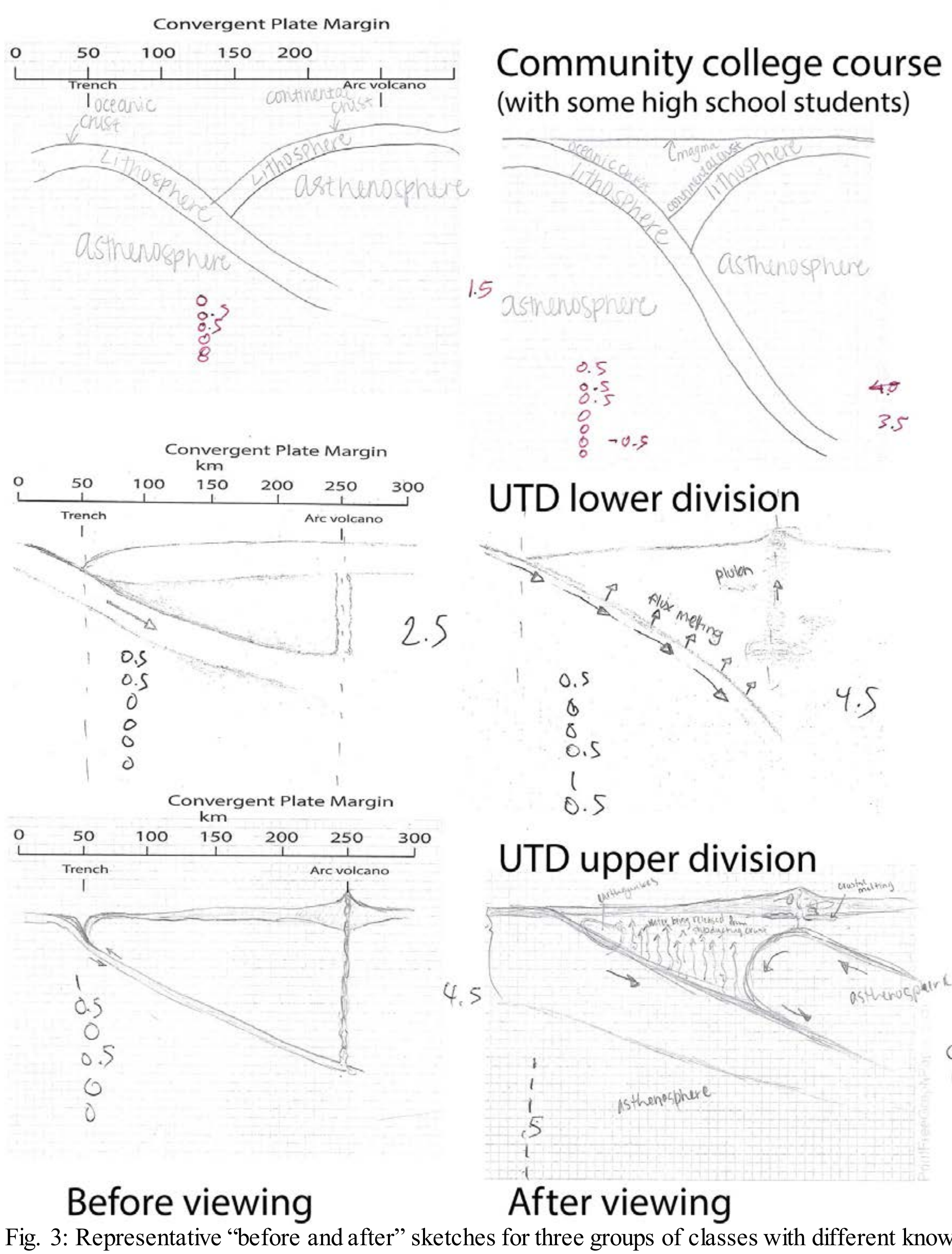

Fig. 3: Representative "before and after" sketches for three groups of classes with different knowledge bases. Note that only the convergent margin sketches are shown because of space limitations.

It is also clear from sketch assessments that students have misconceptions about the mantle melting beneath ridges and above subduction zones. This hurdle may stem from a strongly embedded misconception that the whole mantle is molten, given the many incorrect portrayals to this effect in textbooks, past videos, and popular culture (e.g., Kirby 2008). As is often the case, students struggle to integrate these misconceptions into new conceptual frameworks, resulting in incorrect visualizations. While conscious efforts were made in the animation to portray the mantle as a solid, but one that can deform and flow, it is evident that more emphasis should be placed on making that clearer in the animation and the narration.

Overall, our pilot assessment indicates the potential for enhancing student learning through the use of geologically accurate animations of major tectonic processes. Improvements in understanding were more pronounced for advanced undergraduate geology majors, suggesting that the animation facilitated their organization and refinement of previously assimilated knowledge. For introductory level students, it appears that the animation runs up against a some misconceptions, and that while some incremental improvement in understanding occurs, more attention needs to be paid to key aspects of these processes in order to help students shift their paradigms. As such, what seems to be necessary is two different kinds of animations: for introductory students shorter versions that focus on a small number of key processes, and longer, richer versions for upper-level students .

3. EDUCATIONAL QUESTIONS AND PROPOSED WORK:

Our pilot project highlighted a number of potential benefits to more scientifically accurate plate boundary animations in support of undergraduate and community college student learning. It also pointed to a number of conceptual challenges that made the pilot animation less effective for introductory-level students than for those with more geoscience curricular experience. In our proposed efforts, we seek to more comprehensively characterize the educational benefits and challenges of this and other scientifically accurate animations of the Earth's tectonic processes, both to formatively improve on our initial effort, and to provide the foundation for developing and testing new animations on a small selection of key topics.

Research Questions:

Our fundamental hypothesis is that making classroom use of scientifically accurate and aesthetically attractive visualizations of dynamic Earth processes can improve the development of student understanding of these processes, and can avert/ameliorate the implanting of key geoscience misconceptions. Our key working hypotheses are:

a) Students with more geoscience curricular experience gain greater educational benefit from longer, more detailed animations, as they are better prepared to use visualizations to clarify and refine their stronger conceptual frameworks.
b) Introductory-level geoscience students will show the greatest improvements in understanding from shorter Earth process animations with fewer "call-outs" and a focus on introducing fewer new concepts.
c) Fundamental geoscience misconceptions about plate rheology and the environments of melting can be successfully addressed with realistic animations that focus on these issues.
d) More experienced geoscience students require less pedagogical scaffolding to benefit educationally from Earth process animations.
e) Students gain confidence in their understanding of fundamental geologic processes through the classroom use of scientifically accurate animations of these phenomena.

To address these questions, we propose the following two sequenced activities:

1) Production and educational testing of 2 new animations that will target upper division students; and
2) Modification of these animations for lower division audiences and testing with university and community college introductory students.

