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: **CCLI-Phase 2: Expansion**
2. Name of **Principal Investigator/Project Director** (as shown on the Cover Sheet):
   Kaner, Cem
3. Name of submitting **Institution** (as shown on Cover Sheet):
   Florida Institute of Technology
4. **Other Institutions** involved in the project's operation:

Project Data:

A. Major Discipline Code: **34**
B. Academic Focus Level of Project: **BO**
C. Highest Degree Code: **D**
D. Category Code: **--**
E. Business/Industry Participation Code: **PSP**
F. Audience Code: _ _ _ _ _ _ _ _
G. Institution Code: **PRIV**
H. Strategic Area Code: **IT**
I. Project Features: **R C F I A**

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

J. Undergraduate Students: **15**
K. Pre-college Students: **0**
L. College Faculty: **4**
M. Pre-college Teachers: **0**
N. Graduate Students: **6**

Curricular Support for Software Testing

In this project, we will:

- ***Develop a free education community for our courses,*** analogous to communities that form around successful free software products. Our intent goes beyond projects that post high quality instructional materials available free for use (such as Utah State's and MIT's Open Courseware). We are bringing together people and companies (10 collaborating organizations so far) who contribute, review and modify instructional material, coach each other on teaching/grading the material and facilitate segments of free online versions of the course. Most free software projects fail to gather collaborators. This project will demonstrate a model for free education projects.

- ***Create new activity-based learning materials*** for undergraduate courses in software metrics and software testing. This includes developing a design framework (essentially an organized set of templates or patterns, with supporting examples) that categorizes many types of activities to help instructors develop their own activities.

- ***Develop teaching strategies*** that blend remote and live teaching and combine story-based learning, in-class activities, and real-world applications of the work in class, appropriate to visions of testing and metrics as involving a collection of complex cognitive skills.

- ***Integrate academic and commercial approaches*** to teaching software engineering and preparing software engineering students for continuing professional education.

- ***Assess the materials we create extensively,*** broadening and adapting the set for diverse groups of instructors and students.

Intellectual Merit: In the new structure, the instructor videotapes lectures before class. Students watch the lectures before class. During class time, students and instructor work together on various coached activities, many applied to a designated open source project, which all students join. The course design applies many of the principles of activity-based, constructivist and service learning. The principal investigator (Kaner) is well known for his work on software testing—for example, Widkipedia describes one of his texts as "the seminal work" in the modern approach to the field. The external evaluator (Katzenmeyer) is widely respected in the evaluation community. The doctoral students associated with the project have extensive work experience in education (Fiedler) or software development and testing (McGee, Tinkham).

***Broader Impacts*:** Courses developed under this grant will be released to the public under a Creative Commons license. These materials include much more than lecture slides. They include video lectures, sample exams, grading notes, assignments, rubrics, and other supports for another instructor to pick up and adapt the course, whether the instructor is a professor, a corporate trainer, or one of an unaffiliated group studying the subject together. The courses are provided on a Moodle course management platform that provides extensive support for peer-to-peer discussion and instructor management of interaction with individual students and groups. The two courses of this proposal, testing and metrics, will help broaden the skilled job market because they are vital topics in industry but not widely taught in university. The testing course is already the focus of an enthusiastic mailing list. These materials will improve the quality of professional education of these topics. This project makes high quality courseware and an instructional support community available to institutions who might find it hard to afford to develop courses of comparable quality. One of our collaborating instructors is Allen Johnson, who chairs Computer Science at Huston-Tillotson College, a Historically Black College and University. We don't know what modifications will be needed to make this course effective at Huston-Tillotson, but we intend to create variations as needed to make this work. We expect that the resulting course will be attractive to other institutions who serve minorities and have very tight course development budgets.

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*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.

CCLI – Curricular Support for Software Testing

1. Overview

One of the outcomes of grant EIA-0113539 ITR/SY+PE: "Improving the Education of Software Testers" was an activity-based course in software testing. We posted video lectures and other instructional materials on the web (available to the public for free, under a Creative Commons license). Students watch lectures before class. Classroom time is for discussions and coached activities. Other instructors, some academic and some commercial, have adopted these materials (some with success, others with difficulty). Several hundred individuals have been trying to self-study from them.[1]

Our next steps include several of the key activities in the CCLI cyclic model:

- **Develop a free education community for our courses,** analogous to the communities that form around successful free software products. Our intent goes beyond projects that post high quality instructional materials available free for use (such as Utah State's and MIT's Open Courseware). We are bringing together people who contribute, review and modify instructional material, coach each other on teaching/grading the material and facilitate segments of free online versions of the course. Most free software projects fail to gather collaborators. We have some experience in the free software community and a sense of tactics for motivating others to join such projects. The most time-consuming part of the present proposal was lining up (including negotiating collaboration agreements with) potential collaborators from the three communities that we want working together: university instructors, independent trainers, and corporations who want to train their own staff. If support communities develop in the way we expect for the two courses, we will have useful guidance for others who want to form free-courseware communities in areas of science, math, or engineering of interest for both, undergraduate and professional development instruction.
- **Create new learning materials** for undergraduate courses in ***software metrics*** and expand the collection for ***software testing***. We have about half the testing material in hand—enough for my testing course but missing key topics in the new ACM/IEEE (2004) software engineering curriculum guide and desired by other instructors. Materials include content (videos, slides, supplementary readings and supporting research) as well as extensive sets of review questions, essay questions, grading guides, activities, and tips on how to run/coach each activity. ***A key objective is developing a design framework (with supporting examples) that categorizes many types of activities (with supporting examples) to help instructors develop their own activities***. Regarding the metrics course, we want to demonstrate that this approach to teaching and bringing together a teaching community can extend beyond the initial, fairly well-known, testing course. I chose metrics because, like testing, it is of significant interest to practitioners but not widely enough taught at the undergraduate level.
- **Develop teaching strategies** that blend remote and live teaching and combine story-based learning, in-class activities, and real-world applications of the work in class, appropriate to a vision of testing as involving a collection of complex cognitive skills. None of the elements of the course are new, but the combination is original and student-motivating, though it has some rough edges. I say "*strategies*" because I expect our current approach to change in many ways as we apply it to new populations of students, extend it to purely online teaching, and adapt it to a different subject (metrics) that is very different to teach from software testing.
- **Implement educational innovation and developing faculty expertise** by adapting our teaching strategies and learning materials for several organizations and by facilitating crosstalk among instructors. Letters of commitment are attached from other university faculty, managers who will offer the course to their staff, and commercial trainers who will offer the course to the public. I have encountered more interest in this than I can manage and will limit the primary research group to 9-12 organizations.
- **Assess the materials and strategies that we create, revising the course and the instructor support as we go.** We won't break new ground in the process of assessment. We just want to understand what works and how to improve our strategies and materials. We will use several qualitative and quantitative methods to study reactions, longer term evaluations and, in some cases, longer-term outcomes.

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[1] "Our" and "we" refer collectively to Kaner, Rebecca Fiedler, Kaner's students, and several colleagues who have contributed to the project so far. "I" refers to the PI, Kaner.

- **Integrate academic and commercial approaches** to teaching software engineering and preparing software engineering students for continuing professional education. It is essential to our community / course-sustainability model that we develop courses useful for both academic and professional development education.
- **Create an open-source, free certification exam in software testing.** As we discuss below, this has significant intrinsic value but is largely outside the CCLI focus on undergraduate education. Certification is part of our strategy for motivating corporations to take over long-term support for the course. Many of the materials needed for the exam will spin off naturally as output of processes that are within the proper (undergraduate education) scope of this proposal. We will complete the rest in parallel with this project, but with private funds. Satisfice, Inc. has already committed $10,000 for this purpose if this CCLI proposal is funded.

2. Project Details

2.1 The Need for These Materials

In a recent survey of software development managers, the most often cited top-of-mind issue was software testing and quality assurance (Zeichick, 2005). Testing is not quality assurance—a brilliantly tested product that was badly conceived, incompetently designed and indifferently programmed will end up a well-tested, bad product. However, software testing has long been one of the core technical activities that can be used to improve the quality of software. Many organizations invest heavily in testing and many software developers work as testers. For example, most Microsoft projects employ one tester per programmer (Cusumano & Selby, 1998; Gates, 1997).

Despite the enormous investment in testing work, testing practice is insufficient. For example, according to *The Economic Impacts of Inadequate Infrastructure for Software Testing* (National Institute for Science & Technology, 2002), software weaknesses cost the U.S. economy $59 billion per year. This is a lower bound estimate of the problem. For example, the NIST calculations do not include the many "one-time" software crises, such as $300-600 billion spent in 1996-2000 to fix the Year 2000 bug (Leuning, 1999), loss of NASA's Mars Climate Orbiter (Oberg, 1999), a defect that crippled the USS Yorktown for almost 3 hours while at sea (Slabodkin, 1998), and recurring costs of dealing with viruses and worms that exploit holes in current software (estimated as high as $45 billion worldwide for 2002 and $119 to 145 billion for 2003) (Jenkins, 2003). Better testing would not eliminate these costs, but weak testing contributes to them.

The need for skilled testing is greater, not less, when companies and government agencies outsource software development. If you can't control how a product is made, you must carefully check what you get. To deal efficiently with contracted software, we must improve our ability in rapid, risk-focused investigation of contractors' products.

Much of what passes for testing is mere generation of voluminous paperwork. Some of this is necessary for project control, but this is not the essence of testing. Testing is not routine checking for the same problem time and again. Unlike manufacturing quality control (test many of the same type of widget), software testing focuses on *design flaws* –errors designed into the product, propagated into every instance of that product. This calls for strategies and skills different from those applied to manufacturing QC.

The essence of software testing is technical investigation of product risks. The more skilled the investigator, the more and better insights we should expect about the product's weaknesses, and perhaps underlying process weaknesses. The most important way to develop skilled investigators is through better test-related education.

Before coming to Florida Tech, I was a successful commercial consultant. I owned/ran a successful consulting firm focusing on technical, legal and educational issues involving software quality. The most lucrative parts of my business were short courses in software testing and software test automation architecture. Over two decades, I gradually lost my belief that the conceptual development needed to become a skilled investigator could be well-fostered by industry short courses or the certification-focused curricula that I was often brought in to review. Nor do I believe that the short courses can help us *enough* with development of the technical skills and process insight needed to create new test tools or imagine powerful applications for the new generation of tools, especially the code-focused (such as unit) test tools that have recently come to market.

As a result, in 1999 (before the software industry slowdown), I decided to close my consulting firm in order to join a university faculty and do research/development on software testing education. Everything I've learned about education since 1999 has reinforced the conclusion that this level of educational support should come from universities rather than industrial short courses. My objective has been to develop a blended curriculum, a set of materials and teaching methods that provide the depth and challenge of university instruction, but that also work well for professional development.

Until recently, software testing played a minor role in the undergraduate computer science curriculum. The ACM/IEEE computer science curriculum guides (1991, 2001) virtually ignored it, though a few universities offered a course or two. The recent curriculum for undergraduate software engineering (ACM/IEEE Joint Task Force on Computing Curricula, 2004) gives testing a larger role, equivalent to about a semester-length course. I think this is an appropriate minimum, but it is challenging because there is so much potential material for such a short time. (One illustration of the breadth of the field is that Ross Collard, a well-known commercial instructor, teaches from a 10-volume--several thousand pages--set of course notes.)

A computer science or software engineering student interested in a testing career will graduate with one (at most three) semester-length testing courses—most of what s/he will learn about testing will still be learned on the job.

From the perspective of developing course materials in software testing, I suggest these conclusions:

- The field is so broad, relative to the amount of time we will spend in courses, that courses will differ substantially from school to school. A set of materials needs many more self-contained learning units than would be needed for any single course.

  My current materials (see http://www.testingeducation.org/BBST) focus on system-level black box testing.

  In the proposed project, I would add theory and technique for glass box unit testing and low-level integration testing, using Tian's (2005) excellent new text as a foundation. These are important topics in the ACM/IEEE software engineering curriculum. I would also include learning units on test-driven programming, the focus of Florida Tech's second software testing course and of a course I teach on introductory Java programming (CSE 1001).

- Testing poses so many theoretically intriguing puzzles that it is easy to design a strong theoretical course that has no relevance to industrial testing tasks. We need detailed guidance from test managers and instructors in industry to achieve balance.

  Practitioner courses often focus too narrowly on current skills, on immediately applicable new skills, on vocabulary rather than insight, on assertion rather than theoretical proof or empirical evidence, and on what can be learned by a very diverse group in the short time available. Many academic courses offer stronger theoretical, empirical and conceptual material—sacrificing some skill development in order to achieve a better foundation for long-term learning.

  - ***In this project, commercial instructors will provide extensive feedback about how to improve this course for an applied audience. For example, they may provide examples of how a technique would be used (or misused) in the field, with stories of actual use, and with compelling activities.***
  - ***Undergraduate education is being increasingly offered remotely, with web-based instruction. Many people who work in testing will not have taken testing courses at school and will not have access to testing courses at a nearby university.*** (Testing might be required in the software engineering program, but fewer than 20 software engineering programs are accredited in the United States.) ***Students in online courses are generally older than typical undergraduates, with work experience. These adult learners are often more intrinsically motivated but less tolerant of material they perceive as incredible or irrelevant (Knowles, Holton, & Swanson, 2005). Lessons from local and remote teaching to industrial students will help us adapt the course for distance-learning undergraduates.***

My broader objective is to create a rich set of free software testing instructional materials that workgroups can learn (and adapt) together and highly motivated individuals can successfully self-study, without involving a university. This is synergistic with the goal of developing flexible, credible, interesting materials to support undergraduate education in software testing (the focus for this proposal).

Regarding the metrics course, this is another area of software engineering that is richer and more complex than what I have seen in current practice, and could be better served at school. Most software engineering metrics involve human performance to some degree (such as productivity, expected time to market, cost or quality of work) or another attribute that is intensely human (such as complexity, especially as a predictor of maintainability, scalability or cost). However, leading texts (Fenton & Pfleeger, 1997; Zuse, 1998) treat the field from a mathematical model that is difficult to tie to real-world application. At the other extreme are cookbook characterizations of metrics, perhaps better suited for students who are much less mathematically capable than software engineers. Discussions that are commonplace in other fields, such as the nature and importance of construct validity in human performance measurement, are almost completely absent from the computer science literature (Kaner & Bond, 2004), as are discussions of the risks of measurement, especially theoretically questionable measurement (Austin, 1996;

DeMarco, 1995).

I have some experience with this material (Kaner, 1999c, 2000a, 2000c, 2001b, 2002f, 2003e, 2006; Kaner & Bond, 2004) and have taught Florida Tech's metrics course. I recently gave a tutorial on metrics to Canadian software engineering students (Kaner, 2006) and they have the same problems imagining how to apply this material as my students at Florida Tech. My current teaching style is dominated by lectures and theoretical assignments. From talks with other people who teach metrics, this seems common.

The approach developed under this project would be dominated by activities that would help students understand the links between theory, applications, benefits, and risks.