New Animations: We will generate two new animations designed to present important plate tectonic processes. We are considering 4 possible topics and are currently discussing these topics with colleagues and students. One animation could focus on continental rifting and how rifts evolve with time into new oceans. Uplift and volcanism associated with lithospheric extension could be shown in motion, followed by subsidence of rifted continental margins and burial of these by sediments to form passive continental margins like those of the eastern US or Gulf coast. Another possible animation would focus on showing and explaining what happens when two continents collide: for example, India colliding with Asia. Such an animation would address why the overriding plate is so much weaker than the downgoing plate, and how continental collision can result in crustal melting and formation of an orogenic plateau, like Tibet, on the overriding plate. A third possible animation would explain transform faults, where two plates move past each other. If chosen, we will likely use well-known examples such as the San Andreas Fault of California, the Dead Sea fault in the Middle East, and/or the North Anatolian Fault in Turkey to show how small deviations in fault orientation can result in compression and mountain-building or in extension and rifting, and why so little igneous activity is associated with transform faulting compared to convergent and divergent plate boundaries. A final possible animation could compare Earth's tectonic style with that of other Earth-like planets and moons in order to show how unique plate tectonics is. Such an animation would likely capture student interest in the results of space exploration and use this interest to strengthen student understanding both fundamental plate tectonic processes and planetary evolution.

Whichever are chosen, the animations will be based on state-of-the-art geoscience concepts. Development of storyboards will be explicitly linked to the peer-reviewed literature, as described in Stern et al. (submitted). Expert input will be solicited from "content specialists" (i.e., geoscientists whose research expertise is well aligned with animation content).

Two levels of products will be developed: Advanced and Introductory. Advanced animations will be dense with narration (~100 words/minute) and word labels (call-outs) associated with use of geoscientific terms that may be unfamiliar to students. For example, Plate Tectonics Basics 1 has 46 call-outs that appear on the animation when narration uses these terms and then fade out; other visual cues include arrows indicating flow, fluid and magma motions, and scale bars. Because of the large amount of information presented in each animation, a ~10 minute length is likely needed to present this material. Introductory animations will be based on the advanced products but will be shorter and more focused, as explained below.

Development of advanced animations begins with roughing out on a storyboard. This work will be carried out by PI Stern in consultation with Mr. Lieu, and will be reviewed by PI Ryan. Once the storyboard is done, UTD undergraduates in the ATEC program (see Work Plan below) with interest and training in animation will be hired (10 hours/week) to work with Stern and Lieu to generate draft animations. PI Ryan will provide formative review as storyboards and draft animations are developed. As the rough animation progresses, Stern and

Lieu (in consultation with Ryan) will work out narrations. Storyboard, draft animations, and narration text will be turned over to Archistration LLC (Windler), who will then generate second (polished) draft of animation. The polished animations will be distributed via YouTube, textbook publishers, Facebook, and by being placed in competition for the NSF Vizzies https://www.nsf.gov/news/special_reports/scivis/ . They will also be presented at national geoscientific meetings for scientific vetting by research scientists involved in and NSF-funded initiatives such as GeoPRISMS. The animations will be assessed for their impacts on student learning at UTD and USF (see below), as well as for student perception and affective response to them. These data will be used to conduct final revisions on the animations.

Based on our scientific reviews and assessment results, each of these longer videos will then be edited and re-visioned for an introductory-level audience.

a) We will test and assess the longer videos in selected introductory courses at UTD and USF to assay their comparative educational benefit, identify key aspects of the animations to emphasize on revision, and to identify student misconceptions that may need to be addressed. As well, we will seek reviews of the videos from geoscience faculty who teach introductory courses.
b) Based on these results, we will revise the original animations to produce a shorter (< 6 minutes) and more focused version designed to be more level-appropriate for lower division undergraduate and community college students. Special effort will be given to simplifying terminology and reducing the number of call-outs (as an example, while there were 46 call-outs in the pilot video, we will seek to reduce these to 20 or less for the introductory course audience).
c) The introductory-level animations will be deployed and tested in introductory geoscience courses at both UTD and USF using means similar to those for the upper-level videos. We will also pilot them in upper-level courses to compare their impacts to the advanced versions. Final revised versions will be developed based on these results.

The primary curricular deliverables from this project will be a set of scientifically vetted and field-tested animations of fundamental plate tectonic processes. We will introduce them into geosciences courses at institutions of higher education in the Dallas-Fort Worth and the Tampa-St. Petersburg area. These are two of the US's largest and fastest-growing metropolitan areas and are where increasingly diverse populations live, work, and learn. The many universities and community colleges in these two provide a representative cross-section of young people who will benefit from these new instructional materials.

WORK PLAN: Animations

We will begin Y1 and Y2 (August) by choosing a topic, roughing out a storyboard, and recruiting two talented undergraduates to work on the rough animation. UTD is uniquely well-suited to provide undergraduates with talents for animation because of its innovative School of Arts and Technology (ATEC). The UTD ATEC program states that its mission is to "…merge the innovation processes of artists, scientists and engineers. ATEC explores their experimental models through new technologies. It augments the study of the arts and humanities by engagement with the research tools, measures and practices of the sciences and technology. UTD-ATEC offers degree programs from the BA through the Ph.D. that prepare more than 1,100 students to achieve in fields of e-culture design, research and development."

It is a rigorous and popular program, largely filled with young people who want to design video games. Examples of some student projects can be seen at https://www.utdallas.edu/atec/portfolio/ The ATEC students will likely have no geologic background, but they will have strong technical skills because the ATEC BA degree program emphasizes technical training, as shown by courses listed in the degree (supplementary document 1). All BA students must take courses in Drawing, 2D Design, Computer Imaging, Basic Design, Computer Science, and Computer Graphics, along with 15 hours of ATEC electives (Supplementary Document 1). The ATEC students that we recruit to work on this project can be expected to be fully prepared to carry out the work if they are properly supervised on scientific content.

The ATEC undergraduate students who will do this work are not yet identified but as soon as we receive notification that an award will be made, we will start the recruitment process. Each year, this will consist of posting flyers around the spaces at UTD where ATEC students frequent, such as bulletin boards around the ATEC department office and ATEC classrooms. Having two undergraduate students do the work is optimal because the two students can pursue different animation approaches interact and learn from each other. The ATEC undergraduates will meet with Stern and Lieu each week to review progress and move forward with the draft animation and narration. Preparation of the draft animation will be accompanied by development of narration, which will lead to signaling cues such as arrows and highlighting to emphasize important features.

WORK PLAN: Educational Review, Assessment of Animations and Project Evaluation

PI Ryan and Ph.D. graduate assistant in geoscience education Victor Ricchezza will oversee the educational data collection and analysis activities. These activities will constitute a portion of Ricchezza's doctoral dissertation research. As an active domain geoscience researcher, and also a geoscience education investigator, Ryan is uniquely qualified to oversee both the scientific and educational review of the animations.

Ryan will work closely with Stern to secure feedback on the scientific accuracy of the animations through their professional contacts. They will work through the GeoPRISMS Program, in which both of them are active, to conduct "mini-workshops" focused on the animations at the AGU Fall Meeting, where they can be presented and feedback obtained from scientific participants, as well as direct outreach to other research-active geoscientists with expertise aligned with the animation topics.

Learning assessments for the animations will continue to use the "concept sketch" strategy of the pilot study (Johnson and Reynolds 2005), as this is a flexible assessment strategy that can work in both upper-level and introductory course settings. Concept sketch assessments will be used in course pre-tests, to assay students' incoming knowledge; as part of dedicated in-class activities associated with animation use; and later as part of course exams, to assay longer term retention of conceptual understanding. Some 90 students/yr (30 in GEOS 3464: Igneous and Metamorphic Petrology at UTD; 60 in GLY 3311C: Geochemistry, Mineralogy and Petrology at USF) will interact with the animations. Sketches will be scored by Ryan and Ricchezza and at least one other geoscientist (either another of Ryan's graduate students, or Stern's student Lieu) to ensure inter-rater reliability. For the introductory courses (up to 500 students/yr may be involved from USF, UTD and Richardson CC) the sketches will be augmented with a selection of validated questions (ideally from the expanded Geoscience Concept Inventory: see Libarkin et al 2011) chosen to target misconceptions that are evident from our piloting activities with introductory students.

Along with learning assessments, surveys will be conducted to get feedback on student affective perspectives on the animations and their perceived educational benefits. These surveys will be developed by Ricchezza with input from Ryan, and will be implemented in every UTD and USF course in which the animations are tested. Based on findings from the surveys and learning assessments, a small number of semi-structured student interviews will also be conducted, with the goal of better assaying the value of the animations as a means for improving student understanding of plate tectonic concepts, for zeroing in on any perceptual difficulties with the animations as may become evident from the survey and concept sketch data, and to better clarify the level of instructional scaffolding needed to optimize their use.

Project evaluation activities beyond the data collection and analysis efforts outlined above will be the responsibility of Ryan and will involve oversight of video production and revision activities at UTD (i.e., making sure that videos are completed on schedule, and per the findings from their formative reviews), the completion of data collection efforts on both campuses, and on completion of project dissemination activities.

WORK PLAN: Dissemination and Sustainability

The draft and final animation videos will be made available to the community on YouTube, and through dedicated pages on the SERC site. They will be offered to the GeoPRISMs and Earthscope offices for presentation on their sites. The PI's will continue their direct outreach to university colleagues, which have thus far led to a number of faculty in the US and Japan making use of the original video in their courses and gathering data on its effectiveness through the concept sketch strategy. The videos will also be made available to publishers for use as online supports to existing and upcoming geoscience textbooks, and to media outlets for use in documentaries and longer-formatted educational videos. PI Ryan will build the animations into exhibitor outreach activities he conducts at sectional GSA meetings and the NCUR Annual Conference on behalf of his several active TUES Programs, and in his role as a Geoscience Division Councilor at the Council on Undergraduate Research. An additional important dissemination activity will be presentations and submission of scientific papers for on how the animations were developed, and how they impact student learning. These will be submitted to peer-reviewed journals such as *Journal of Geoscience Education*.

Once produced the videos will be maintained and publicly available as part of a YouTube channel on scientifically vetted geoscience animations that the project will establish.

4. PERSONNEL

The team consists of PIs Stern and Ryan, professional animator Windler, UTD graduate student Warren Lieu, USF grad student Vic Ricchezza, and two UTD ATEC undergraduate students.

Dr. Robert Stern is Professor of Geosciences at the University of Texas at Dallas, where he has been for 34 years. Each he teaches undergraduate petrology and graduate Tectonics classes, plus an additional course that varies yearly. The PI began his career at UTD as a field-oriented geoscientist, working both on continental crust (in NE Africa and Egypt) and on oceanic crust (in the Mariana arc in the Western Pacific). These research foci had to be abandoned as Stern was progressively affected by muscular dystrophy, re-orienting research towards research focusing on syntheses of important geoscientific processes and regional geology. This proposal, focused on animation, is another manifestation of that re-orientation.

Mr. Warren Lieu is a UTD Geosciences PhD student supervised by PI Stern. Before discovering Geosciences, Mr. Lieu worked as an architect and has consequently has unusually strong design and graphic skills. His PhD research will summarize the nature and origin of first-order variations in magmas produced at the GeoPRISMS "Subduction Cycles and Deformation" focus site in the Aleutian-Alaska arc. He will liase with instructors in UTD lower division courses and local community colleges to show animations, administer assessment sketches by students, and score them. The undergraduate students will be expected to work on the project for 10 hours per week (9 hours animation work and 1 hour weekly meeting).

Dr. Jeffrey Ryan is a Professor of Geology at the University of South Florida in Tampa, FL. He conducts NSF funded research on the geochemistry of subduction zones, and on the impacts and benefits of emergent information and computer technologies on undergraduate education and undergraduate research in the geosciences. He mentors Ph.D. students in both igneous/metamorphic geochemistry and in geoscience education, and he mentors geoscience faculty in developing and testing classroom interventions to improve the educational impact of their courses and curricula. He is a member of the convening team of the Summit on the Future of Undergraduate Geoscience Education series of national meetings and workshops.

Mr. Victor Ricchezza is a Ph.D. student in geoscience education at USF, who recently completed his MS research on a narrative analysis of alumni perspectives from 20 years of the course "Computational Geology" (e.g., Vacher 2000). Before beginning his graduate studies at USF, Mr. Ricchezza taught high school in the Atlanta area, and worked as an environmental consultant in New York.

Mr. Jeffrey Windler is owner of Archistration, llc http://archistrationcg.com/. Archistration produces multimedia content for architectural, legal, medical, and scientific purposes. Mr. Windler specializes in producing 3D virtual environments, as well as website development. He has a professional degree in architecture and his experience working in the field of architecture lends to his graphic skills and spatial understanding. Mr. Windler produced the 3D visuals for UTD Geoscience's "Plate Tectonics Basics 1" video. His commitment letter and resume can be found under Supplementary Documents.

5. BROADER IMPACTS

Six main broader impacts are expected to result from this study:

1. The animations resulting from this project will positively impact the learning and motivation to learn by many geoscience students and these are likely to help attract more students to study geoscience. Our animations will be broadly disseminated, both before and after revision. They will be entered into NSF "Vizzie" competition, will be freely available via YouTube and will be offered to textbook publishers for inclusion in their supplementary materials. We will post these on SERC website along with assessment materials. We will add links to our animations via Wikipedia articles. We will present and discuss them at scientific meetings

2. Working with ATEC undergraduate students to develop the draft animation will strengthen ties between two very different schools at UTD which otherwise would not have much interaction. This interaction is likely to foster future collaborations between the two schools to better show scientific concepts via animation and visualization.
3. The animations resulting from this project will be offered to NSF geoscience initiatives like GeoPRISMS and IODP to post on their "Education and Outreach" sites, increasing the impact of their research.
4. It is our hope and expectation that, once high-quality animations of the sort that we propose to develop are available, the major science media outlets like Discovery Channel, National Geographic, and History channel will have the basic material that they need to generate better documentaries on fundamental Earth processes. This is an anticipated "multiplier effect" that we expect if this proposal is funded.
5. The expected success of this three-year project promises to lead to an even more ambitious geoscientific animation proposal three years hence. Our success will encourage other groups to propose making more realistic animations of important Earth processes.
6. This work will allow a disabled geoscientist (Stern) to continue to contribute to the geosciences.

Results of Previous NSF-DUE Support: ***Jeff Ryan***: **DUE 1323275 - Collaborative: Expanding the Use of Online Remote Electron Microscopy in the Classroom to Transform Undergraduate Geoscience Education; DUE 1323419 - Collaborative: Google Earth in Onsite and Distance Education (GEODE). Intellectual Merit:** These ongoing NSF-TUES projects seek to expand use of effective technologically-based curricular practices (remote operation of analytical instrumentation, and Google Earth-based virtual classroom activities) toward both improving undergraduate education in introductory and upper-level courses, and engaging students in undergraduate research. **Broader Impacts:** These projects have established a range of new institutional partnerships, and are using non-traditional outreach and engagement strategies to involve faculty across the US at a wide range of institutional types. **Products:** Online resources (fcaem.fiu.edu/TUES; www.geode.net); 3 publications, >15 presentations (see "References")

References

Barak, M., Ashkar, T., and Dori, Y.J., 2011. Learning science via animated movies: Its effect on students' thinking and motivation. Computers & Education 56, 839-846.