2.2 The Learning Materials and the Teaching Strategy

This section primarily describes what we have already achieved with the software testing course. It is too easy to get the misimpression from this that the project is almost complete. I don't know how to convey what we have without describing it in detail, but please keep these in perspective. Here is some of what is not yet done:

- We have very little of this for the metrics course.
- We have very little of this for test-driven programming, unit testing, integration testing, API-level testing, or user-interface-level automated testing, all important for the broader testing course.
- The activities work well for one (1) instructor but need much better documentation. As the course is adapted for several audiences, we must develop a broader guidance on how to create activities that align well with the instructor's objectives. Better documented versions of the current activities (and new ones) will serve as examples in this presentation.
- The course works well for one instructor (Kaner), we have some informal reports from commercial instructors self-studiers, some encouraging, others reporting difficulties. Making the course adaptable for a more diverse group of instructors and students will take significant assessment and improvement.

The original testing course was based on *Testing Computer Software* (Kaner, 1988), which evolved into the best selling book in the field (Kaner, Falk, & Nguyen, 1993) and another popular book (Kaner, Bach, & Pettichord, 2001). Reviewed, rewritten and extended by several colleagues, it matured into a commercially successful practitioner training course that I taught about 105 times. I joined Florida Tech in 2000 and transformed the course into an academic, lecture-based course that seemed effective for undergraduate and graduate students.

The 2000-2004 course successfully encouraged many students to work in groups, to have group discussions of key issues in software testing, and to apply what they were learning to open source projects. Many students appeared to (and claimed to) learn more from these activities than from lecture.

I decided to reorganize the course, to use precious student contact hours on active learning experiences (more labs, more projects, more seminars) that involved real-world problems, communication skills, teamwork, critical thinking, and instructor scaffolding (National Panel Report, 2002; Project Kaleidoscope, 2002), but without losing the instructional benefits of a polished set of lectures.

2.2.1. Overview of the Learning Materials

The new version of the course is available to the public for free under a Creative Commons license, at http://www.testingeducation.org/BBST. Classes are organized around learning units—the site currently has 16 units. Learning units provide a variety of materials relevant to this proposal:

- ***A video lecture.*** Students watch the lecture *before coming to class.* To see our current style, watch http://www.testingeducation.org/k04/video/BBSTguiAuto2.wmv.
- ***The lecture slides.*** Provided in PDF to preserve formatting across platforms and PowerPoint to make it easy for other faculty to customize them.
- ***The application under test.*** Students joins an open source software project: activities and assignments produce work products that often contribute to the project (Lave & Wenger, 1991), giving students the opportunity to apply newly-acquired knowledge and skills to the product under test. They also gain real-world experience to talk about in job interviews. Software applications have included Open Office and Mozilla Firefox.

  Classroom activities. The course is taught in a lab room, with one computer per student. Activities are open book and students work in groups. They might apply ideas, practice skills, try a test tool, further explore ideas

from lecture, or work through a discussion-driving question from the study guide. The instructor coaches individuals and small groups in their tasks. Results may be presented to the class or turned in for grading.

- ***Examples.*** Supplementary materials illustrate application of a test technique to a shipping product.
- ***Assigned and suggested readings*** come from course texts or electronic sources.
- ***Assignments*** involve larger tasks (students have about two weeks with them). Some come with grading rubrics. Students can work on them alone or in with one or two partners.

2.2.2 Learning Objectives

Kaner and Fiedler worked through Angelo and Cross's (1993) Teaching Goals Inventory to prioritize goals (learning objectives) for several iterations of the testing course (Kaner & Fiedler, 2005a, 2005b). We will do the same for the metrics course and strongly encourage other instructors to develop their own prioritized list of goals and evolve them over time. Given the degree to which software testing involves complex cognitive tasks, most learning objectives should focus on high-level intellectual skills (National Panel Report, 2002). Evaluation of examination materials and assignments should consider whether they require demonstration/application of higher-level skills (Anderson et al., 2001). For most of the material in these classes, we want students to be able to explain it (conceptual knowledge, remembering, understanding), apply it (procedural knowledge, application), explain why their application is a good illustration of how this technique or method should be applied (understanding, application, evaluation), and explain why they would use this technique instead of some other (analysis).

Learning objectives goals for this project (testing and metrics) include:

- Create learning objectives for each learning unit to support other instructors teaching the course and to help make sections modular. These currently exist for a few learning units in the testing course.
- Create some mappings that illustrate how different groups of learning goals yield different selections of material, activities and student-knowledge assessments. Much of the underlying data will come from the mappings developed by the collaborating instructors; the task is to capture, rationalize, and document them.

2.2.3 Lectures

Lectures can be as effective as other instructional techniques for transmitting basic information about a topic but less effective than some other methods for teaching behavioral skills, promoting higher-level thinking, or changing attitudes or values (Bligh, 2000).

In terms of Bloom's learning objective taxonomy (Anderson et al., 2001; Bloom, 1956), lectures would be most appropriate for conveying factual and conceptual knowledge at the remembering and understanding levels. Our students need to learn the material at these levels, but as part of the process of learning how to analyze situations and problems, apply techniques, and evaluate their own work and the work of their peers.

Carefully crafted lectures can have several other benefits that we consider particularly important:

- Lectures can organize and integrate material. As Forsyth (2003, p. 50) eloquently puts it, "Lectures provide the scholar with the means of not just disseminating information but also transforming that information into a coherent, memorable package. Scholars, when they reveal their unique interpretation of questions they have spent years researching and contemplating, are an unmatched source of information and interpretation."
- Lectures can convey the *lecturer's* enthusiasm for the subject, which improves student satisfaction with the course (Williams & Ware, 1977).
- Lectures can provide memorable examples to help students learn complex concepts, tasks, or cultural norms (Ford, 2002; Forsyth, 2003; Hamer, 1999; Kaufman & Bristol, 2001). Students' attention improves in a story-telling environment, they better acquire skills and strategies when examples are worked out for them, and their interest increases when they perceive themselves to be working on realistic assignments (Edelson, 1998; Gliner, Goldman, & Hubert, 1983; Van Merrienboer & Kirschner, 2001).

Stored lectures are common in distance learning program (Rossman, 1999). Web-based lecture segments are used to supplement Computer Science courses (Fintan, 2000). Studio-taped, rehearsed lectures with synchronously presented slides (as we do) have been done and described elsewhere (Dannenberg, undated).

Live lectures have disadvantages that stored lectures (lectures that students can access at any time) can fix:

- Short-term memory capacity varies among learners, especially as they age. Live lectures can't be rewound—what was said is past; what is not remembered is lost. (Langer, 2002) In contrast, students watching a recorded video can—and do (He, Gupta, White, & Grudin, 1998)—jump backwards in videos to review what was said.
- Students whose first language is not English often have difficulty keeping up with live lectures and can benefit from the ability to replay material.
- Live lectures can become fragmented as students ask questions (and are responded to). We prefer the stored lectures we create (no students and no interruptions) over replay of a live lecture with unscripted interruptions.
- Live lecturers sometimes drift, ramble or tell excessively long anecdotes. An example that takes too long can be cut during post-production, or shortened in a retelling / retaping of the example.
- Students can replay a stored lecture while studying for an exam or working on an assignment, relearning the material in the context of a specific problem or task they are working with.

Students commonly report that they prefer live lectures (Firstman, 1983; Maki & Maki, 2002). However, it appears that, on average, students learn as well from video as from live lecture (Bligh, 2000; Saba, 2003). Faculty often comment that live lectures allow them to interact with students in ways that taped lectures do not. I feel the same way, but relatively few students make comments or ask questions in lecture. Live lectures allow more interaction that taped lectures viewable on the web, but the non-lecture classroom activities can provide far more time and opportunity for interaction than live lectures.

Lecture goals for this project include:

- **Software Testing**: Add lectures for about 20 more instructional units, including:
  - Black box system testing: more on exploratory testing, specification analysis, user testing, user-interface-level automation, basics of performance modeling, status reporting and progress measurement.
  - Glass box: analyze control structures, logical expressions, program graphs and state models, common programming errors and techniques to catch them, code analyzers and other static test tools, coverage measurement, analyze web logs and other interprocess communications, protocol testing.
  - Programmer-driven testing: goals and testing techniques in test-driven development.
- **Software Metrics:**
  - Produce lectures sufficient for teaching the course. Essentially, get the metrics course to the point that the Testing course is today, with a full semester of learning units but few if any spares.
- **General Materials:**
  - Add modules to support learning skills that many software engineering students need coaching on, such as active reading, preparing presentations, finding technical information on the web, and writing essay exams.

2.2.4 Examples

Worked examples can be powerful teaching tools (Clark & Mayer, 2003, ch. 10) especially when motivated by real-life situations. They are fundamental for some learning styles (Felder & Silverman, 1988). Exemplars play an important role in the development and recollection of simple and complex concepts (Brooks, 1978; Medin & Schaffer, 1978; Smith, 2005). The lasting popularity of problem books, such as the *Schaums Outline* series and more complex texts like Sveshnikov (1968), attests to the value of example-driven learning, at least for some learners.

In our initial work under NSF Award EIA-0113539 ITR/SY+PE: *Improving the Education of Software Testers*, we expected to be able to bring testing students to mastery of some techniques through practice with a broad set of examples. Padmanabhan (Kaner & Padmanabhan, 2006 submitted; Padmanabhan, 2004a) applied this to domain testing in her Master's thesis project at Florida Tech, providing students with 15 classroom hours of instruction, including lecture, outlines of ways to solve problems, many practice exercises and exams. Students learned exactly what they were taught. They could solve new problems similar to those solved in class. However, in their final exam, we included a slightly more complicated problem that required them to apply their knowledge in a way that had been described in lecture but not specifically practiced. The students did the same things well, in almost exactly the same ways. However, they all failed to notice problems that should have been obvious to them but that only required a small stretch from their previous drills.

This result (and some less formally conducted prior failures to achieve transfer) was our primary motivator to

ultimately redesign the testing course to root it more in meaningful activity than lecture plus drill.

Examples goals for this project include:

- **Software Testing**: We have several worked examples online, developed by undergraduate research assistants who found software errors themselves or replicated publicly reported bugs. The typical example shows a test technique in action**,** walking the reader through , rather than a written description (with screen shots) of the test design, application, and discovery of a bug. We want to provide ten quite different examples for each technique, to help students abstract the common essence of the technique from the details of individual examples. Work done so far has been thoughtful and creative, but some examples are too similar to each other, most could use a copy editor, and many would be more effective if redone as a voice-annotated video walkthrough. We intend to broaden and improve this pool. We also have complex examples in the lectures, stories from the development of commercial products. These can be broken out into standalone videos, and integrated into the example set.
- **Software Metrics:** The testing examples illustrate the concept of the technique and how an experienced practitioner might use it. The metrics course includes more traditional mathematics:
  - Some examples will focus on the intent and application of a type of measurement, others on basic computations (how to calculate the value), others on evaluation of the validity or trustworthiness of a given metric for a given problem.
  - We expect to work through sections of the mathematics education literature several times, increasing insight into their discussions of examples in math education as we create and try out new examples for the course.
- **Grading examples (both courses):** Using prior years' student work, we can create sets of annotated examples (ranging from bad to good) to help students understand the differences between strong and weak work and the diversity of good answers. We plan to use annotated grading, videos that show what the instructor is reading while the instructor describes (audio track) his or her reactions as s/he grades (for an example of this approach, see http://ia300124.us.archive.org/3/items/Reader_Response/journalism.swf.)

2.2.5 In-Class Activities and Assignments

Applying what we learn to a sample application has been an important aspect of the testing course.

- It makes concepts we teach "real" to students by situating them in the development of well-known and well-regarded products (Lave & Wenger, 1991). Students file work with the project (such as bug reports in the project's bug database) that they can cite, show and explain during employment interviews. Knowing there are stakes outside of the classroom is a strong motivator for some students to try to do excellent work.
- It facilitates transfer of students' new knowledge and skills to the workplace, because they do the same tasks and face some of the same problems as they would with any commercial software (Clark & Mayer, 2003). More generally, as long as the assignments are not too far beyond the skill and knowledge level of the learner, authentic assignments yield positive effects on retention, motivation, and transfer (Gagne, Yekovich, & Yekovich, 1994; Haskell, 2001; Lesh & Lamon, 1992; Van Merrienboer, 1997).
- When students create work products for a project, we can rework imperfect examples in class to show what a better job would look like. Sometimes, students submit work that is blasted as incompetent by an irascible project manager. This creates a real-world context for the friendly, corrective lecture by the teacher, saying here's how to do something like this really well next time. Worked examples can be powerful teaching tools (Clark & Mayer, 2003, ch. 10) especially when they are motivated by real-life situations.

In the testing course, only some of the activities involve the application under test. Others develop a theoretical point from lecture, address a question in the study guide, address a question raised by a student, or help the students work through a complex section of one of the readings.

As we develop more activities, we see themes. Here are three examples:

- One type of activity gives the students a problem to work through that they probably won't adequately solve—but that will be solved in the next lecture (Kaner, 2004a). "Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned" (Savery & Duffy, 2001, p. 2).
- In another, we divide the class into groups. Each group works with almost the same problem. The difference might be that different groups play different roles (one is a tester, the other a programmer) or they join the project at different times or with different resources, or they are tasked to protect the company or project from

different risks. After considering the problem together, each group presents its analysis to the others.

- The third involves regrading. Take three to five answers to an exam question, split the class into groups and have each group grade all answers. Then the groups report and justify their grades to each other.

I can now spin off new activities for a class much more quickly, by using a theme as a template and applying it to the content/objectives of the day's learning unit. These themes (generic types of activities) are as applicable to metrics, or other courses in software engineering, as they are to testing.

Activities goals for this project include:

Create a collection of themes for activities in technology classes for adults. This applies to the Software Testing and Software Metrics courses.

- The *Activities Handbook(s) for the Teaching of Psychology* (Benjamin & Lowman, 1981; Benjamin, Nodine, Ernst, & Broeker, 1999; Makosky, Sileo, Whittemore, Landry, & Skutley, 1990; Makosky, Whittemore, & Rogers, 1987) have been an inspiration. These are discipline-specific, documentation of activities is uneven, and activities are described in isolation without pulling together underlying themes. Even though I have taught courses in psychology (the field in which I received my first doctorate), I often find it hard to imagine how to apply what was done for the psychology course to a software engineering course. Despite those inconveniences, this has been a rich source of ideas. ***In the collection of activities we create, we can search for and present underlying commonalities.***
- The WebQuest design patterns (Dodge, undated) provide another source of inspiration. This popular, inquiry-oriented instructional strategy has small groups of students use identified resources to gather information and use higher order thinking skills to transform their knowledge. Dodge reviewed WebQuests developed by teachers worldwide to identify basic design structures he calls patterns. Three examples are *Analyzing for Bias*, *Concept Clarificatio*n, and *Genre Analysis*. Each pattern must be instructionally solid, easily modified for other content, and distinct from other patterns. For each pattern, he offers a description, instructional purpose, example WebQuests, applicability, limitations, variations, and HTML templates to facilitate others wishing to develop WebQuest for their own curriculum.
- **Reading strategies.** The National Reading Panel has identified strategies applicable across age levels and disciplines for vocabulary building (word walls (Cunningham, 2000) and word maps (Santa, Havens, & Valdes, 2004)); pre-reading strategies (anticipation guide (Head & Readance, 1986); during reading strategies such as reciprocal teaching (Palincsar & Brown, 1984); and after reading strategies including QAR (Raphael, 1986), summarizing (Brown & Day, 1983), and cubing (Cowan & Cowan, 1980; Vaughan & Estes, 1986).
- **Cooperative learning activities.** The effectiveness of cooperative learning activities has strong support in the research literature. Such activities are commonly used in K-12 schools and there is growing interest in higher education. Felder and Brent (Felder, 1996; Felder & Brent, 1994, 1996, 2003) have published about using cooperative learning strategies in college science and engineering classes for their pedagogical benefits and student engagement and enjoyment. Example activities include guided reciprocal peer question (King, 1993), Think-Pair-Share (Johnson, Johnson, & Smith, 1991), Thinking-Aloud Pair Problem-Solving (TAPPS) (Lockhead & Whimbey, 1987), and jigsaw activities (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978).
- **Classroom Assessment Techniques (CATs)**. Angelo & Cross (1993) developed 50 CATs. Some have been field-tested and broadly disseminated for STEM instructors at http://www.flaguide.org. This website offers useful information for each CAT including focus questions, description, purpose, limitations, teaching goals, suggestions for use, steps for implementation, variations, and the theory and research behind the CATS. In addition, they provide links to additional resources on the technique, citations for sources, and bios of the scholars who field-tested the technique.
- Finally, there are excellent structures for interpreting the educational intent of an activity, such as Anderson/Krathwohl's update to Bloom's taxonomy (Anderson et al., 2001; Bloom, 1956).

I want to bring these together and apply them to software engineering in a way that gives instructors a pool of good activities for their classes and a powerful support tool for creating their own.

2.3 Implementing educational innovation and developing faculty expertise

Instructors joining this project have signed letters of commitment in which they promise to teach the testing course at least three times (in some cases, twice) in 2006-2008.

To support this instruction, I will set up an instructors' master site on Moodle (an open source course management system that we will use to host all courses). Moodle supports many types of student-to-student and faculty interaction. We can use this to collect and critique sample answers, draft exercises, and so on, cross-grade (some of) each other's classes' exams or assignments, and answer each other's questions.

The implementation will be at

- a historically black college in the United States (Huston-Tillotson), and universities in Canada (Dalhousie: Morven Gentleman), and Latvia (University of Riga: Juris Borzovs)
- two large American companies that do extensive inhouse software development (Texas Instruments and Safeco Insurance) and one small American software test lab (Quardev), teaching the course to their staff or contractors
- three consultants (two American: Michael Bolton, Scott Barber; one in India: Vipul Kocher) who will teach the course face-to-face or over the Web to "the public" (students who register for the course).

At least one consultant (Bolton) will provide web-based facilitation of self-studiers for free. (Self-studiers will sign up for a section of the course that starts an advertised date, with an advertised schedule for assignments and discussions. A single volunteer instructor can facilitate the entire course or a group of volunteers can split learning units, facilitating (leading discussions and grading) the same unit across several sections of the same course.

I plan to teach at least one free web-based section and at least one web-based academic credit (traditional for-credit distance learning) section. One or more of my students will also facilitate web-based sections.

We will meet annually to compare notes, develop materials, and try out new ideas face-to-face. Meetings will include the core instructors (above) and anyone else who has joined us to do free facilitation of web-based classes.

2.4 Integrating academic and commercial approaches

The blend of academic and commercial instructors (see Section 2.3) creates a strong opportunity for mutual instructional support across the industry-versus-academic divide. As we share and discuss our assessment materials (see Section 3), we will naturally gain further insight into each others' needs and expectations.

The core group of instructors, and probably a few additional volunteers, will form the first Board of Advisors for the course. The Board will meet often by email and annually face-to-face to:

- review assessment (of the course) materials and analyses of them, recommending additional or alternative assessments
- recommend, and ultimately set, policies regarding review and acceptance of contributed materials and updates
- publish guidelines and advice for creating video materials, activities and evaluation (of student work) materials
- provide guidance to me, and eventually make decisions, regarding the order and depth of new instructional units
- review instructional objectives for the existing learning units, and review the relationship between the objectives and the learning units' associated activities and evaluation materials

The Board will start as a purely advisory group. I hope to gradually transform this into an executive board that makes decisions about the course and finds ways to raise funds to support it.

2.5 Developing a free education community, analogous to the communities that form around some successful free software products

Our mixture of supporters for the course includes academic instructors who are used to updating and enhancing course materials, companies who need this type of education and would normally pay for their staff to get it, and commercial instructors who will incorporate this material into courses they teach for a fee. All have reasons to support the course (maintain and update the materials) if it serves their needs well enough and if we make the update process clear enough. Along with the individuals and companies who have submitted letters of commitment are several individuals who have made less formal offers to facilitate a section of the course or a learning unit.

The potential economic benefits of free courseware and a free certification exam are particularly strong for larger corporations. One of my objectives during the grant period will be to persuade some of these companies to support the course through donations and contracted-for customized course segments.

2.6 Creating an open-source, free certification exam in software testing

Adelman (2000) described widely varying standards for information technology certification exams. Certification in software testing has been a powerful marketing tool for commercial course providers, but I have two key concerns:

- The testing certifications are based on outdated instructional materials. The British Computer Society's Information Systems Examinations Board (ISEB) (1999, 2001) created one of the most successful certification programs for software testing practitioners and published detailed syllabi for certification preparation courses. The American Society for Quality's *Certified Software Quality Engineer Body of Knowledge* (undated-a) is similar. Unfortunately, most of the ideas and practices in these syllabi would have fit comfortably in courses offered in 1983, when I started writing *Testing Computer Software* (Kaner, 1988).
- The exams themselves ask simplistic questions that don't reach to higher-order knowledge or to much (if any) skill. (The American Society for Quality's certification exam study guide (American Society for Quality, undated-b) illustrate the level of questions asked.)

Despite the weaknesses, many employers use testing certification as a screening tool or for qualifying or managing remote contractors. This has generated significant certification-related interest in my course—the most commonly emailed question from visitors to the testing course website is whether it leads to a certificate.

I have started working on an alternative certification that would be free and could be administered by anyone at any time. An exam would be drawn as a stratified (across topic areas) sample from a very large pool of objective questions. The question pool would be available for public review and comment on a wiki or other electronic forum.

Imagine a test manager using it as part of the hiring process. S/he would see the candidate's questions and answers—keep in mind that knowledgeable people often select "wrong" answers for sensible reasons and it could be very interesting to talk with the candidate, as part of the interview, about the "wrong" answers. (I have fairly extensive experience recruiting software testers, have given several industry seminars on this (Kaner, 1999a, 1999b, 2000b, 2000d), and believe such discussions would typically be more informative than the test scores.)

As with the other current testing certification exams, this would not address testing skill. But it would be free and would cover a more modern body of knowledge.

Certification might be the most widely noticed aspect of our work, but it is an *application* of our core project, not the driver of it. ***Certification is relevant to this proposal because it provides a tangible benefit to companies who want to use it as a recruiting or contractor-qualification tool, providing them with an incentive to help us (with labor or money) to develop questions and to keep the underlying body of knowledge up to date. This is an important part of my sustainability plan for the materials to be developed under this grant.***

From a funding perspective, I do not plan to spend NSF funds on activities primarily focused on certification, because I see that as industrial education rather than undergraduate STEM education. However, several tasks offer synergy between undergraduate education and the certification efforts, such as developing the large pool of objective-style review questions for quizzes and students' self-assessment. I believe it would be appropriate to use NSF funding for those tasks. In general, this project will fund tasks that contribute directly to the courses under development, providing benefit for the certification exam as a spin-off.

3. Assessment plan

We have three approaches to assessment of the course:

- Rebecca Fiedler (a doctoral student in education at UCF), James Patrick McGee (a doctoral student at Florida Tech), other students and I will assess the course as taught at Florida Tech or by us in distance learning courses to collect student reactions to individual learning units; instructor reactions to learning units; student appraisal of the full course using the Student Assessment of Learning Gains (Kaner & Fiedler, 2005a); instructor retrospective on the full course using a questionnaire to be developed; feedback from other commercial and academic instructors who regrade student work; and detailed interviews of current and previous students.
- As outlined in their letters of commitment, several companies, individual commercial trainers, and university faculty have agreed to teach the course multiple times and provide assessment results. As with the materials collected at Florida Tech, we will collect student reactions, instructor reactions, student appraisals and instructor retrospectives. From the companies using this course for in-house training, we will also collect outcome data—memos from the students' managers several months after training has completed, that indicate the impact the

course has had on the quality of the student's work. The external teachers (and possibly some other volunteers) will form a Board that discusses the quality and direction of materials, meeting annually. This Board is distinct from the Certification Board described above.

- We are contracting with the University of Central Florida's Program Evaluation and Educational Research unit for external evaluation services, including help preparing questionnaires.

3.1 Current results

I have now taught the course this way twice (Kaner & Fiedler, 2005b). Student evaluations have been enthusiastic (Kaner & Fiedler, 2005a), though students report that they worked much harder in this course than most others.

To my eyes, midterm and final exam results were good.

We're in the midst of our first blind regrading. At this point, here is how the data look:

- I regraded all answers several months after the end of the course, long after I was able to recognize which paper might have come from what year. The students in the new version of the course performed better by my grading standards. I believe the results are statistically significant, but the effect size is not huge.
- There were strong differences among graders. Even though I supplied them with very detailed grading guidelines, some graders appear to have ignored the guidelines, relying on a more holistic impression.
- Individual differences among graders may swamp any between-groups effects in the student performance.

The difference between my assessment and external regraders' suggests that I should change my grading standards and coaching to students on how to answer exam questions. I have discussed this at length with one regrader (Robert Sabourin, who teaches the testing course at McGill University). This will make exams more difficult. Pat McGee will probably interview the regraders and present a more detailed qualitative analysis of their impressions of the exams, answers, and associated grading standards.

3.2 External Evaluation Plan (PEER)

Evaluation will be carried out both internally and externally. Internal evaluation will be done by project staff. The external evaluation will be done by Program Evaluation and Educational Research (PEER), an evaluation unit within the University of Central Florida. Two Advisory Boards for course and the certification examination, respectively, will also aid in the external evaluation.

The Executive Director of PEER is Dr. Conrad Katzenmeyer, Chair of UCF's Department of Educational Research, Technology and Leadership within the College of Education. Prior to joining the UCF staff on January 1st, 2005, Dr. Katzenmeyer was Senior Program Director for Evaluation in NSF's Directorate for Education and Human Resources, Department of Research, Evaluation and Communication. The Director of PEER is Dr. Nancy Lewis who will be directing this external evaluation. Dr. Katzenmeyer will also contribute to the evaluation but his time will be donated.

The general model of evaluation to be employed is:

A. Content Fidelity. Do course lectures, materials and assessments have appropriate quality? Also, does the certification examination have quality items with an appropriate mix?

Those offering the courses will collect reactions from participants and provide materials for the certification exam under the guidance of the Project Director and external evaluators. Two advisory boards will review these materials. The external evaluators will collect and analyze the advisory boards' reviews and will compile an examination.

B. Short-term Outcomes. What is the satisfaction, knowledge gained, and attitude changes of participants?

The *Student Assessment of Learning Gains* (SALG) used previously in the course development, and other measures designed by the project staff and external evaluators, will be administered at the end of courses by those offering the courses. This will include interviews and focus group protocols. As verification of these activities, the external evaluators will also conduct several interviews/focus groups on site, and will analyze the data collected.

In addition, project staff will complete the collection and analysis of the data from comparisons of current year exams with previous years' examination items to determine whether student achievement gains have occurred. These data will be reviewed by the external evaluators for verification.

C. Medium-term Outcomes. Application of short-term outcomes and participant follow-ups.

The project staff and external evaluators will conduct follow-ups with participant instructors 6 months and 12 months after the courses have been completed. The external evaluators will analyze the results.

Additionally, the project staff and external evaluators will plan and conduct pilot studies of the expanded course materials and the certification examination. For the coursework, they will be tried in new courses identified by the project staff and results analyzed by the advisory boards. For the certification exam, project staff will identify appropriate candidates for taking the exam while the external evaluators will organize administration. Results will be reviewed by the advisory board.

D. Projected Long-term Outcomes. Improvement in the field.

Versions of both the courses and the certification examination will be prepared by the project staff and the external evaluators. This will include technical manuals based on the pilot results plus instructions for use.

E. Reports. As part of their role, the external evaluators will prepare yearly and final project evaluations.

4. Project plan

We are in the midst of evaluating the first two teachings of this course, offering it a third time and revising it as we gain insight from the first two evaluations. We are also enhancing examples, moving the course to Moodle, preparing more multiple choice questions and activities. This work will complete before the presently proposed project begins.

- ***Fall 2006.*** Kaner (and/or his students) teach the testing course again locally or as a distance learning course that is closely supervised. Negotiate details of the nondisclosure agreements with the remote instructors (something we won't do until the project approval, because it requires significant work and time). If we are not already teaching a distance learning course, arrange for one to start in the spring. Begin a detailed review of classroom activity descriptions; publish a first-draft activity framework on testingeducation.org, with examples. Integrate Kaner's metrics course slides with Dr. Pat Bond's and other top quality free courseware found on the web, circulating the result for review by colleagues. Kaner will teach the next offering of the Metrics course (Fall 2007). Tape at least two new segments for the testing course. Collect assessment data on the course as taught. Analyze assessment data, including exam regrading (very time consuming) from the Spring 2006 course. Create activities for students that highlight grading standards and improve their skills as essay test takers.
- ***Spring 2007.*** **Kaner's lab:** Teach at least one distance learning section of the testing course. Tape 2-4 new segments for the testing course, primarily glass box (unit test) segments that broaden the course to include more of the topics in the ACM/IEEE software engineering curriculum. Tape at least two segments for the metrics course that will be taught in Fall 2007. Conduct detailed interviews of students in this and previous sections of the course. **Remote instructors:** Most will begin teaching the course this term, collecting assessment data. North American instructors will attend the first workshop (Board meeting) on the course between April and July 2007, after they have gained experience teaching the course.
- ***Summer 2007.*** The distance-learning course in testing is in full swing, with volunteer facilitators for some sections (Kaner and students do the others). Extensive work on review questions (objective-style questions that students can use to assess their basic comprehension of lectures, etc. and that teachers can use in quizzes to check whether students watched the lectures before coming to class). Deliverable: 10-20 usable questions for each learning unit. Extensive work on activities, with at least one activity per learning unit and at least one take-home assignment for half of the learning units. Begin collecting instructor experience reports with the activities, in a form agreed to in the Board meeting (Spring 2007).
- ***Fall 2007.*** Kaner teaches the metrics course, at least half the course is video lecture. Plus activity development, etc. (see next paragraph).
- ***By the end of 2007.*** Every remote instructor will have offered the testing course at least once. We might lose a remote instructor through attrition. If so, I will replace them as needed, with a recruiting goal of 3 university instructors, 3 in-house trainers and 3 public trainers. In addition to those who teach the entire course, recruit at least 5 volunteers to facilitate at least one learning unit each (same unit across several offerings of the course).
- ***By the end of 2008.*** Most remote instructors will have offered the course at least twice. The Board will have met twice. The certification board will have met at least once, probably twice. We will have a draft certification exam, a full set of videos for the metrics course, a substantially expanded set of videos for the testing course

(including unit testing and other topics in programmer testing, plus a few other special topics taught by experts—such as a performance testing section that Scott Barber has volunteered to create with me), and extensive assessment data. At least two peer-reviewed publications on the course structure, content and assessment. At least two peer-reviewed conference presentations and at least two practitioner conference presentations on the course, the assessment, and the certification system. At least one peer-reviewed publication (journal or conference) on the actvity themes and examples.