Braga, J., Phillips, L.M., and Norris, S. P., 2010. Visualizations and Visualization in Science Education, in Norris, S. (ed.) Reading For Evidence and Interpreting Visualizations in Mathematics and Science Education, Sense Publishers, 123-145.

Cramer, B.D., Lewandowski, K.J., Goldstein, A., Asher, P., Ryan, J.G., et al., 2015. Who will build the 21st century? Addressing critical demographic gaps in the geosciences. GSA Today 25, no. 12, doi: 10.1130/GSATG243GW.1

DePaor, D.G., Ryan, J.G., Bailey J.E., and Rogers, N.T., 2014. New developments in Google mapping and visualization technologies. Presented at the 2014 GSA Southeastern Section Meeting, Blacksburg, VA.

Hoblik, S., Ryan, J.G., Hickey-Vargas, R., MacDonald, J. and M. Beck (2015) Enabling and facilitating undergraduate research through the use of remotely operable EPMA and SEM instrumentation in introductory and upper-level geoscience curricula: early success and challenges. Geological Society of America Abstracts with Programs 47, No. 7, p. 621.

Höffler, T. N., and Leutner, D., 2007. Instructional animation versus static pictures: A meta-analysis. Learning and Instruction 17, 722-738.

Hsin, W.-J., and Cigas, J., 2013. Short Videos Improve Student Learning in Online Education. Consortium for Computing Sciences in Colleges, 253-259.

Jee, B. D., Gentner, D., Uttal, D. H., Sageman, B., Forbus, K., Manduca, C.A., Ormand, C. J., Shipley, T. F., and Tikoff, B., 2014. Drawing on Experience: How Domain Knowledge is Reflected in Sketches of Scientific Structures and Processes. Res. Sci. Education. DOI 10.1007/s11165-014-9405-2

Johnson, J., and Reynolds, S. 2005. Concept sketches—using student—and instructor-generated, annotated sketches for learning, teaching, and assessment in geology courses. Journal of Geoscience Education 53, 85–95.

Libarkin, J., Ward, E., Anderson, S., Kortemeyer, G., and Rayburn, S., 2011, Revisiting the geoscience concept inventory: a call to the community. GSA Today 21, n. 8, pp. 26-28.

Lin, L., and Atkinson, R.K., 2011. Using animations and visual cueing to support learning of scientific concepts and processes. Computers & Education 56, 650-658.

Lowe, R.K., 2003. Animation and learning: Selective processing of information in dynamic graphics. Learning and Instruction 13, 157-176.

Najar, L. J., 1998. Principles of educational multimedia interface design. Human Factors 40, 311-323.

Pashler, H., McDaniel, M., Rohrer, D., and Bjork, R., 2008. Learning Styles: Concepts and Evidence. Psychological Science in the Public Interest 9, 105-119.

Phillips, L.M., Norris, S.P., and Macnab, J.S., 2010. Visualization in Mathematics, Reading, and Science Education. Springer.

Ryan, J.G., 2013. Authentic, low/no cost research experiences in introductory courses and labs; promising strategies using geoinformatics resources and remotely operable instrumentation. Geological Society of America Abstracts with Programs 45, No. 7, p. 434. [Invited Talk]

Ryan, J.G., 2013. Chapter 8: Integration of Research into the Classroom and Curriculum, in Schuh, M, (ed.) *Starting out in Undergraduate Research,* Council on Undergraduate Research, Washington, DC, pp. 44-49.

Ryan, J.G., 2013. Embedding research practice activities into earth and planetary science courses through the use of remotely operable analytical instrumentation: interventions, and impacts on student perceptions and activities. In Tong, V. (ed). *Geoscience Research and Education: Teaching at Universities*. New York, Springer Verlag., p. 149-162.

Ryan, J.G., 2014. Leveraging Global Geo-Data and Information Technologies to Bring Authentic Research Experiences to Students in Introductory Geosciences Courses. Invited presentation, 2014 AGU Fall Meeting. Abstract ED21-3468.

Ryan, J.G., 2015. Supporting the long-term investigation of southern Blue Ridge meta-igneous rocks through classroom research on collected samples, facilitated by remotely operable EPMA analyses: scientific and human resource outcomes. Geological Society of America Abstracts with Programs 47, No. 7, p. 553.

Ryan, J.G., DePaor, D., and Thau, D., 2013. Big Geodata sets, Google Maps Engine, and Google Earth Engine. Geological Society of America Abstracts with Programs 45, No. 7, p.369

Ryan, J.G. and De Paor, D., 2016. Leveraging global geo-data resources to support guided student investigations in an introductory earth science course. Geological Society of America Abstracts with Programs 48, No. 3 doi: 10.1130/abs/2016SE-274019

Ryan, J.G. and De Paor, D., 201. Leveraging earth and planetary datasets to support student investigations in an introductory geoscience course. Geophysical Research Abstracts, vol. 18, EGU2016-11575-1.

Ryan, J.G., Hickey-Vargas, R., Macdonald, J., and Beck, M., 2014. Expanding an effective strategy for research preparation and facilitation: investigations using remotely operated EPMA and SEM instruments in introductory and upper-level geoscience courses. Presented at the 2014 GSA Southeastern Section Meeting, Blacksburg, VA.

Ryan, J.G., Hoblik, S., Ricchezza, V., MacDonald, J., Beck, M., and Hickey-Vargas, R., 2015. Lowering barriers to piloting the classroom practice of SEM or electron microprobe usage: connecting with new faculty participants through their students. Geological Society of America Abstracts with Programs 47, No. 7, p.621.

Stern, R. J. 1998. A Subduction Primer for Instructors of Introductory Geology Courses and Authors of Introductory Geology Textbooks. J. Geoscience Education 46, 221-228.

Stern, R.J., 2002. Subduction Zones. Reviews of Geophysics, 40, 10.1029/2001RG000108

Stern, R.J., Lieu, W., Mantey, A., Ward, A., Farrar, E., Fechter, T., McComber, S., and Windler, J. 2015a. A New Animation of Subduction Zone Processes Developed for the Undergraduate and Community College Audience. GSA Annual Meeting, Abstracts with Program.

Stern, R.J., Lieu, W., Mantey, A., Ward, A., Farrar, E., Fechter, T., McComber, S., and Windler, J. 2015b. A New Animation of Subduction Processes for Undergraduates. AGU Fall meeting.

Stern, R.J., Lieu, W., Mantey, A., Ward, A., Farrar, E., Fechter, T., McComber, S., and Windler, J. submitted. A New Animation of Subduction Zone Processes Developed for the Undergraduate and Community College Audience. Geosphere.

Vacher, H.L. 2000, A course in geo-mathematical problem solving. Journal of Geoscience Education 48, 478-481.

Wood, D., Ahrendt, G. Gude, Z, Noto, M. and J.G. Ryan, 2015. Origins and evolution of amphibolites from the Glade Gap exposures of the Chunky Gal/Buck Creek mafic-ultramafic complex, western North Carolina. Geological Society of America Abstracts with Programs 47, No. 7, p.544.