- ***By Fall 2009.*** Most remote instructors have taught the course three times. We have extensive assessment data in hand and have made substantial revisions to the testing course and the metrics course in response to them. The online (self-studyable) version of the course is well underway, with most learning units covered by volunteers and several (three?) learning units developed by others or co-developed in conjunction with others. The Board has met three times. A third (or later) draft of the Certification exam has been published and some organizations have started using it even though it is still "beta" level.

5. Dissemination Plan

Broad dissemination is one of NSF's criteria for evaluating the merit of a proposal. Given that goal, I propose the following activities and characteristics for the project.

- ***Creative Commons licensing:*** In consideration of this merit criterion, we agree that any course materials funded under this grant will be published on the Web and licensed to the public under a Creative Commons license.
- ***Web Hosting:*** The Testing course will continue to be hosted at http://www.testingeducation.org. Because of the cost of bandwidth (the full course is a gigabyte of data), we are looking for corporate mirror sites. The Metrics course will also be hosted at http://www.testingeducation.org (as are several other testing courses).
- ***Metadata:*** The CCLI call for proposals requires a plan to tag web materials with metadata. I am not yet familiar with these standards, but I'm experienced with classification/coding schemes. I will learn the codes and supervise a student research assistant who will do the actual coding. If appropriate under the standard, I'll do a retrieval study to check whether the encoding yields the search results that one would expect.
- ***Facilitate adoption of the testing course by academic and commercial instructors and self-studiers:*** This is achieved through the multi-instructor strategy. The course will evolve as we learn what makes it hard to teach. I moderate a 200-member mailing list of self-studiers and instructors who signed up to help improve the testing course. Based partially on their commentst, one hurdle to adoption of the course appears to be insufficient contact with peer learners and facilitators who can answer questions; another is insufficient support for self-evaluation. We chose Moodle rather than OpenCourseware specifically to support strong peer interaction. We're also working on self-evaluation materials, which can support all learners, including remote ones.
- ***Workshops***: The previous ITR grant provided funding for the annual Workshop on Teaching Software Testing (WTST). WTST has met for five years and will continue to meet, but without further NSF funding. This proposal seeks travel expense funding for the annual project Board meeting.
- ***Publications***: We (Kaner, Fiedler, students, collaborators) will publish articles in traditional journals and industry magazines, and make presentations at academic and commercial conferences. See *Results from Prior NSF Support* for pointers to publications related to the Software Testing course so far.

6. Broader Impact

- *How well does the activity advance discovery and understanding while promoting teaching, training, and learning?* We think this is the core of the proposal.
- *How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)?*

  Test departments are traditional entry points into software development organizations. One way to improve diversity in a professional field is to deliver to the field's entry points more people from underrepresented groups who are credible job candidates.

  This project makes high quality courseware and an instructional support community available to institutions who might find it hard to afford to develop courses of comparable quality. One of our collaborating instructors is Allen Johnson, who chairs Computer Science at Huston-Tillotson College, a Historically Black College and University (HBCU). We don't know what modifications will be needed to make this course effective at Huston-

Tillotson, but we intend to create variations as needed to make this work. We expect that the resulting course will be attractive to other institutions who serve minorities and have very tight course development budgets.

The materials are also available for self-study and we are creating a cadre of volunteers to support the online course. We already have significant interest in this as a self-study course—200 people have signed up on a mailing list intended for instructors and others who want to help improve the course as a self-study resource. Most are self-studiers. This course is available to people around the world, whether they are close to a university or to a high-tech hub where you would expect to see high-quality testing courses taught.

Getting candidates in the door is only part of the employment picture. How will they be promoted, either within the testing department or into other, more prestigious (and typically, better paying) departments?

According to *Software Technology Magazine*'s staff (2004) summary of a series of surveys of the information technology workforce by Data Masters,

> "Women in the studies comprised 18% of the total population samples, and men represented 82%. While women made up nearly one-third of software testing and QA staffs, their male counterparts accounted for an overwhelming 93% of hard-core software coding and software systems design. Women in database development faired better — particularly in Federal, State, and Local Government fields — accounting for 22% of all developers and managers".

The proportion of women in software testing is much higher than the other areas of software development. This has been discussed widely among software testers. Here is an important puzzle: why are women able to move freely into product development by getting into testing groups but apparently less able to move from testing into more senior groups?

From 1993 to 2000, I helped several companies hire test managers. One striking issue was the candidates' lack of education or training. For a time, across recruiting assignments for a few companies, I tallied some data from resumes and telephone interviews. I no longer have the original tallies, but the summary was memorable. Consider only resumes of candidates who had been test supervisors or test managers or technical (non-testing) managers with some testing experience. *Of these*, a small majority had never been to a testing conference, never taken a testing course, and never read a testing book. The practitioner community is undereducated.

A strong, self-paced, set of technical testing materials available for free on the web, should help motivated junior practitioners increase their technical credibility and breadth, helping them raise the probability of promotion within the test group or to another technical group in the company. Because the testing subcommunity includes a disproportionately high number of women, professional development support for testers reaches out to women more than such materials would if directed to other areas of software engineering.

- *To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships?* The instructional collaborations are creating new partnerships among schools and companies in North America, Europe and India. The support community that we believe we can foster will demonstrate a method of collaboration among universities, corporations who are self-training their staff, individual consultants and individual students. This model has already been demonstrated for free software. It doesn't always work for free software—the vast majority of free software projects attract few collaborators. It won't always work for educational projects. We believe we can show a way to make this work for education.
- *Will the results be disseminated broadly to enhance scientific and technological understanding?* Yes. See Section 5 on Dissemination, above.
- *What may be the benefits of the proposed activity to society?* We expect to improve the average tester's skill, technical sophistication, and judgment. Testing is not the only activity that impacts the quality of software, but it is an important activity. Better testing will yield better software. In a society that embeds software into more consumer and industrial devices every day, a lower probability of deaths, injuries and losses caused by defective software. Fewer patches for commercial software. Fewer projects abandoned late, long after failure should have been obvious and undeniable. Fewer user-irritating defects. Reduced commercial losses due to software defects and therefore increased workforce productivity due to the reduction of unnecessary cost. ***This project is driven by a passionate belief that we can improve satisfaction and safety of software customers by improving the education of the software testing community, and that the current educational situation for testers is so weak that a few people can make a noticeable difference.***

7. Intellectual Merit

- *Importance for advancing knowledge and understanding within its own field or across different fields?* Our contributions to the underlying pool of knowledge about software testing will be incremental. In many cases, we need to clear up confusions and either resolve or clarify conflicts, in order to make subject matter reasonably teachable. In some cases (particularly failure mode and effects analysis, exploratory testing, and high volume test automation), we have to extend what is known so we can teach how to use a technique rather than merely mentioning it. See Kaner (2003b, 2003c, 2004a), Vijayaraghavan (2003), and Vijayaraghavan & Kaner (2002, 2003), for examples of this level of contribution.
- *How well qualified is the proposer (individual or team) to conduct the project?* Kaner is widely published in testing, has commercial and academic classroom success designing and delivering testing courses, and complements a 20-year software engineering background with a doctorate in experimental psychology. Rebecca Fiedler is completing her doctorate in Education at the University of Central Florida, with a research focus on effective use of technology in education. Prior to UCF, she worked in the Florida K-12 school system for 20 years as a classroom teacher and as a school technical specialist. She has successfully taught online courses to distant learners and has made significant contributions to the project for four years. Both doctoral students, Pat McGee and Andrew Tinkham, had many years of testing experience before starting their doctoral studies.
- *To what extent does the proposed activity suggest and explore creative and original concepts?* The course structure is made up of familiar elements, but in a combination that we haven't seen before. The creation of a broad support community for a free online course is a small step from the idea of a free software community, but if this works, the detailed descriptions will be models for future courses by others.

8. Results from Prior Support

I received NSF Award EIA-0113539 ITR/SY+PE: "Improving the Education of Software Testers" for $469,668.00 for 36 months with an effective date of 09/01/01. The period has been extended to 8/31/06.

One outcome of this work was transformation of a popular commercial testing course into the testing course discussed in this proposal. In the process of developing the course, we did research on basic testing techniques and created the testingeducation.org website to provide educational materials under open licenses.

- Published articles on test techniques to supplement several lecture segments (Kaner, 2003c, 2003f, 2003g, 2004d, 2004h; Kaner, Bond, & McGee, 2004; Kaner & Padmanabhan, 2006 submitted; McGee & Kaner, 2004; Padmanabhan, 2004b; Tinkham & Kaner, 2003a, 2003b; Vijayaraghavan & Kaner, 2003).
- Created a failure mode catalog (bug taxonomy) for e-commerce applications (Vijayaraghavan, 2003; Vijayaraghavan & Kaner, 2002, 2003). (This received awards at two industrial software testing conferences.)
- Creating (M.Sc. thesis in progress) a failure mode catalog for wireless PDA applications (Jha & Kaner, 2003).
- Published discussions of the structure and goals of the testing courses (Kaner, 2001a, 2002c, 2002d, 2002e, 2003a, 2004a, 2004b, 2004h, 2004i, 2004j; Kaner & Bach, 2002, 2003; Kaner & Fay, 2004; Kaner & Fiedler, 2005a, 2005b; Tinkham & Kaner, 2003b, 2005) and conference tutorials based on the course materials (Kaner, 2002b, 2002d, 2002e, 2003d, 2004b, 2004j; Kaner & Bach, 2003; Kaner & Fay, 2004).
- Created several examples of the applications of testing techniques. For example, see http://www.testingeducation.org/k04/OracleExamples.htm. These are still quite rough. Two undergraduates, Sam Oswald and Georgi Nikolov, have developed the first-draft examples. We are just beginning the text editing and in some cases videotaping of the examples.
- Published discussions of fundamental or controversial issues in software testing (Kaner, 2002a, 2002d, 2003b, 2003d, 2004c, 2004e, 2004f, 2004g; Kaner & Bach, 2002, 2004)

Kaner and two doctoral students (Andy Tinkham and Pat McGee) also created a course on programmer-testing that focuses on techniques likely to be used by programmers testing their own code (Tinkham & Kaner, 2005). This is now a required course in Florida Tech's undergraduate software engineering curriculum. Students come into the course knowing Java and knowing how to test. We teach them to be better programmers by applying tests at many levels while they design and write programs. We also teach them to be better testers by making them better testing toolsmiths and tool users. The course is activity-based rather than lecture-based. Students work in groups through assignments, some of which are more defined by them than by the instructor, present their ideas, tests and code to the class and are coached by the instructor, the teaching assistant, and by other students.

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Tinkham, A., & Kaner, C. (2003b, October). Learning styles and exploratory testing. Presented at the *Pacific Northwest Software Quality Conference*, Portland, OR. from http://www.testingeducation.org/articles/ExploratoryTestingandLearningStyles(Final).pdf

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Vijayaraghavan, G., & Kaner, C. (2003, May). Bug Taxonomies: Use Them to Generate Better Tests. Presented at the *Software Testing Analysis & Review Conference (STAR) East.* from http://www.testingeducation.org/a/bugtax.pdf

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BIOGRAPHICAL SKETCH

BIOGRAPHICAL SKETCH – CEM KANER

a. Professional Preparation

Brock University, Ontario	Arts & Sciences, primarily Math & Philosophy	B.A., 1974
McMaster University, Ontario	Experimental Psychology	Ph.D. 1984
Golden Gate University, CA	Law	J.D., 1994

b. Appointments

- Director, Center for Software Testing Education & Research, Florida Institute of Technology, November 2003–present.
- Professor of Software Engineering, Florida Institute of Technology, August 2000–present
- Extension Instructor, University of California Extension (Berkeley and Santa Cruz), 1994-2000
- Attorney, Law Office of Cem Kaner, 1994-present [My client list is private, but it doesn't include anyone relevant to this grant, other than people who are elsewhere listed as collaborators].
- Proprietor, kaner.com (software consulting), 1993-present [Representative clients: Avid Technologies, Autodesk, BEA Systems, BMC, Catalysis (through them, California Dept of Transportation), CDI, Compaq, Fenwick & West, Fonix, Hewlett-Packard, IDTS, Intel, Kodak, Microsoft, MyTurn.com, Oracle, OrCAD, Peoplesoft, PowerQuest, Safeco, Satisfice, ShareData (now E-Trade), Software AG, Software Quality Engineering, Stevedoring Services of America, the WELL, and Wind River]
- Deputy District Attorney (full-time volunteer), Santa Clara County, April 1994-July 1994.
- Law Clerk, Law Office of Berne Reuben, Dec. 1993-April 1994.
- Director of Documentation and Software Testing; Documentation Group Manager; Software Development Manager, Power Up Software (later Spinnaker Software), 1989-1994.
- Software Test Manager, Electronic Arts, 1988
- Human Factors Analyst / Software Engineer, Telenova, Inc, 1984-1988.
- Testing Technology Team Leader; Software Testing Supervisor, MicroPro (WordStar), 1983-1984.
- Associate (and then Senior Associate) (part-time), Psylomar Organization Development, 1983-1985.

c. Publications

c.(i) Most closely related

- Cem Kaner, "Teaching domain testing: A status report," *Conference on Software Engineering Education & Training*, Norfolk, VA. March 2004 http://www.kaner.com/pdfs/teaching_sw_testing.pdf
- Cem Kaner, " Software engineering metrics: What do they measure and how do we know?," *10th International Software Metrics Symposium (METRICS 2004)*, Chicago, IL. September 2004, http://swmetrics.mockus.us/metrics2004/lbp/KanerBond.pdf
- Cem Kaner, "Assessment in the software testing course," *Workshop on the Teaching of Software Testing (WTST 3)*, Melbourne, FL. February 2003, http://www.testingeducation.org/a/assessment.pdf
- Cem Kaner, "Issues in commercial law of interest to software engineering educators." (Tutorial session.) *Conference on Software Engineering Education &* Training, Cincinnati OH, February 2002.
- Cem Kaner, "The proposed florida tech stored course policy." *Computer Graphics*, *36*(2), 15-17, 21-22, 2002. http://www.siggraph.org/pub-policy/CGColumn-05-2002.html

c.(ii) Other significant publications

- Cem Kaner, James Bach & Bret Pettichord, *Lessons Learned in Software Testing*. Wiley, 2002.
- Cem Kaner, Jack Falk & Hung Quoc Nguyen, *Testing Computer Software* (2nd Ed.), Wiley, 1993.
- Cem Kaner & David Pels, *Bad Software: What to do When Software Fails*, John Wiley & Sons.
- Cem Kaner, "Software engineering & UCITA." *John Marshall Journal of Computer & Information Law*. *18(2*), 435-546, 1999. http://www.kaner.com/pdfs/engr2000.pdf
- Giri Vijayaraghavan & Cem Kaner, "Bugs in your shopping cart: A taxonomy," *15th International Software Quality Week*. San Francisco, CA, September 2002. http://www.kaner.com/pdfs/BugsInYourShoppingCart.pdf. (Received Best Paper award).

d. Synergistic Activities

Editor of the *Journal of the Association for Software Testing*, the journal of a new professional society for software testers.

Co-organizer of several ongoing workshops, including the Los Altos Workshops on Software Testing, the Software Test Managers Roundtable, the Workshop on Heuristic and Exploratory Techniques, the Florida Workshops on Model-Based Software Test Automation, the Austin Workshop on Test Automation, the Mountain Enterprise Testing Roundtable, and the Workshop on the Teaching of Software Testing.

Elected to the American Law Institute, May, 1999. One of the most prestigious organizations of attorneys in the country, memberships are life-long and the Institute's total membership is limited to 3000. This organization drafts legislation, treaties, and the Restatements (of Torts, Products Liability, Agency, Contracts, etc.), a series of authoritative treaties that are heavily relied on by appellate judges. I was elected in recognition of my legislative work on computer law. My primary current work with this group is on the *Restatement of Employment Law*.

e. Collaborators and Other Affiliations

e.(i) Collaborators: James Bach (Satisfice Inc), Shirley Becker (Florida Tech), Walter P. Bond (Florida Tech), Phillip Bernhard (Florida Tech), Jean Braucher (University of Arizona), Jennifer Brock (ADP), Hans Buwalda (CMG), Phil Chan (Florida Tech), Ross Collard (independent), Ward Cunningham (Microsoft), Ed Foster (InfoWorld), David Gelperin (SQE), Jens Gregor (U. Tennessee), Sam Guckenheimer (IBM), Elisabeth Hendrickson (Quality Tree Consulting), Doug Hoffman (Software Development Technologies), Allen Johnson (Huston-Tillotson College), Bob Johnson (Agorics), Mark Johnson (Cadence), Alan Jorgensen (Florida Tech), Phil Koopman (Carnegie Mellon University), Richard Kopec (St.Edwards University), Brian Lawrence (Coyote Valley Software), James Love (Consumer Project on Technology), Brian Marick (University of Illinois, Urbana-Champaign), Gerald Marin (Florida Tech), Fran McKain (Hewlett-Packard), David McMahon (attorney), Renaldo Menezes (Florida Tech), Mark Minasi (independent journalist), Debasis Mitra (Florida Tech), Hung Quoc Nguyen (LogiGear Technologies), David Pels (independent), Bret Pettichord (pettichord.com), David Rice (University of Rhodes Island, Law School), Sharon Roberts (Roberts consulting; Independent Computer Consultants Association), Johanna Rothman (Johanna Rothman Consulting), Patrick Schroeder (Milwaukee School of Engineering), William Shoaff (Florida Tech), Marius Silaghi (Florida Tech), Ryan Stansifer (Florida Tech), Scott Tilley (Florida Tech), Michael Thomason (U. Tennessee), James Tierney (Microsoft), Tim Van Tongren (MCI), James Whittaker (Florida Tech).

e.(ii) Graduate and Post Doctoral Advisors. A.B. Kristofferson (retired), John R. Platt (McMaster U.), Woody Heron (retired), Ibrahim Ahmad (Mathematics, McMaster U.), Roger Bernhardt (Golden Gate U. Law School).

e.(iii) Thesis Advisor and Postgraduate-Scholar Sponsor: Turky Al-Otaiby, Ibrahim El-Far, Sabrina Fay, Saurabh Gupta, Jia Hui Liu, James Patrick McGee, Sowmya Padmanabhan, Sujit Raghavan, Amit Singh, Andy Tinkham, Giri Vijayaraghavan, (all at Florida Tech.).

BIOGRAPHICAL SKETCH

BIOGRAPHICAL SKETCH – REBECCA L. FIEDLER

a. Professional Preparation

Ph.D. University of Central Florida, Education Defense scheduled for March 2006
MBA, University of Central Florida, Management 1993
BM, Southern Illinois University at Edwardsville, Music Education 1982

b. Appointments

Doctoral fellow, University of Central Florida, 2002 – present
- Teaching
  - Technology specialist, Brevard Public Schools, Florida 1995 - 2002
  - Teacher, Brevard Public Schools, Florida 1986 - 2002
  - Teacher, Dade County Public Schools, Florida 1982 - 1986
- Instructional Design
  - Southeast Initiatives Regional Technology in Education Consortium (SEIR*TEC) 2002 – 2005
  - Florida Online Reading Professional Development 2002 – 2003
- Research
  - Program Evaluation Team, Florida Online Reading Professional Development 2004
  - Contract Researcher, Beacon Associates 2003 – present
  - Contract Researcher, Acclaro Research Solutions 2003

c. Publications

c. (i) Most closely related

Hahs, D., Zygouris-Coe, V, & Fiedler, R.L. (in review). *A Hybrid Model for Evaluating Online Professional Development*.

Kaner, C. & Fiedler, R.L. Blended Learning: A Software Testing Course Makeover. Sloan Conference on Asychronous Learning, Orlando, FL.

Kaner, C. & Fiedler, R.L. Inside Out: A Computer Science Course Gets a Makeover. Association for Educational Communications and Technology (AECT).

Hahs-Vaughn, D. L., Fiedler, R.L., Yao, Y. (2004). *Florida Online Reading Professional Development Preliminary Evaluation Report*. Orlando: University of Central Florida, Department of Educational Research, Technology, and Leadership.

Soliven, S., Tuttle, J., & Fiedler, R. (2000). *Southwest Middle School Southern Association of Colleges and Schools School Improvement Model Accreditation Report*. Viera: Southwest Middle School, Southwest Middle School.

c. (ii) Other significant publications

Fiedler, R.L., & Baumbach, D. (2005). *Portfolio as Comprehensive Exam: Instigating Change*. Society for Information Technology and Teacher Education International Conference 2005.

Fiedler, R.L., & Pick, D. (2004). Adopting an Electronic Portfolio System: Key Considerations for Decision Makers. Association for Educational Communications and Technology (AECT) Fall Conference Proceedings.

Fiedler, R.L. & Salas, E. (2004). Concept Mapping: How to Help Learners Visualize Knowledge. Association for Educational Communications and Technology Summer Conference Proceedings.
Fiedler, R.L., & Baumbach, D. (2004). CyberTools for Today's Schools: A Pilot Project Society for Information Technology and Teacher Education International Conference 2004(1), 2145-2149 [online]. Available: http://dl.aace.org/14658.

d. Synergistic Activities
Participant, Workshop on Teaching Software Testing, 2004, 2005, and 2006

e. Collaborators and Other Affiliations: NA

e. (ii) Graduate and Post Doctoral Advisors: Donna Baumbach, Professor, University of Central Florida

e. (iii) Thesis Advisor and Postgraduate-Scholar Sponsor: NA

Resume
Conrad G. Katzenmeyer, Ph.D.

a) Professional Preparation

University of Minnesota	B.A.	Philosophy, 1959
University of Minnesota	Ph.D.	Psychology, 1967

b) Appointments

Current Position: Chair, Department of Research, Technology and Leadership. College of Education. University of Central Florida (2005 – Present).

Previous Positions: Senior Program Director for Evaluation, Division of Research, Evaluati and Communication, National Science Foundation. (1993 – 2005).

Director, Eisenhower National Science and Mathematics Program, U.S. Department of Education (1992 – 1993).

Division Director, Schools and School Professionals, Office of Educational Research and Improvement, U.S. Department of Education (1987 – 1992)

Adjunct Instructor, Department of Educational Measurement and Statistics, College of Education, University of Maryland – College Park. Fall 1987; Fall 1989; Fall 1991; and Fall 1997.

Associate Dean of the Graduate College and Director of Research, Western Michigan University. (1979 – 1984)

Program Officer, Office of Program Integration, National Science Foundation. (1976 – 1979)

State-wide Evaluator, Wisconsin Department of Public Instruction (1973 – 1974)

Associate Director, Information Systems and Evaluation Center and Visiting Associate Professor, College of Education, University of Oklahoma. (1971 – 1972)

Director, Bureau of Educational Research and Assistant Professor, Department of Educational Psychology, Kent State University. (1968 – 1971)

Project Director, Research Psychologist, U.S. Naval Personnel Research Activity, San Diego, California. (1967 – 1968)

c) Publications

Katzenmeyer, C., & Lawrenz, F. "National science foundation perspectives *on* the nature of stem program evaluation." In F. Lawrenz and D. Hoffman (Eds.), *Perspectives on the "Scientific Evaluation of Science, Technology, Engineering and Mathematics (STEM) Education Programs.* San Francisco, CA: Jossey-Bass (in press).

Dietz, J.S., Anderson, B., and Katzenmeyer, C. (2002). Women and the crossroads of science: Thoughts on policy, research, and evaluation. Journal of Women and Minorities in Science and Engineering, 8, 395-408.

Katzenmeyer, C. (1991). Singing the same old tune: Federal evaluation policy and the program effectiveness panel. In J.N. Altschuld (Ed.)*, Educational Evaluation: An Evolving Field. Theory Into Practice, XXX(1), 69-73.* Columbus, OH: Ohio State University.

Katzenmeyer, C., et al. (1987). Rationale for Establishing Content Centers for the Learning and Teaching of Subject Matter Knowledge. Washington, D.C.: U.S. Department of Education.

d) Synergistic Activities

With Frances Lawrenz, I just completed a summary of the evaluations that had been completed during the last years I was with NSF. This document includes 4the approaches that we had taken and a summary of some of the results. This work bears on all evaluations that I am involved with, and particularly the most recent evaluations.

I am organizing an institute within my my Department and the College of Education to conduct evaluations. We will draw on faculty with appropriate academic backgrounds and experiences as well as full-time evaluators.

e) Collaborators

Dr. Frances Lawrenz Ph.D. University of Minnesota
Dr. Stephen Sivo Ph.D. University of Central Florida
Dr. Lea Witta Ph.D. University of Central Florida
Dr. Nancy Lewis Ph.D. University of Central Florida

Biographical Sketch

Nancy S. Lewis
Department of Teaching and Learning Principles **Orlando, Florida 32816-1250**
University of Central Florida **nlewis@mail.ucf.edu**

Professional Preparation

2001 University of Central Florida, Ph. D., Curriculum and Instruction
1998 University of Central Florida, Lockheed-Martin/UCF Academy for Mathematics and Science, Master of Education
1981 University of North Florida, Bachelor of Art in Education
1980 University of Florida, Associate of Art

Appointments

2001-present: Research Associate, University of Central Florida

As a research associate my main activities have included creating and directing a new program to transition people from industry into teaching and conducting evaluation work for various projects.

Inquiry Teaching and Learning: Connecting Research and Practice (20005-present) - Directed all aspects of the evaluation for this NSF funded research grant.

Greater Orlando GK-12 (2005-present) - Directed the evaluation of this NSF funded project that matched graduate students in the sciences with 9th grade public school teachers.

Florida Online Reading Professional Development (2004- present) – Directed the evaluation of this state wide online reading course with over six thousand participants. Responsibilities included supervising three graduate assistants, using online survey tools, analyzing qualitative and quantitative data, report writing.

T-MAST Scholars (2004-present) – PI and administrator of this NSF funded project to recruit and support 10 people from science, technology, engineering and mathematics as they learned to become effective middle grades mathematics and science teachers.

Evaluation Internship (2004) –Participated in an evaluation internship through Western Michigan University's Evaluation Center funded through the National Science Foundation.

Member - Program Evaluation and Educational Research Group (PEER Group) at UCF.

Longitudinal Study of a Teacher Enhancement Project (Director/Co- PI)- Director of a $934,081 grant to evaluate the Lockheed Martin/UCF Academy (NSF award 9815931). Responsibilities include scheduling, instrument development, data collection, analysis of qualitative and quantitative data, report writing, supervision of three employees, and dissemination of evaluation results at state, national, and international conferences.

1998-2001: Graduate Research Assistant

As a doctoral student I worked extensively on the Lockheed Martin/UCF evaluation including: assisting in design of observational protocol, assisting in design of focus group protocol, mediating focus groups, analyzing both qualitative and quantitative data, disseminating findings. Additionally I supervised senior intern experiences for 24 elementary education majors.

1981-1998- Teacher in Orange County Public Schools

Publications

Peer Reviewed

Lewis, N., and Swan, B., (manuscript submitted). Mentoring Matters: Helping Transitioning Teachers. *Journal of Mathematics Educational Leadership.*

Jeanpierre, B., and Lewis, N. (manuscript submitted). Becoming a Teacher. *Action in Teacher Research.*

Lewis, N. (Summer, 2004). The Intersection of Post-Modernity and Classroom Practice. *Education Quarterly. 30(4).*

Lewis, N (Fall, 2002). Systemic Reform Through a Master's Degree. *Florida Educational Leadership.* 3 (1), 60-64.

Proceedings- Reviewed

Lewis, N. & Jeanpierre, B. (2004). The story of a teacher inductee and a program. *Proceedings of the Fifth International Conference on Self-Study of Teacher Education Practices.*

Lewis, N. & Johnson, J. (2002). Finding post-modernity in classroom practice. *Proceedings of the Fourth International Conference on Self-Study of Teacher Education Practices.*

Synergistic Activities

University Teaching

LAE 5337- Literacy Strategies for Middle and Secondary School
IDS 6939- Curriculum Reform in Mathematics and Science
IDS 6937- Reflecting on Mathematics and Science Instruction
IDS 6933- Seminar in Mathematics and Science
EDE 4943- Internship II - Elementary
EDS 5356- Clinical Supervision
RED 3310- Emerging Literacy

2005 Attended the nine-day NSF funded Howard University Evaluation Training Institute

2004 Elected to the **Board of Directors for the National Evaluation Institute**

2004 Authored the award winning proposal based on the evaluation of the Lockheed Martin/UCF Academy for Mathematics and Science to the American Association of State Colleges and Universities for the prestigious Christa McAuliffe award for excellence in teacher education.

2003 Attended an NSF supported three-week Materials, Training, Support Evaluation Institute at Western Michigan University

Recent Professional Presentations

Mentoring Matters. (July, 2005) Consortium for Research on Educational Accountability and Teacher Evaluation National Evaluation Institute. Memphis, TN.

Moving Beyond Measurement: Integrating Mathematics and Science. (Jan., 2005) American Association of Mathematics Teacher Educators. Dallas, TX.

The Use of Appreciative Inquiry: Mentoring New Teachers. (Jan., 2005) Southeastern Evaluation Association. Tallahassee, FL.

An Alternative Certification Program: Transitioning Novices to Middle School Science Teaching. (Nov., 2004) American Evaluation Association. Atlanta, GA .

Linking Student Performance to Graduate Studies. (Jan., 2004) Association of Mathematics Teacher Educators Eighth Annual Conference. San Diego, CA.