Name: Stern, Robert J.
Address: Geosciences Dept., U Texas at Dallas, Richardson TX 75080-3021
Personal Data: Born, February 2, 1951 in Sacramento, California USA

Professional Preparation:

1968-1970: Studies in Political Science, University of California at Davis
1971-1974: Studies in Geology, University of California at Davis
June, 1974: B.S. in Geology (with honors)
1974-1979: Studies in Earth Science and Oceanography, Scripps Institution of Oceanography
Thesis title: "Late Precambrian Ensimatic Volcanism in the Central Eastern Desert of Egypt" - Thesis adviser: A.E.J. Engel
December, 1979: Ph.D., Earth Science, UC San Diego.

Appointments:

1981: Post-doctoral fellow, Department of Terrestrial Magnetism, Carnegie Institution of Washington.
January, 1982 - September, 1987: Assistant Professor, Programs in Geosciences, The University of Texas at Dallas.
September, 1987 - September 19, 1991: Associate Professor with Tenure, Programs in Geosciences, The University of Texas at Dallas.
September 19, 1991 - Present: Professor with Tenure, Programs in Geosciences, The University of Texas at Dallas.
Aug. 1997 – Aug. 2005 : Head of Geosciences Department, The University of Texas at Dallas
Sept. 2005 – Dec. 2005: Blaustein Fellow, Stanford University
Jan. 2006 – June 2006: Tectonics Observatory Fellow, Caltech
Sept. 2011 – Feb. 2012: Blaustein Fellow, Stanford University

Synergistic Activities:

Member of American Geophysical Union, Geological Society of America (Fellow), Geochemical Society
Editor-in-Chief of International Geology Review
Executive Board member, International Association for Geoscience Diversity

Main Research Topics:

Tectonics, Geochemistry, Isotope Geochemistry

10 Recent Relevant Products:

Stern, R.J., Lieu, W. S., Manley, A., Ward, A., Fechter, T., Farrar, E., McComber, S., and Windler, J., in revision. A New Animation of Subduction Zone Processes Developed for the Undergraduate and Community College Audience. Geosphere
Stern, R. J., 1998. A Subduction Primer for Instructors of Introductory Geology Courses and Authors of Introductory Geology Textbooks. J. Geoscience Education, 46, 221-228.
Stern, R.J., 2002. Subduction Zones. Reviews of Geophysics, 40, 10.1029/2001RG000108
Stern, R.J., Fouch, M.J., and Klemperer, S., 2003. An Overview of the Izu-Bonin-Mariana Subduction Factory in J. Eiler and M. Hirschmann (eds.) Inside the Subduction Factory, Geophysical Monograph 138, American Geophysical Union, 175-222.
Stern, R.J. 2004. Subduction Initiation: Spontaneous and Induced. Earth Planet. Sci. Lett. 226, 275-292
Pujana, I., Stern, R.J., and Ledbetter, C. 2006. Geology, Resources and Environment of Latin

America: Incorporating Earth Systems Science Education in an Undergraduate Science Service Course. J. Geoscience Education 54, 3, 357-363.
Stern, R.J., and Scholl, D. 2010. Yin and Yang of Continental Crust Creation and Destruction by Plate Tectonics. International Geology Review 52, 1-31.
Stern, R.J., and Johnson, P., 2010. Continental Lithosphere of the Arabian Plate: A Geologic, Petrologic, and Geophysical Synthesis. Earth Science Reviews 101, 29-67.
Stern, R.J. 2010. The Anatomy and Ontogeny of Modern Intra-Oceanic Arc Systems. Kusky, T. M., Zhai, M.-G. & Xiao, W. (eds) The Evolving Continents: Understanding Processes of Continental Growth. Geological Society, London, Special Publications, 338, 7–34.
Stern, R.J., Reagan, M., Ishizuka, O., Ohara, Y. and Whattam, S., 2012. To Understand Subduction Initiation, Study Forearc Crust; To Understand Forearc Crust, Study Ophiolites. Lithosphere 4, 469–483

BIOGRAPHICAL SKETCH

Jeffrey G. Ryan

Department of Geology, University of South Florida
4202 East Fowler Ave. Tampa, Florida 33620
Phone: (813) 974-1598
FAX: (813) 974-4808
Email: ryan @ mail.usf.edu

Professional Preparation:

1983: B.S. (Summa Cum Laude), Geology, Western Carolina University
1985; 1987;1989: M.A., M. Phil., Ph.D., Columbia University.
Dissertation Title: The Systematics of Lithium, Beryllium and Boron in Young Volcanic Rocks. Advisor: C.H. Langmuir
1989-1991: Postdoctoral Fellow, Department of Terrestrial Magnetism - CIW, Washington, DC.

Appointments:

2002-Present: Professor, Department of Geology, University of South Florida
2013-2015: founding Chair/ Director, School of Geosciences, University of South Florida
2009-2013 and 2000-2001: Chair, Department of Geology, University of South Florida
2005-2009: Assistant Chair, Department of Geology, University of South Florida
2003-2005: Program Director, EHR/DUE, National Science Foundation
1996-2002: Associate Professor, Department of Geology, University of South Florida
1991-1996: Assistant Professor, Department of Geology, University of South Florida

Five Relevant Publications and Products:

Ryan, J.G., (2013) Embedding research practice activities into earth and planetary science courses through the use of remotely operable analytical instrumentation: interventions, and impacts on student perceptions and activities. In Tong, V. (ed). *Geoscience Research and Education: Teaching at Universities*. New York, Springer Verlag., p. 149-162.

Ryan, J.G. (2013) Chapter 8: Integration of Research into the Classroom and Curriculum, in Schuh, M, (ed.) *Starting out in Undergraduate Research,* Council on Undergraduate Research, Washington, DC, pp. 44-49.

Mogk, D., Ryan, J.G., and Manley, P. (2011) *Undergraduate Research as a Teaching Practice*. http://serc.carleton.edu/NAGTWorkshops/undergraduate_research/overview.html. On the Cutting Edge/Council on Undergraduate Research online resource collection. [Primary author on “Preparing for Research”, “Obtaining Grant Support”, and “Geo-cyberinfrastructure” pages]

Ryan, J.G. and S.E. Ericksson (2011) *Planning the Future of Geocybereducation: Report from a Workshop, Arlington, VA, January 6-8, 2010*.

Peterson, VL, J.G. Ryan, SP Yurkovich, SE Kruse and J. Burr A collaborative field-laboratory summer Research Experiences for Undergraduates (REU) program in geosciences. *CUR Quarterly*, Sept. 2003, p. 5-9.

Other Relevant Publications (students in **Bold)**:

Ryan, J.G. and Chauvel, C., (2014), “The Subduction Zone Conveyor and the Impact of Recycled Materials on the Evolution of the Mantle.” Chapter 3.13: The Mantle and Core (Carlson, R. Ed.), *Treatise on Geochemistry, Second Edition* p. 479-508.

Agostini, S., Tonarini, S., Ryan, J.G., and Innocenti, F. (2008) Drying and dying of a subducted slab: Li and B isotope variations in Western Anatolia Cenozoic Volcanism. *Earth and Planetary Science Letters*, v. 272; 139-147.

Peterson, V.L., J.G. Ryan, and **the 1997-1998 REU Site Program Participants** (2008) Geochemistry and petrogenesis of the Buck Creek mafic/ultramafic complex, western North Carolina. *Geological Society of America Bulletin*, v. 121, pp 615-629.