Collaborators and Other Affiliations

Dr. Michael Hynes	University of Central Florida	Research Director
Dr. Conrad Katzenmeyer	University of Central Florida	Department Chair

Professional Memberships

American Evaluation Association
American Educational Research Association
Consortium for Research on Educational Accountability and Teacher Evaluation
National Council of Teachers of Mathematics
Association of Supervision and Curriculum Development
Phi Delta Kappa
School Science and Mathematics Association
Southeastern Evaluation Association
Association of Mathematics Teacher Educators

SUMMARY PROPOSAL BUDGET YEAR 1

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

ORGANIZATION: **Florida Institute of Technology**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Cem Kaner**

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. **Cem Kaner - PI**	0.00	0.00	2.00	$ 20,000	$
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	2.00	20,000	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				22,050	
4. (0) UNDERGRADUATE STUDENTS				32,640	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				22,725	
TOTAL SALARIES AND WAGES (A + B)				97,415	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				5,260	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				102,675	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Laptop Computers (2) $ 4,400					
TOTAL EQUIPMENT				4,400	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				5,100	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 5,000					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (15) TOTAL PARTICIPANT COSTS				5,000	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				4,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				500	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				20,738	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				25,238	
H. TOTAL DIRECT COSTS (A THROUGH G)				142,413	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
Fringe (Rate: 43.5000, Base: 5260) (Cont. on Comments Page)					
TOTAL INDIRECT COSTS (F&A)				24,186	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				166,599	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 166,599	$

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

PI/PD NAME: **Cem Kaner**

ORG. REP. NAME*: **Robert merrill**

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 YEAR 2

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

ORGANIZATION: **Florida Institute of Technology**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Cem Kaner**

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. **Cem Kaner - PI**	0.00	0.00	2.00	$ 20,000	$
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	2.00	20,000	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				22,050	
4. (0) UNDERGRADUATE STUDENTS				32,640	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				22,725	
TOTAL SALARIES AND WAGES (A + B)				97,415	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				5,260	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				102,675	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **Laptop Computers (2)** $ 4,400					
TOTAL EQUIPMENT				4,400	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				5,100	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 5,000					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (15) TOTAL PARTICIPANT COSTS				5,000	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				4,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				500	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				21,283	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				25,783	
H. TOTAL DIRECT COSTS (A THROUGH G)				142,958	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Fringe (Rate: 43.5000, Base: 5260) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				17,019	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				159,977	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 159,977	$

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

PI/PD NAME: **Cem Kaner**

ORG. REP. NAME*: **Robert merrill**

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INDIRECT COST RATE VERIFICATION		
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: **Florida Institute of Technology**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Cem Kaner**

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. **Cem Kaner - PI**	0.00	0.00	2.00	$ 20,000	$
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	2.00	20,000	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				22,050	
4. (0) UNDERGRADUATE STUDENTS				32,640	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				22,725	
TOTAL SALARIES AND WAGES (A + B)				97,415	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				5,260	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				102,675	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Laptop Computers (2) $ 4,400					
TOTAL EQUIPMENT				4,400	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				5,100	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 5,000					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (15) TOTAL PARTICIPANT COSTS				5,000	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				4,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				500	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				22,059	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				26,559	
H. TOTAL DIRECT COSTS (A THROUGH G)				143,734	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
Fringe (Rate: 43.5000, Base: 5260) (Cont. on Comments Page)					
TOTAL INDIRECT COSTS (F&A)				15,165	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				158,899	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 158,899	$

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

PI/PD NAME: **Cem Kaner**

ORG. REP. NAME*: **Robert merrill**

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 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

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

ORGANIZATION: **Florida Institute of Technology**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Cem Kaner**

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. **Cem Kaner - PI**	**0.00**	**0.00**	**6.00**	$ **60,000**	$
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**	**6.00**	**60,000**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**0**) GRADUATE STUDENTS				**66,150**	
4. (**0**) UNDERGRADUATE STUDENTS				**97,920**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**68,175**	
TOTAL SALARIES AND WAGES (A + B)				**292,245**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**15,780**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**308,025**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ **13,200**					
TOTAL EQUIPMENT				**13,200**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**15,300**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **15,000**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**45**) TOTAL PARTICIPANT COSTS				**15,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**12,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**1,500**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**64,080**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**77,580**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**429,105**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**56,370**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**485,475**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **485,475**	$

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

PI/PD NAME: **Cem Kaner**

ORG. REP. NAME*: **Robert merrill**

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C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

BUDGET JUSTIFICATION

COST SHARING

Nine external organizations will collaborate with Florida Institute of Technology in this project, teaching courses, collecting and providing assessment data at their own expense. The larger corporations will also pay for their staff's travel expenses to project meetings. Another corporation, Satisfice Inc., has agreed to donate $10,000 to the project for certification-related work if this proposal is funded.

Rebecca Fiedler will contribute 150-200 hours per year to this project unpaid. Dr. Conrad Katzenmeyer (Executive Director of PEER) has helped in the planning of this proposal and will contribute to the evaluation without pay. Cem Kaner will contribute at least $10,000 toward additional travel costs associated with this project.

SENIOR PERSONNEL

Cem Kaner -- $20,000 in summer support corresponds to less than two month's pay at his 9-month rate of $145,000 per year. He will provide 2 person-months of work per summer for this project.

Rebecca Fiedler is a doctoral candidate in the College of Education at the University of Central Florida (graduation expected in Spring 2006), with 20 years of prior teaching experience. She helped plan and develop some aspects of the Testing course and the literature review and evaluation plan in this proposal, has given presentations at the Workshop on Teaching Software Testing and coauthored presentations on the testing course at educators' conferences (Sloan Foundation, AECT). In 2005, she contributed 300 unpaid hours to this project. Fiedler and Kaner are married and she does not have a long-term institutional affiliation or manager (her doctoral work completes in March, 2006). To avoid questions of conflict of interest and of the management of conflict of interest, she will continue to contribute to this project as a volunteer.

OTHER PERSONNEL:

Graduate Students -- $22050 per year

Two graduate students will work on the project at a rate of $15 per hour. One will work for 20 hours per week during the academic year (38 weeks) plus 30 hours per week during the 11-week summer. The other will work for 10 hours per week for 38 weeks. (Total $22050 per year.)

Undergraduate Students -- $14400 per year

1 student, 49 weeks, at a rate of $12 per hour for 20 hours per week during the school year (38 weeks) and 40 hours per week during the 11-week summer (total, $14,400 per year).

2 students, 38 weeks at a rate of $12 per hour for 20 hours per week during the school year (38 weeks) (total $9120 each per year).

External Evaluator (PEER) --$64080 total

Total cost is $64080 over three years. The following is quoted from PEER's letter to us. The PEER budget spreadsheet is appended at the end of this Justification.

> Evaluation will be carried out both internally and externally. Internal evaluation will be done by project staff. The external evaluation will be done by Program Evaluation and Educational Research (PEER), an evaluation unit within the University of Central Florida. Two Advisory Boards for course and the certification examination, respectively, will also aid in the external evaluation.
>
> The Executive Director of PEER is Dr. Conrad Katzenmeyer, Chair of UCF's Department of Educational Research, Technology and Leadership within the College of Education. Prior to joining the UCF staff on January 1st, 2005, Dr. Katzenmeyer was Senior Program Director for Evaluation in NSF's Directorate for Education and Human Resources, Department of Research, Evaluation and Communication. The Director of PEER is Dr. Nancy Lewis who will be directing this external evaluation. Dr. Katzenmeyer will also contribute to the evaluation but his time will be donated.

DOMESTIC TRAVEL -- $3600 PER YEAR; INTERNATIONAL TRAVEL -- $1500 PER YEAR

Assumption: we spend $1200 per conference in conference fee, airfare and hotel for domestic conferences and $1500 for international conferences.

We expect to present results of this research at ACM SIGCSE, other computer society meetings, and other meetings on education and technology (such as Sloan). This grant will typically support travel when the traveler is presenting a paper or tutorial at the conference.

In addition to the funding from NSF, if this project is funded, Cem Kaner will contribute at least $10,000 toward additional travel costs associated with this project, during the period of the project.

OTHER DIRECT COSTS

Materials & Supplies -- $4000 per year

Along with the usual miscellaneous supplies, this includes license fees for qualitative analysis software (Atlas.ti), updates for Adobe Premiere on two computers and other software for data analysis and video production, plus replacement of some aging CRT's with LCD's, plus $2000 for storage: two non-colocated copies of an anticipated 2.5 terabytes of data. (The space estimate is based on the 3/4 terabyte of data used so far by the Testing 1 course. We are counting on the price of storage declining.)

Publication Costs -- $500 per year

IEEE Transactions in Engineering Education charges a publication fee. The fee is optional for short articles, but the article we are preparing on this project will

require a fee. Several conferences charge fees for articles that exceed a very short page count.

Tuition Reimbursement -- $22725 per year

$22725 per year is intended to provide 13 hours per year tuition support for one of the graduate students and $12,000 per year to split across three of the undergraduates. Students often come to us with scholarships and so we are budgeting for partial tuition support.

Capital Equipment -- $4400 per year

Most of my lab's computers are now 4-5 years old. Many were inexpensive when purchased. Some are failing, others are becoming too slow relative to the performance requirements and will have insufficient expansion capability, especially when the new version of Windows hits us. We expect to replace 2 machines per year with laptops.

PARTICIPANT SUPPORT -- $5000 PER YEAR

Project collaborators will come to Florida Institute of Technology once per year to compare notes, evaluate and improve materials together, and make decisions about the evolution of the courses for the next year. These meetings will operate jointly as research workshops and advisory board meetings. As laid out in their letters of commitment (attached as supplementary documents to this proposal), some of the collaborators are willing to pay their own expenses to attend these 3-day meetings. Most are faculty or consultants in small businesses who could not agree to donate travel expenses along with their time. Some of the collaborators will be willing to donate their travel expenses some years, and so I cannot precisely estimate total cost. Instead, my approach to participant support funding will be to *subsidize* and not fully reimburse travel expenses to these meetings. The exact subsidy will depend on the amount donated. My target is to pay for hotel room and tax and a capped amount (up to $250) for airfare.

Budget Spreadsheet from PEER:

NSF Three Year Budget					
		Year 1	Year 2	Year 3	Total
SENIOR PERSONNEL					
Dr. C. Katzenmeyer (PI)					$ -
Dr. N. Lewis	Yr 1 1.80 mths .15 FTE	$ 9,734	$ 10,026	$ 10,326	$ 30,085
	TOTAL	**$ 9,734**	**$ 10,026**	**$ 10,326**	**$ 30,085**
OTHER PERSONNEL					
Postdoc - OPS		$ -	$ -	$ -	$ -
GRA					

Undergrad			$ -	$ -	$ -	$ -
	TOTAL		**$ -**	**$ -**	**$ -**	**$ -**
FRINGE BENEFITS						
			$	$	$	$
Faculty		30.50%	2,969	3,058	3,150	9,176
OPS (postdoc)		1.60%	$ -	$ -	$ -	$ -
Student		0.00%	$ -	$ -	$ -	$ -
	TOTAL		**$ 2,969**	**$ 3,058**	**$ 3,150**	**$ 9,176**
TOTAL SALARY & FRINGE			**$ 12,702**	**$ 13,083**	**$ 13,476**	**$ 39,261**
EQUIPMENT						
None			$ -	$ -	$ -	$ -
	TOTAL		**$ -**	**$ -**	**$ -**	**$ -**
TRAVEL						
			$	$	$	$
Domestic			1,800	1,800	1,800	5,400
Foreign			$ -	$ -	$ -	$ -
	TOTAL		**$ 1,800**	**$ 1,800**	**$ 1,800**	**$ 5,400**
PARTICIPANT SUPPORT						
Stipend			$ -	$ -	$ -	$ -
Travel			$ -	$ -	$ -	$ -
Subsistence			$ -	$ -	$ -	$ -
Other			$ -	$ -	$ -	$ -
	TOTAL		**$ -**	**$ -**	**$ -**	**$ -**
OTHER DIRECT COST						
Materials and Supplies						$ -
					$	$
Publication					150	150
Consultant						$ -
Other						$ -
Tuition			$ -	$ -	$ -	$ -
	TOTAL		**$ -**	**$ -**	**$ 150**	$ 150
TOTAL DIRECT COST			**$ 14,502**	**$ 14,883**	**$ 15,426**	**$ 44,811**
INDIRECT COST						
BASE	**RATE**					
			$			$
$ 14,502	43.00%		6,236			6,236
				$		$
$ 14,883	43.00%			6,400		6,400
$ 15,426	43.00%				$	$

				6,633	6,633
	TOTAL INDIRECT	$ 6,236	$ 6,400	$ 6,633	$ 19,269
TOTAL PROJECT COST		**$ 20,738**	**$ 21,283**	**$ 22,059**	**$ 64,080**

CURRENT & PENDING SUPPORT

CURRENT AND PENDING SUPPORT TO CEM KANER

Current support: NSF grant EIA-0113539 ITR/SY+PE: "Improving the Education of Software Testers." Award **0113539** was made on **08/31/01** for **$ 469,668.00** for 36 months with an effective date of **09/01/01**. I was able to stretch this funding out, via donations from Texas Instruments and consulting payments related to the grant from Rational Software and AutoDesk. However, as of 9/1/06, the final extension will expire and I will have no remaining funds.

There is no other current support for Cem Kaner.

At this time, I have a pending application with Texas Instruments for money to support this project (a continuation of the ITR project) until the present proposal is (hopefully) approved. I expect to receive $25,000 to $50,000.

CURRENT AND PENDING SUPPORT TO REBECCA FIEDLER

There is no other current or pending support for Rebecca Fiedler.

CURRENT AND PENDING SUPPORT TO PEER (Katzenmeyer & Lewis)

PEER (Program Evaluation and Educational Research) is an evaluation unit within the University of Central Florida. They are doing our external evaluation. The Executive Director of PEER is Dr. Conrad Katzenmeyer, Chair of UCF's Department of Educational Research, Technology and Leadership within the College of Education. The Director of PEER is Dr. Nancy Lewis who will be directing this external evaluation.

We listed them as senior members of the project because they will play a significant evaluation role and so their resumes are probably relevant for your evaluation. As I understand how to work with Fastlane, to give you their resumes, I have to label them as senior members of the project.

PEER is a subcontractor. They probably have many other sources of support, but those are not visible to us, nor were they relevant to our negotiation of their fee.

FACILITIES, EQUIPMENT & OTHER RESOURCES

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: **The Center uses two laboratory rooms in the Olin Engineering office, 238 and 265. These are on the same floor as Kaner's office. Together they can house up to 8 students. Additionally, Kaner maintains a large office/studio at home, where all of the course videotaping has been done**

Clinical:

Animal:

Computer: **Course development and evaluation require two computers capable of video production and at least one good camera. Additionally, the project requires two to three computers to be available as course/video servers and computers for students working on the project for development and**

Office:

Other: **Florida Institute of Technology will provide sufficient internet bandwidth for this project. The Center's website, www.testingeducation.org, is hosted at Florida Tech and the public downloads the course materials from that site. We are exploring mirror sites to reduce the load on Florida Tech.**

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.

Assessment-related services will be provided by Conrad Katzenmeyer's group at the University of Central Florida. This is discussed in more detail in the main body of the proposal.

Continuation Page:

LABORATORY FACILITIES (continued):

so far. Taping and production at his house has required an area of about 300 square feet--an area of at least 400 square feet will be available for the project at all times.

COMPUTER FACILITIES (continued):

assessment of materials. The Center has suitable machines on hand today. The video production systems are relatively new. The others are five years old and should be replaced during the term of this grant.

RITI
Rīgas Informācijas tehnoloģijas institūts

Sabiedrība ar ierobežotu atbildību
Rīgas Informācijas tehnoloģijas institūts
Vien. reģ. nr. LV40003244297
Kuldīgas iela 45b
LV-1083 Rīga, Latvija
Tel.: 7067701
Fakss: 7619573

To: The National Science Foundation
Regarding: CCLI grant application by Cem Kaner
Date: January 10, 2006
From: Prof. Juris Borzovs, University of Latvia and Riga Information Technology Institute, Riga, Latvia

This letter indicates our support for the project proposed by Dr. Kaner.

I am an Information Technology professor at the University of Latvia, Riga, Latvia. I also serve as Chairman of the Board of Riga Information Technology Institute, a research subsidiary of a major custom software development company a/s DATI Exigen Group located in Riga, Latvia. I am faculty member responsible for software quality subjects incl. software testing (electives in bachelor and master computer science programmes). At RITI, we have several training courses in software testing being delivered to relevant employees. Local employers repeatedly claim that software testing skills and basic knowledge of the University graduates need to be substantially improved. So, I am really interested to collaborate with Prof. Kaner.

I have reviewed the instructional materials that Dr. Kaner has published at http://www.testingeducation.org/BBST.
If the National Science Foundation awards funding to Dr. Kaner to extend these materials, we have agreed to collaborate in this project in the following ways:

- In the period 2006 to 2008, I will teach a course based on these materials at least twice
- In each case, I will evaluate the course and the instruction at several levels:
    - At the start of the course, I will advise students in writing that this course is part of an international research project on the effectiveness of teaching software testing and that I intend to share their work products (such as exams and homework) and evaluations with other instructors after stripping their names and other information that could identify them or their company, and that we may publish research reports that quote briefly from their work products or their evaluations. I will advise students that they have the right to withhold their permission for us to use their data. I will not forward or make any use of permission-withheld work products. However, because the evaluations are submitted anonymously, if a student submits one, the research group will share it and use it. I will encourage all students, especially students who are dissatisfied with the course or who find it difficult, to allow us to include their work in our studies.
    - I will collect student reactions to each instructional unit (a unit includes its associated activities)
    - I will note my instructor reactions to each instructional unit as I teach the course
    - I will collect detailed student evaluations at the end of the course using a questionnaire based on the Student Assessment of Learning Gains

- I will provide a detailed instructor evaluation at the end of the course, using a questionnaire that asks the instructor to reflect on how the instructional materials helped (or did not help) achieve my course objectives, and what changes to the materials could make the course more effective next time.
- A single course may involve several instructors, or an instructor and several teaching assistants. In this case, I will collect reactions from each instructor / TA to the instructional units they worked on, and I will collect end-of-course reflections from each of them, with the understanding that they may leave some parts of that questionnaire blank because they weren't sufficiently involved in it.
- I will ask students to allow us me contact them some time (perhaps six months or a year) after the end of the course for a reflection on the value of the course and the extent to which the lessons in this course helped them in later courses or other work.

We have not settled on the details of the questionnaires. I expect to develop questionnaires in collaboration with Dr. Kaner and perhaps with other companies or instructors who are working on this project. I agree that the questionnaire I actually use will be subject to Dr. Kaner's approval and I understand that one of his reasonable objectives is a degree of standardization across research sites.

I expect to use a mixture of activities developed by Dr. Kaner's lab and activities that I already use or that I develop over the next few years. I expect to base many of the application activities on the taxonomy of activities and collection of examples that are developed as part of this research. I will share descriptions of the activities with Dr. Kaner and grant permission for their inclusion in the free courseware.

I understand that I will not be financially compensated for participation in this project. I am donating the significant labour that will be involved in the assessments and their analysis.

I expect reimbursement for reasonable travel expenses when I travel to meet with Dr. Kaner and other researchers to discuss our results and next steps. I understand that his travel budget will be limited and that it may not stretch to cover all of my expenses.

I understand that within this project, Dr. Kaner intends to expand his basic testing course and to develop a second course on software metrics. I expect my primary involvement to be with the testing course but I would like to be informed also regarding the metrics course.

I understand that Dr. Kaner is trying to develop an open source, free certification exam for software testers that would be based on the testing course and on other materials freely available on the Web. I believe that there is a significant need for a trustworthy certification of knowledge of the basic facts of testing and of the ability to apply the basic techniques of testing. I will decide on the extent to which I can assist with this work as I come to understand the details better how I could contribute. In principle, I believe that this is a worthy endeavour that it might help some of my students get appropriate jobs, and that it should be supported.

Best regards,

Juris Borzovs

Quardev
Laboratories

To: The National Science Foundation
Regarding: CCLI grant application by Dr. Cem Kaner
Date: January 10, 2006
From: Jon Bach, Director of Corporate Intellect and Methodology, Quardev Laboratories

This letter indicates support for the project proposed by Dr. Kaner.

I represent Quardev Laboratories, a service company in Seattle that specializes in software testing. We have about 25 clients, the biggest being Microsoft, which is located just a few miles from our facility. To meet the demand for outsourced software testing services, we have a staff of 35 people who work either in our facility or onsite at clients.

It is our growth that recently warranted us a place on the top 25 fastest growing private companies in the state of Washington. To compete with offshoring to India and China, we need to have a robust training program here at the lab. Training and methodology is my domain as Corporate Intellect Officer for Quardev.

I have reviewed the instructional materials that Dr. Kaner has published at http://www.testingeducation.org/BBST and find them not only to be relevant to the training goals I have set forth for my company, but crucial to our success in our mission to be considered "thought leaders" in our industry – setting us apart from service threats from offshore nations.

If the National Science Foundation awards funding to Dr. Kaner to extend these materials, I have agreed to collaborate in this project in the following ways:

- In the period 2006 to 2008, we will teach a course based on these materials to our own staff or to individuals who will provide contracted services to us at least three times.
- In each case, we will evaluate the course and the instruction at several levels:
  - At the start of the course, we will advise students in writing that we are part of an international research project on the effectiveness of teaching software testing and that we intend to share their work products (such as exams and homework) and evaluations with other instructors after stripping their names and other information that could identify them or their company, and that we may publish research reports that quote briefly from their work products or their evaluations. We will advise students that they have the right to withhold their permission for us to use their data. We will not make any use of permission-withheld work products. We will encourage all students, especially students who are dissatisfied with the course or who find it difficult, to allow us to include their work in our studies.
  - We will collect student reactions to each instructional unit (a unit includes its associated activities)
  - We will collect instructor reactions to each instructional unit
  - We will collect detailed student evaluations at the end of the course using a questionnaire based on the Student Assessment of Learning Gains
  - We will collect a detailed instructor evaluation at the end of the course, using a questionnaire that asks the instructor to reflect on how the instructional materials helped (or did not help) achieve her or his course objectives, and what changes to the materials could make the course more effective next time.
  - We will contact the students and their managers some time after the course, perhaps six months, asking them to assess in retrospect how the course has (or has not) helped the students in their work.

We have not settled on the details of the questionnaires. We expect to develop questionnaires in collaboration with Dr. Kaner and perhaps with other companies or instructors who are working on this project. We agree that the questionnaire we actually use will be subject to Dr. Kaner's approval and we understand that one of his reasonable objectives is a degree of standardization across research sites.

Our typical training sessions provide face-to-face instruction over short time periods in series, such as one-hour "brownbags" over three or four days. Some classes are in three-hour blocks after normal business hours. We are not sure how to present an intense short course that is based on the BBST material at this time. This project is an opportunity for us to try to develop a new structure that is more activity-based. We expect to benefit in this from the taxonomy of activities and organized collection of example activities that are to be developed as part of this research. It is our expectation that, as part of this NSF-funded project, Dr. Kaner will assist us, without further compensation, in thinking through several of the details of the new structure. We will report what we try, sharing our experiences and our activities, though we reserve the right to protect those of our activities and lectures that involve confidential information or are otherwise proprietary.

If it is necessary to enable him to understand what happened in our courses, we will also share proprietary materials with Dr. Kaner, under a nondisclosure agreement that allows him to publish an honest summary that omits proprietary details. We will draft the nondisclosure agreement when and if it is needed but we have agreed in principle that it will allow him to present such summary data as is needed to give the reader an honest appreciation of the instructional issues and results.

We understand that we will not be financially compensated for participation in this project and that our expenses, including travel expenses will not be reimbursed. We are donating the significant labor and other expenses that will be involved in the assessments and their analysis.

We understand that within this project, Dr. Kaner intends to expand his basic testing course and to develop a second course on software metrics. We expect our primary involvement to be with the testing course, but this second course would have great value to us in providing a deeper level of accountability of service to our clients.

We understand that Dr. Kaner is trying to develop an open source, free certification exam for software testers that would be based on the testing course and on other materials freely available on the Web. We believe that there is a significant need for a trustworthy certification of knowledge of the basic facts of testing and of the ability to apply the basic techniques of testing. We aren't yet sure how this certification will work, but if it does work, we believe that it will help us recruit staff, qualify contractors, and do some staff development planning. These are important benefits to us and we do not feel that we realize these benefits via the certifications currently available in software testing. We will decide on the extent to which we can assist with this work as we come to understand the details better what it is and how we could contribute. In principle, we believe that this is a worthy endeavor and that it should be supported

We also expect to publicize our work in this project. We understand that our publicity must give appropriate credit to the National Science Foundation, but we also expect that Dr. Kaner will help us write up descriptions of our work that would be published in channels our customers are likely to read. We also expect that Dr. Kaner will cosign some or all of these papers with our staff and that he will publicize our efforts in other ways, such as acknowledgements in publications or on his website(s).

Sincerely,

Jon Bach
Director, Corporate Intellect and Methodology
Quardev Laboratories
3411 Thorndyke Ave
Seattle, WA 98119
206-547-7771 x. 106

DevelopSense

61Ashburnham Road Toronto, ON M6H 2K4 (416) 656-5160 info@developsense.com

13 January, 2006

To: The National Science Foundation
Regarding: CCLI grant application by Cem Kaner
From: Michael Bolton, Principal, DevelopSense

This letter indicates my support for the project proposed by Dr. Kaner.

I am a tester, testing trainer, consultant, and writer. For the last eight years, I have been providing training and consulting services in testing and software quality to organizations in the United States and Canada, and other countries around the world including France, Spain, India, Australia, New Zealand. (I am a citizen of both the United States and Canada.) When I'm teaching a course, it is usually one called "Rapid Software Testing", which is based on materials developed by James Bach, and much of that material has in turn been developed in collaboration with Dr. Kaner.

I am very familiar with the instructional materials that Dr. Kaner has published at http://www.testingeducation.org/BBST. I recommend them, more or less on a daily basis, to aspiring testers; to established testers who wish to develop their skills further; and to developers who wish to learn something about testing and the tester's role and point of view.

If the National Science Foundation awards funding to Dr. Kaner to extend these materials, we have agreed to collaborate in this project in the following ways:

- In the period 2006 to 2008, I will continue to teach as many courses as I can which are strongly based upon these materials.
- I will attempt to provide online and telephone-based support for those who wish to take online, but who (for whatever reason) are unable to have me teach software testing to them in person. I will attempt to do this for at least three individuals or organizations.
- In each case, I will evaluate the course and the instruction at several levels:
    - At the start of the course, I will advise students in writing that I am part of an international research project on the effectiveness of teaching software testing and that I intend to share their work products (such as exams and homework) and evaluations with other instructors after stripping the students' name(s) and other information that could identify them or their company, and that I may collaborate in publishing research reports that quote briefly from their work products or their evaluations. I will advise students that they have the right to withhold their permission for me to use their data. I will not make any use of permission-withheld work products. I will encourage all students, especially students who are dissatisfied with the course or who find it difficult, to allow me to include their work in our studies.
    - I will collect student reactions to each instructional unit (a unit includes its associated activities)
    - I will supply instructor reactions to each instructional unit

- I will collect detailed student evaluations at the end of the course using a questionnaire based on the Student Assessment of Learning Gains
- I will complete a detailed instructor evaluation at the end of the course, using a questionnaire that asks me to reflect on how the instructional materials helped (or did not help) me to achieve my course objectives, and what changes to the materials could make the course more effective next time.
- I may teach materials from the course from several perspectives (e.g. on test design, test execution, reporting, critical thinking) or to several kinds of students (e.g. developers, novice testers, experienced testers, test managers).
- I will ask students and to allow me to contact them some time (perhaps six months) after the end of the course for feedback on the impact of the course on their work, and I will report on its influence on me.

I have not settled on the details of the questionnaires. I expect to develop questionnaires in collaboration with Dr. Kaner and perhaps with other companies or instructors who are working on this project. I agree that the questionnaire I use will be subject to Dr. Kaner's approval and I understand that one of his reasonable objectives is a degree of standardization across research sites.

Often I work at client sites and consult on testing activities. I recommend the course to my clients or their employees, but have not taught the material formally as such. I normally provide face-to-face instruction during a three-day course. I have sometimes received inquiries (some independently, and some forwarded to me by Dr. Kaner) asking if I would help students through the course. So far, I have not responded affirmatively to such inquiries; I have not felt sufficient motivation to do so. However, this project and the prospect of engaging the material on a more formal basis would provide a powerful incentive to use the materials. As I mentioned above, Dr. Kaner's material is already strongly integrated with the material that I teach, and I expect our relationship to continue.

I will report what we try, sharing our experiences and our activities, though we reserve the right to protect those of our activities and lectures that involve confidential information or are otherwise proprietary. If it is necessary to enable him to understand what happened in our courses, I will also share proprietary materials with Dr. Kaner, but under a nondisclosure agreement that allows him to publish an honest summary but one that omits proprietary details. Dr. Kaner and I will draft the nondisclosure agreement when and if it is needed but we have agreed in principle that it will allow him to present such summary data as is needed to give the reader an honest appreciation of the instructional issues and results.

I understand that I will not be financially compensated for participation in this project. I expect to donate significant labor that will be involved in the assessments and their analysis.

I expect at least partial reimbursement for reasonable travel expenses for at least some of the times when I travel to meet with Dr. Kaner and other researchers to discuss our results and next steps.

I understand that within this project, Dr. Kaner intends to expand his basic testing course and to develop a second course on software metrics. I expect my primary involvement to be with the testing course, but the topic of metrics is very poorly understood in industry; and to the extent that the topic is understood, it is typically misapplied at considerable cost both to organizations

and to the nation as a whole. A course on the metrics would be of enormous benefit to the state of the practice, to my clients, and to me personally. I would be grateful for an opportunity to work with Dr. Kaner on such a course in any way that he deems worthwhile.

Current certifications in software testing are almost entirely commercial products. Such certifications are typically based on nomenclature promoted by some person or organization, and on a terribly shallow understanding of the real issues associated with software testing. These bogus certifications pollute the pond under the intellectual thin ice upon which they rest. I understand that Dr. Kaner is trying to develop an open source, free certification exam for software testers that would be based on the testing course and on other materials freely available on the Web. I believe that there is a significant need for a trustworthy certification of knowledge of the basic facts of testing and of the ability to apply the basic techniques of testing. Current certifications don't do that. I would be interested in assisting with the development of a trustworthy certification, and would work towards that goal as I come to understand better the ways in which I could contribute. In principle, I believe that this is a worthy endeavor and that it should be supported.

I expect to publicize work in this project through my writings in trade publications, through presentations at conferences and trade shows, through my own course materials, and on the Word Wide Web. I understand that any publicity must give appropriate credit to the National Science Foundation, but I believe that I can expect Dr. Kaner's support in developing materials that would help to publicize the effort, in forums familiar to my customers. I would also hope that Dr. Kaner might cosign some this work with me, and that he will publicize the efforts of the project in other ways, such as acknowledgements in publications or on his website(s).

If you have further questions, please do not hesitate to contact me.

Sincerely,

Michael Bolton

DALHOUSIE
University

FACULTY OF
COMPUTER SCIENCE

To: The National Science Foundation
Regarding: CCLI grant application by Cem Kaner
Date: January 15, 2006
From: W. Morven Gentleman, Professor
Faculty of Computer Science,
Dalhousie University

This letter indicates our support for the project proposed by Dr. Kaner.