Savov, I.P., Ryan, J.G., D'Antonio, M. and P. Fryer (2007) Petrology and geochemistry of serpentinized peridotites from Mariana Forearc, South Chamorro Seamount, ODP Leg 195: Implications for the elemental recycling across and along the Mariana arc-basin system. *Journal of Geophysical Research*, v. 112, doi:10.1029/2006JB004749.

Ryan, J.G. and Kyle, P.R. (2004) Lithium and lithium isotope variations in intraplate mantle sources: insights from McMurdo Group lavas (Mt. Erebus) and other intraplate volcanic rocks. *Chemical Geology*, v. 212, pp 125-142.

Synergistic Activities:

NSF-funded Education-focused investigations: Serving as PI or Senior Personnel on the following active NSF-Transforming Undergraduate Education in STEM projects:

- "Expanding the Use of Online Remote Electron Microscopy in the Classroom to Transform Undergraduate Geoscience Education,"
- "Google Earth for Onsite and Distance Education,"
- "Faculty Development to Support High Impact Activities That Transform Undergraduate Geoscience Education";

PI and Convener, NSF-NSDL supported Workshop: "Planning the Future of Geo-Cybereducation", 1/10; PI on a half-dozen past CCLI, REU and CCEP Program grant awards, and two REU Supplements.

Council on Undergraduate Research: Geoscience Councilor, 2001-present; Chair of the CUR-Geosciences Division and Executive Board member, 2006-2008; Member, National Conference on Undergraduate Research (NCUR) Oversight Committee, and CUR Nominations Vetting Committee; Facilitator for the CUR Institutes " Beginning a Research Program in the Natural Sciences at a Predominantly Undergraduate Institution", "Institutionalizing Undergraduate Research", and "Proposal Writing Institute"; CUR Consultant and external reviewer, Furman Univ. (2010), Northern Arizona Univ. (2010), Middle Tennessee State Univ. (2016)

Interdisciplinary Earth Data Alliance (NSF-funded geoinformatics facility) **Policy Committee:** 2011-present.

UNAVCO Education/Community Engagement Advisory Committee, Member, 2011-present; Chair of the committee 2013-2015.

Convening Committee, Summit on the Future of Undergraduate Geoscience Education 2013-present. Helped coordinate/facilitate three national meetings (for geoscience educators, geoscience employers, and geoscience department chairs/administrators), toward a comprehensive re-examination and re-visioning of the geoscience undergraduate curriculum.

SUMMARY PROPOSAL BUDGET

YEAR 1

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

ORGANIZATION
University of South Florida

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Jeffrey Ryan

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Jeffrey G Ryan - Professor	0.00	0.00	0.50	6,628	
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.50	6,628	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (1) GRADUATE STUDENTS				9,000	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				15,628	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				1,949	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				17,577	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				2,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				3,879	
TOTAL OTHER DIRECT COSTS				3,879	
H. TOTAL DIRECT COSTS (A THROUGH G)				23,456	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) All but tuition (Rate: 49.5000, Base: 19578)					
TOTAL INDIRECT COSTS (F&A)				9,691	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				33,147	
K. SMALL BUSINESS FEE				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				33,147	

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

PI/PD NAME
Jeffrey Ryan

ORG. REP. NAME*
Kelley Schuler

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION **University of South Florida**				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Jeffrey Ryan**				AWARD NO.		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)	
1. **Jeffrey G Ryan - Professor**	0.00	0.00	0.50	6,761		
2.						
3.						
4.						
5.						
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0		
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.50	6,761		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0		
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0		
3. (1) GRADUATE STUDENTS				9,180		
4. (0) UNDERGRADUATE STUDENTS				0		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0		
6. (0) OTHER				0		
TOTAL SALARIES AND WAGES (A + B)				15,941		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				1,973		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				17,914		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)						
TOTAL EQUIPMENT				0		
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				5,000		
2. FOREIGN				0		
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0						
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0		
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES				0		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				400		
3. CONSULTANT SERVICES				0		
4. COMPUTER SERVICES				0		
5. SUBAWARDS				0		
6. OTHER				3,879		
TOTAL OTHER DIRECT COSTS				4,279		
H. TOTAL DIRECT COSTS (A THROUGH G)				27,193		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **All but tuition (Rate: 49.5000, Base: 23314)**						
TOTAL INDIRECT COSTS (F&A)				11,540		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				38,733		
K. SMALL BUSINESS FEE				0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				38,733		
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $					
PI/PD NAME **Jeffrey Ryan**				FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Kelley Schuler**				Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 3

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

ORGANIZATION
University of South Florida

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Jeffrey Ryan

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Jeffrey G Ryan - Professor**	0.00	0.00	0.25	**3,448**	
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.25	**3,448**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**1**) GRADUATE STUDENTS				**6,242**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**9,690**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**1,377**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**11,067**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**5,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**1,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**2,586**	
TOTAL OTHER DIRECT COSTS				**3,586**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**19,653**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **All but tution (Rate: 49.5000, Base: 17068)**					
TOTAL INDIRECT COSTS (F&A)				**8,449**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**28,102**	
K. SMALL BUSINESS FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**28,102**	

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

PI/PD NAME
Jeffrey Ryan

ORG. REP. NAME*
Kelley Schuler

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

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

ORGANIZATION
University of South Florida

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Jeffrey Ryan

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Jeffrey G Ryan - Professor	0.00	0.00	1.25	16,837	
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	1.25	16,837	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (3) GRADUATE STUDENTS				24,422	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				41,259	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				5,299	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				46,558	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				12,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				1,400	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				10,344	
TOTAL OTHER DIRECT COSTS				11,744	
H. TOTAL DIRECT COSTS (A THROUGH G)				70,302	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				29,680	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				99,982	
K. SMALL BUSINESS FEE				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				99,982	

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

PI/PD NAME
Jeffrey Ryan

ORG. REP. NAME*
Kelley Schuler

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification: USF

A. Senior Personnel: 1.25 months of salary for PI Ryan over the life of the award. He will oversee all data collection and evaluative activities in the project, and supervise the graduate assistant tasked with the project's data collection efforts. As an expert in subduction zone geoscience, he will also contribute to the scientific vetting the animations.

B. Graduate Assistant: One calendar year of support over the life of the award for a graduate assistant, a Ph.D. student working with PI Ryan on a dissertation focused on geoscience education. (S)He will work with the PIs in developing student surveys and additional learning assessments, and will be the person tasked with implementing surveys, interviews and other student data collection activities as part of his/her dissertation research.

C. Fringe benefits for faculty at USF are 17.73% of salary costs: GA fringe rates are 0.3% + charges for student health insurance for each semester on aid.

E. Domestic Travel:
a. Costs for Ryan and/or his graduate student to travel to UT-Dallas for project development and data collection activities: $2000 each year.
b. Travel by Ryan and his graduate student to a major professional meeting (GSA or AGU) to present results and conduct outreach activities for the project: $3000/year in years 2 and 3.

G: Other:
2. $1400 over the life of the award for dissemination activities, including abstract fees, exhibitor fees at sectional GSA meetings, and/or publication costs.
6. a) Tuition for the graduate assistant in years 1 and 2 of the award, calculated at 9 hrs/semester and 6 hrs/summer and an in-state tuition rate of $431/credit hour.

H. Indirect Cost rates at USF are 49.5% of direct costs, excluding tuition, equipment and participant costs.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Robert Stern

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Research: Geoscience Animation: Construction, Evaluation, and Modification of Plate Tectonic Concepts for Geosciences Education (this proposal)

Source of Support: NSF-IUSE

Total Award Amount: $ 199,999 Total Award Period Covered: 06/01/17 - 05/31/20

Location of Project: UTD

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Jeffrey Ryan

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: COLLABORATIVE: Faculty Development to Support High Impact Activities That Transform Undergraduate Geoscience Education

Source of Support: NSF

Total Award Amount: $ 137,263 Total Award Period Covered: 08/01/11 - 07/31/17

Location of Project: USF and Buffalo State College

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative: Expanding the Use of Online Remote Electron Microscopy in the Classroom to Transform Undergraduate Geoscience Education

Source of Support: NSF

Total Award Amount: $ 161,648 Total Award Period Covered: 09/01/13 - 08/31/17

Location of Project: USF, FIU, FGCU, Valencia College

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.25

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative: Google Earth in Onsite and Distance Education (GEODE)

Source of Support: Old Dominion University (NSF subaward)

Total Award Amount: $ 45,115 Total Award Period Covered: 09/01/13 - 08/31/17

Location of Project: USF, ODU, JMU, many others...

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.25

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Research: Subduction Initiation and Development of the Izu-Bonin-Mariana arc: An Investigation of Samples from Cores from Recent Ocean Drilling

Source of Support: NSF

Total Award Amount: $ 104,196 Total Award Period Covered: 06/01/16 - 05/31/18

Location of Project: USF, Univ. Iowa, Towson Univ., Utah State Univ.

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Research: Characterizing Subduction Components in an Along-Arc Study of Aleutian Lavas With Boron Isotopes and Fluid-Mobile Trace Elements

Source of Support: NSF

Total Award Amount: $ 98,942 Total Award Period Covered: 02/01/17 - 01/31/20

Location of Project: USF, Univ. South Carolina, CNR-Pisa

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Summ: 1.00

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Jeffrey Ryan

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Participation on IODP Expedition 366

Source of Support: USSSP (NSF flowthrough)
Total Award Amount: $ 69,002 Total Award Period Covered: 12/01/16 - 01/31/18
Location of Project: JOIDES Resolution
Person-Months Per Year Committed to the Project. Cal:3.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: GEOPATHS-IMPACT - Expanding and evaluating the role of academic-professional partnerships in growing the geoscience academic pipeline in Florida

Source of Support: NSF
Total Award Amount: $ 300,000 Total Award Period Covered: 04/01/17 - 03/31/19
Location of Project: USF
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Research: Geoscience Animations: Construction, Evaluation and Modification of Plate Tectonic Concepts for Geoscience Education

Source of Support: NSF
Total Award Amount: $ 100,000 Total Award Period Covered: 04/01/17 - 03/31/20
Location of Project: USF
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

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

Laboratory:

Clinical:

Animal:

Computer: Two Macintosh desktop computers (running OS10.8) and two PCs (running Windows

Office: Printers

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

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

Relevant USF Facilities:

The USF School of Geosciences supports its geoscience education program through a dedicated laboratory space (managed by H.L. Vacher) used by students and faculty, with computers and workspace for data analysis. PI Ryan is a member of the USF Center for the Improvement of Teaching and Research in Undergraduate STEM education (CITRUS), a group encompassing discipline-based education researchers in chemistry, physics, life sciences, mathematics and geosciences. The USF Coalition for Science Literacy, a longstanding research and support center for improving STEM education in Florida, provides support for education researchers at USF in project evaluation and human subjects oversight within projects.

Data Management Plan:

The scholarly products in this proposed project will occur in two forms:

a) The animations that will be produced
b) Human subjects data focused on student learning and student affective and cognitive perspectives on the use of animations in their classroom activities.

The animations and human subjects data will be managed as explained below:

a) Once produced, the draft animations will be made public, on YouTube and at other sites, for participating faculty and student use and review. Revised animations will replace the draft versions once revisions related to student responses to them are compiled and interpreted. The animations will be made available to publishers or any other educational user community (teachers, documentarians, etc.).
b) Data for human subjects are subject to IRB oversight. The USF IRB will be the lead organization in reviewing and overseeing the project's data collection activities, and we will follow their guidance in terms of handling these data. UTD IRB will also be involved and consulted. General practice will be to anonymize all learning assessment results and survey responses, maintaining records only of the specific courses (number and semester/year) the data come from in order to facilitate compilation and interpretation. Interviews will be taped and transcribed, and interviewees will be pseudonymed. The original interview audio files will be destroyed once transcriptions are completed, and the coded transcriptions will be the official record of this activity. Data summaries and statistical compilations will be the primary data products disseminated through presentations and publications. The "raw" anonymized data will be maintained at USF on a secure computer in PI Ryan's office, and made available to other investigators on request per the strictures of human subjects regulation.

FEEDBACK FROM THE SCIENTIFIC COMMUNITY ABOUT PLATE TECTONIC BASICS 1

We have shared the Plate Tectonics Basics 1 with content experts around the world. Here are some of their comments:

1. Comments from Teaching Professors:

Taras Gerya (Professor of Fluid Dynamics, ETH Zurich, Switzerland):
"Wow, Bob! This is just great stuff! P.S. Make sure that students do not confuse thin basaltic crust at ridges with thicker thermally accreting mantle lithosphere."

Gray Bebout (Professor, Dept. of Earth and Planetary Sciences, Lehigh U., PA):
"Do you mind if I use this in my freshman seminar (Volcanoes and the Ring of Fire)? 20 students, all freshmen, but with extremely varied interests and degree plans .It's exactly at the level of our coverage in the seminar (we're now watching "Dante's Peak" so they're getting a hefty dose of hazards). I'll bet this will really improve their ability to visualize processes at the two plate margin types.

Robert Hazen (Professor GMU and GL-CIW Research Scientist)
"Many thanks for sending me the stylish treatment of plate tectonics. I may use this in my own class, as it covers the topic at a perfect level and the animations are both clear in large-scale picture, and include subtle effects I've not seen in some other efforts."

2. Comments from Research Scientists:

Jun-Ichi Kimura (Research Scientist, Japan Agency for Marine Science and Technology Center, Yokohama, Japan):
"I have seen the video. This is quite well organized and all images are beautiful. I enjoyed this very much. There could be some misleading aspects, of course, in the view point of a specialist. These are
(1) Granitic magma does not exist. Rhyolitic magma (or felsic magma: silica-rich magma) would be better. Solidified felsic magma becomes granites.
(2) Diapiric rise of a felsic magma in the crust may not be valid. Crack flow (diking) would be more realistic.
(3) Mantle convection pattern is not a singular cell but with a shallow convection at MOR and deep subduction thus deep cell in subduction zones.

Elizabeth Cottrell, (Director of Global Volcanism Program, Smithsonian Institution, Washington DC):
"There is a real need and demand for animations like this. I especially liked the way the animation pulled out the wedge of Earth to show the cross section to the core toward the end of the animation. I was surprised that there wasn't an associated reference list discussinwhat/whose models, code, theory etc the animation relied on."

3. Comments from GeoPRISMS Chair:

Peter van Keken (Professor of Geophysics, U. Michigan, MI): "…it looks very nicely done. We'll be happy to add a link through the GeoPRISMS website. Anais can help with that (but probably after our TEI is done). I was just wondering why you have the southwest Atlantic moving north and subducting below the Caribbean..."

4. Comments from Professional Science Animator:

Peter Matulavich (video producer whose work is distributed by Discovery Education aimed at middle and high schools): "I've never seen an animation on subduction that goes into such detail. What a serendipitous coincidence that you came up with this right about the same time I was struggling with it. I became so frustrated by so many different versions I had seen, I had to stop work and move onto other things. I'm back to being inspired."

archistration CG

digital media solutions

November 1, 2016

Dr. Robert Stern
University of Texas at Dallas
Department of Geosciences
800 West Campbell Road
Richardson, TX 75080-3021

Dear Dr. Stern,

This letter serves to state my commitment to carry out my responsibilities in regards to the “Geoscience Animations” grant proposal.

I am fully committed to my responsibilities which include (for 2 videos plus simplified variations of each, over a span of 3 years):

- Producing video content based on storyboards and drafts developed by the UTD research team.
- Coordinate the narration talent.
- Composite and edit final versions of videos.
- Make revisions to final videos based on reviews and assessments.

Sincerely yours,

Jeffrey Windler
Owner, Archistration, llc

3854 Arsenal St. 2F St. Louis, MO 63116 • (636) 492-1554 • info@ArchistrationCG.com • www.ArchistrationCG.com

Name: Jeffrey Windler

Address: 3854 Arsenal Street 2F, St. Louis, MO 63116

Personal Data: Born May 11, 1976 in St. Louis, MO

Education:

University of Kansas, Lawrence, KS – Bachelor of Architecture, 5/2000

Universität Dortmund, Dortmund, Germany - International study, credits toward KU BArch 8/1997 - 5/1998

Experience:

Owner, Archistration, llc (formerly Jeffrey Windler, llc); Dallas, TX – 7/2008-Present

Provide media services to architecture related professionals, such as 3D design support for architects, 2D graphic design and lifestyle videos for developments, project pursuit support for contractors, company website designs, and legal, medical, and scientific multimedia. Archistration, llc has been selected as official website manager for the Ken Roberts Memorial Delineation Competition, beginning 2010, and has since managed and developed the AIA Dallas Design Awards website, AIA Dallas Tour of Homes website, and the IIDA TX-OK Chapter design awards and scholarship application websites, and has provided the web development for American Heart Association's online media library. Current and past work can be seen at www.archistrationcg.com.

Founding Partner, Media Services Director, 5Gstudio_collaborative, llc; Dallas, TX – 5/2005 - 6/2008

One of four founding partners, helped develop the architecture firm from a team of four in 2005 to 20 by 2008

Media Specialist, Beck Group; Dallas, TX – 9/2003 - 5/2005

Joined with Associate Partner in forming Beck Blue Media, a new department within Beck tasked with providing media services such as 3D renderings, animation, and web support both internally and to outside clients.

Architectural Intern, Project Manager, Beck Group; Dallas, TX 5/2000 – 9/2003

Roles included design lead, construction documents, consultant management, and construction administration. Also provided 3D rendering and animation support for internal projects.

Intern, Ginko Design; St. Louis, MO 6/1999 – 9/1999

Provided 3D rendering support for an environment design for a new natural history museum exhibit at the Illinois State Museum.

Expertise:

- Technical expertise with 3D and 2D graphics, video editing and compositing, web and interactive content.
- Uses creative design skills to tell stories and evoke emotional response. Can create photorealistic content as well as stylized to fit the needs of the project.
- Provides full turn-key project management from proposals to delivery, including budgets, creative, research on new techniques, technology, production, managing consultants, and managing creative teams where necessary.
- Highly adaptable to new techniques and technology. Manages own technology infrastructure. Researches new and better techniques at every opportunity and can quickly learn new software.

Personal Achievements, Awards, Publications:

- AIA Dallas "Outstanding Achievement Award" for effectively communicating the value of Architecture - 2013
- Selected as Website Manager for Ken Roberts Memorial Delineation Competition - Beginning 2010
- "3D rendering makes architects work come alive" - design-training.com, October 20, 2009 - http://www.design-training.com/news/20091020/418/3d-rendering-makes-architects-work-come-alive.html
- "Enterprise Zone" - Dallas Business Journal, March, 14-20 2008 - http://www.bizjournals.com/dallas/stories/2008/03/17/smallb1.html
- 31st Annual Ken Roberts Memorial Delineation Competition - Selected for the Exhibition, 2004-2005
- 30th Annual Ken Roberts Memorial Delineation Competition - Selected for the Traveling Exhibition, 2003-2004
- Works exhibited in "Earth Works" Exposition & Symposium of Installation & Environment Art - Chicago Athenaeum - May 26 thru September 9, 2001

- Ewart Scholarship - Exchange program with University of Dortmund, Germany 1997-1998

Recent Work:

- Subduction Zone Processes Animation – Animation production – University of Texas at Dallas, Dr. R.J. Stern, project coordinator.
- American Heart Association Cardiovascular Media Library (http://watchlearnlive.heart.org/) - Web development, video editing – American Heart Association
- Ken Roberts Memorial Delineation Competition – Website development – AIA Dallas
- Jellico Community Hospital – website development – Vivanti Group
- Roanoke City Hall renderings – RGA Architects

BIOGRAPHICAL SKETCH

Victor J. Ricchezza
School of Geosciences, University of South Florida
4202 East Fowler Ave. Tampa, Florida 33620
Email: ricchezza@mail.usf.edu

Professional Preparation:

1999: B.A., Geological Sciences, University of Florida
2016: M.S., Geology, University of South Florida
Thesis Title: Alumni Narratives on Computational Geology (Spring 1997 – Fall 2013)
Advisors: H.L. Vacher & Jeffrey G. Ryan
In progress: Ph.D., Geology, University of South Florida
Advisors: H.L. Vacher & Jeffrey G. Ryan

Appointments:

2014-Present: Teaching Assistant, School of Geosciences, University of South Florida
2012-2014: Adjunct High School Science Instructor, Georgia Virtual School
2011-2012: Subject Matter Expert - course development (Geology), Georgia Virtual School
2009-2013: High School Science Teacher, Fulton County (Georgia) Schools
2004-2009: Senior Geologist, Airtek Environmental Corp., Long Island City, NY
2000-2004: Staff Geologist, Water & Air Research, Inc., Gainesville, FL

Relevant Publications and Products:

Ricchezza, Victor J. and Vacher, H. L. (2016) "On a Desert Island with Unit Sticks, Continued Fractions and Lagrange," *Numeracy*: Vol. 9: Iss. 2, Article 8.
DOI: http://dx.doi.org/10.5038/1936-4660.9.2.8
Available at: http://scholarcommons.usf.edu/numeracy/vol9/iss2/art8

Ricchezza, Victor J. (2016) "Alumni Narratives on Computational Geology (Spring 1997 – Fall 2013). *Graduate Theses and Dissertations.*
http://scholarcommons.usf.edu/etd/6366

Ricchezza, Victor J., and Vacher, H L. (2015) "Review of Developing Quantitative Literacy Skills in History and the Social Sciences: A Web-Based Common Core Approach by Kathleen W. Craver," *Numeracy*: Vol. 8: Iss. 2, Article 14.
DOI: http://dx.doi.org/10.5038/1936-4660.8.2.14
Available at: http://scholarcommons.usf.edu/numeracy/vol8/iss2/art14

Synergistic Activities:

USF Geology Graduate Student Organization: Vice President, 2016-present.