I am Dr. W. Morven Gentleman, professor of Computer Science at Dalhousie University and coordinator of our software engineering program. Most of the 40 years since completing my PhD from Princeton I have spent working as a researcher and research manager for industrial or government research laboratories, including Bell Labs, the UK National Physical Lab, and Canada's National Research Council. The rest of my career has been spent as professor of Computer Science, at the University of Waterloo and now at Dalhousie, teaching practical courses and being heavily involved in industrial research. My research publications span most areas of computer science, from robotics to computer architecture to complexity theory, but in the past decade are primarily in software engineering. My PhD was arguably in numerical analysis or statistics, and I have held joint appointments in the Dept of Statistics. The undergraduate and graduate computer science programs here at Dalhousie are quite conventional, and have been as large as 650 undergrads and 350 graduate students, although today enrolment is down here as everywhere else. Software testing is optionally taken by undergrads in 4th year, as well as being taken by some grad students.

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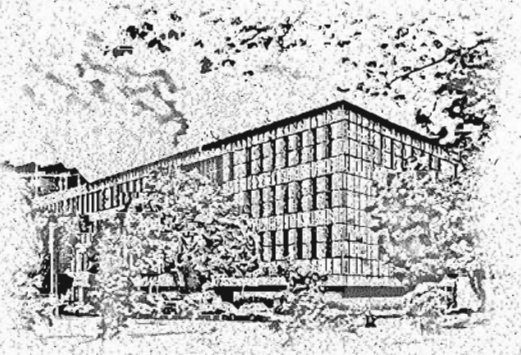
Fax: 902.492.1517
WWW: http://www.cs.dal.ca

I have reviewed the instructional materials that Dr. Kaner has published at http://www.testingeducation.org/BBST. This material presents an interesting perspective on testing, and contains resources valuable for an instructor presented course and for individual study. It also establishes common base points for launching further investigations and discussions.

If the National Science Foundation awards funding to Dr. Kaner to extend these materials, we have agreed to collaborate in this project in the following ways:

- In the period 2006 to 2008, I will endeavor to teach a course based on these materials at least twice



- In each case, I will evaluate the course and the instruction at several levels:
    - At the start of the course, I will advise students in writing that this course is part of an international research project on the effectiveness of teaching software testing and that I intend to share their work products (such as exams and homework) and evaluations with other instructors after stripping their names and other information that could identify them or their company, and that we may publish research reports that quote briefly from their work products or their evaluations. I will advise students that they have the right to withhold their permission for us to use their data. I will not forward or make any use of permission-withheld work products. However, because the evaluations are submitted anonymously, if a student submits one, the research group will share it and use it. I will encourage all students, especially students who are dissatisfied with the course or who find it difficult, to allow us to include their work in our studies.
    - I will collect student reactions to each instructional unit (a unit includes its associated activities)
    - I will note my instructor reactions to each instructional unit as I teach the course
    - I will collect detailed student evaluations at the end of the course using a questionnaire based on the Student Assessment of Learning Gains
    - I will provide a detailed instructor evaluation at the end of the course, using a questionnaire that asks the instructor to reflect on how the instructional materials helped (or did not help) achieve my course objectives, and what changes to the materials could make the course more effective next time.
    - A single course may involve several instructors, or an instructor and several teaching assistants. In this case, I will collect reactions from each instructor / TA to the instructional units they worked on, and I will collect end-of-course reflections from each of them, with the understanding that they may leave some parts of that questionnaire blank because they weren't sufficiently involved in it.
    - I will ask students to allow us me contact them some time (perhaps six months or a year) after the end of the course for a reflection on the value of the course and the extent to which the lessons in this course helped them in later courses or other work.

We have not settled on the details of the questionnaires. I expect to develop questionnaires in collaboration with Dr. Kaner and perhaps with other companies or instructors who are working on this project. I agree that the questionnaire I actually use will be subject to Dr. Kaner's approval and I understand that one of his reasonable objectives is a degree of standardization across research sites.

If I am able to teach the Dalhousie undergraduate course, I expect to offer this course under much the same structure as Dr. Kaner has offered it at Florida Institute of Technology. Students will watch lectures before coming to class, possibly take a quiz at the start of class, and then participate in an in-class activity. I expect to use a mixture of activities developed by Dr. Kaner's lab and activities that I already use or that I develop over the next few years. I expect to base many of the application activities on the taxonomy of activities and collection of examples that are developed as part of this research. I will share descriptions of the activities with Dr. Kaner and grant permission for their inclusion in the free courseware.

However, if I teach Dalhousie graduate students the course, the small number of students taking the course at any time necessitates a different approach. The course itself would be completely web-based course, with little or no face-to-face instruction. However a regularly scheduled seminar would be used as a forum for students who had taken the web-based course by self-study to engage in discussion and other group activities based on Dr. Kaner's materials.

I understand that I will not be financially compensated for participation in this project. I am donating the significant labor that will be involved in the assessments and their analysis.

I expect reimbursement for reasonable travel expenses when I travel to meet with Dr. Kaner and other researchers to discuss our results and next steps. I understand that his travel budget will be limited and that it may not stretch to cover all of my expenses.

I understand that within this project, Dr. Kaner intends to expand his basic testing course and to develop a second course on software metrics. I expect my primary involvement to be with the testing course.

I understand that Dr. Kaner is trying to develop an open source, free certification exam for software testers that would be based on the testing course and on other materials freely available on the Web. I believe that there is a significant need for a trustworthy certification of knowledge of the basic facts of testing and of the ability to apply the basic techniques of testing. I will decide on the extent to which I can assist with this work as I come to understand the details better how I could contribute. In principle, I believe that this is a worthy endeavor, which it might help some of my students get appropriate jobs, and that it should be supported.

Subject: Support pledge
From: "James Bach" <james@satisfice.com>
Date: Mon, 23 Jan 2006 01:28:31 -0500
To: "'Cem Kaner'" <kaner@kaner.com>

To: Cem Kaner
Florida Institute of Technology

From: James Bach
Principal Consultant and CEO
Satisfice, Inc.

Dr. Kaner:

I am sending this note to confirm my commitment to you to provide $10,000 in support for your open source software testing certification project if the National Science Foundation awards you the CCLI research grant that you are submitting in January 2006.

As you know, I have published harsh criticism of the current approach to certification in software testing. I believe that your approach to developing an open exam based on freely available, community-supported material shows much more promise.

My company, Satisfice (www.satisfice.com), was founded on the belief that testing is a skilled activity, rather than a mechanical process. I believe your work has already helped many testers improve their skills. We are eager to support you.

Sincerely,

James

Safeco

To: The National Science Foundation
Regarding: CCLI grant application by Cem Kaner
Date: January 15, 2006
From: Ilene Samowitz

This letter indicates our support for the project proposed by Dr. Kaner.

We at Safeco Insurance, provide insurance for individuals and for small- and mid-sized businesses. We offer a wide array of property and casualty insurance products, including personal auto and home as well as coverage for small- and mid-sized businesses, and surety bonds. We sell our products through a national network of agents and brokers. Our business helps people protect what they value and deal with the unexpected. We have revenues of over 6.2 billion dollars in 2004 and approximately 9,200 employees throughout the United States. The Quality Assurance department which I am representing, is responsible for the quality of over 600 applications that we use to run our business including our claims, financial systems, billing systems, and contact centers.

We have reviewed the instructional materials that Dr. Kaner has published at http://www.testingeducation.org/BBST. We are extremely impressed with this course material and are looking at ways to incorporate this material into our internal classes.

If the National Science Foundation awards funding to Dr. Kaner to extend these materials, we have agreed to collaborate in this project in the following ways:

- In the period 2006 to 2008, we will teach a course based on these materials to our own staff or to individuals who will provide contracted services to us at least three times.
- In each case, we will evaluate the course and the instruction at several levels:
    - At the start of the course, we will advise students in writing that we are part of an international research project on the effectiveness of teaching software testing and that we intend to share their work products (such as exams and homework) and evaluations with other instructors after stripping their names and other information that could identify them or their company, and that we may publish research reports that quote briefly from their work products or their evaluations. We will advise students that they have the right to withhold their permission for us to use their data. We will not make any use of permission-withheld work products. We will encourage all students, especially students who are dissatisfied with the course or who find it difficult, to allow us to include their work in our studies.
    - We will collect student reactions to each instructional unit (a unit includes its associated activities)

- We will collect instructor reactions to each instructional unit
- We will collect detailed student evaluations at the end of the course using a questionnaire based on the Student Assessment of Learning Gains
- We will collect a detailed instructor evaluation at the end of the course, using a questionnaire that asks the instructor to reflect on how the instructional materials helped (or did not help) achieve her or his course objectives, and what changes to the materials could make the course more effective next time.
- A single course may involve several instructors. For example, one member of our staff might instruct/coach students on issues involving a test design technique that she is particularly skilled with, while another staff member might be the resource for issues involving status measurement and reporting. In these cases, we will attempt to collect a retrospective evaluation from each instructor, but some instructors might have nothing to say about some of the learning units.
- We will contact the students and their managers some time after the course, perhaps six months, asking them to assess in retrospect how the course has (or has not) helped the students in their work.

We have not settled on the details of the questionnaires. We expect to develop questionnaires in collaboration with Dr. Kaner and perhaps with other companies or instructors who are working on this project. We agree that the questionnaire we actually use will be subject to Dr. Kaner's approval and we understand that one of his reasonable objectives is a degree of standardization across research sites.

Our typical training sessions provide face-to-face instruction over short time periods, such as several half day classes. We are not sure how to present an intense short course that is based on the BBST material. This project is an opportunity for us to try to develop a new structure that is more activity-based. We expect to benefit in this from the taxonomy of activities and organized collection of example activities that are to be developed as part of this research. It is our expectation that, as part of this NSF-funded project, Dr. Kaner will assist us, without further compensation, in thinking through several of the details of the new structure. We will report what we try, sharing our experiences and our activities, though we reserve the right to protect those of our activities and lectures that involve confidential information or are otherwise proprietary.

If it is necessary to enable him to understand what happened in our courses, we will also share proprietary materials with Dr. Kaner, under a nondisclosure agreement that allows him to publish an honest summary that omits proprietary details. We will draft the nondisclosure agreement when and if it is needed but we have agreed in principle that it will allow him to present such summary data as is needed to give the reader an honest appreciation of the instructional issues and results.

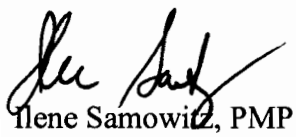
We understand that we will not be financially compensated for participation in this project and that our expenses, including travel expenses will not be reimbursed. We are donating the significant labor and other expenses that will be involved in the assessments and their analysis.

We understand that within this project, Dr. Kaner intends to expand his basic testing course and to develop a second course on software metrics. We expect our primary involvement to be with the testing course. However, we are extremely interested in the software metrics course.

We understand that Dr. Kaner is trying to develop an open source, free certification exam for software testers that would be based on the testing course and on other materials freely available on the Web. We believe that there is a significant need for a trustworthy certification of knowledge of the basic facts of testing and of the ability to apply the basic techniques of testing. We aren't yet sure how this certification will work, but if it does work, we believe that it will help us recruit staff, qualify contractors, and do some staff development planning. These are important benefits to us and we do not feel that we realize these benefits via the certifications currently available in software testing. We will decide on the extent to which we can assist with this work as we come to understand the details better what it is and how we could contribute. In principle, we believe that this is a worthy endeavor and that it should be supported.

We are interested in publicizing our work in this project. We understand that our publicity must give appropriate credit to the National Science Foundation, but we also expect that Dr. Kaner will help us write up descriptions of our work that would be published in channels our customers are likely to read. We also expect that Dr. Kaner will cosign some or all of these papers with our staff and that he will publicize our efforts in other ways, such as acknowledgements in publications or on his website(s).

Sincerely,



Ilene Samowitz, PMP
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Enterprise Technology Services Quality Assurance
Systems Manger
ilesam@safeco.com
206-925-1643

TEXAS INSTRUMENTS

P.O. Box 650311
M/S 3908
Dallas, Texas 75265

To: The National Science Foundation
Regarding: CCLI grant application by Cem Kaner
Date: January 15, 2006
From: Susan Herman

Texas Instruments supports the proposal submitted by Dr. Cem Kaner in response to NSF Program Solicitation 05-559.

Our understanding of the proposal is that it includes three key components:

- Create a free courseware community (similar in principle to a free software community) that brings together learners, course developers, subject matter experts and community facilitators who develop, study, support, assess and improve software-quality-related instructional materials. The base set of materials for this project is the course at http://www.testingeducation.org/BBST.
- Create one or more open source certification exams. Such an exam is based on a large pool of questions that are publicly available on the web, subject to public review and comment, and is available on the web to be administered without charge.
- Create a collection of themes for activities in technology classes for adults. There are some fine collections of activities, such as the 4-volume Activities Handbook for the Teaching of Psychology, and there are some good collections of themes for activities (for teaching children), such as Bernie Dodge's collection of WebQuest Design Patterns (http://webquest.sdsu.edu/designpatterns/all.htm), and there are excellent structures for interpreting the educational intent of an activity, such as Anderson/Krathwohl's update to Bloom's taxonomy. The goal is to bring these together and apply them to software engineering in a way that gives instructors a pool of good activities for their classes and a powerful support tool for creating their own.

We see several benefits from this project.

- We have reviewed the black box software testing course (BBST) at http://www.testingeducation.org/BBST and are impressed with them. This course is designed to make it easy to adjust the pace to suit our needs and to apply the lessons to our products.
- The approach of this course contains many familiar elements but in a new combination. If it is as adaptable to our needs as it looks, we would be interested in applying it to other software engineering courses.
- This approach to certification makes it easy for us to test a job candidate's knowledge at time of interview. The candidate's exam answers provide interesting grist for interview discussions. An answer graded as incorrect might reflect valuable insight—we can't learn that from a pass/fail grade on a exam whose questions are confidential.

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- A body of free courseware combined with a free exam based on public material might also provide us with a valuable new tool for qualifying service vendors, initially in software testing and later in other areas of software engineering.
- The activity analysis would not only help us develop custom activities that apply the proposed course to our products, but would also help us develop activities in other courses.

If the National Science Foundation awards funding to Dr. Kaner to extend these materials, we intend to collaborate in this project in several ways. We will work out the details once the grant is awarded. Our present intent looks like this:

- In the period 2006 to 2008, we will teach a course based on these materials to our own staff or to individuals who will provide contracted services to us at least three times.
- In each case, we will evaluate the course and the instruction at several levels:
    - At the start of the course, we will advise students in writing that this course is part of an international research project on the effectiveness of teaching software testing and that we intend to share their work products (such as exams and homework) and evaluations with other instructors after stripping their names and other information that could identify them and that we may publish research reports that quote briefly from their work products or their evaluations. We will advise students that they have the right to withhold their permission for us to use their data. We will not make any use of permission-withheld work products. We will encourage all students, especially students who are dissatisfied with the course or who find it difficult, to allow us to include their work in our studies.
    - We will collect student reactions to each instructional unit (a unit includes its associated activities).
    - We will collect instructor reactions to each instructional unit.
    - We will collect detailed student evaluations at the end of the course using a questionnaire based on the Student Assessment of Learning Gains.
    - We will collect a detailed instructor evaluation at the end of the course, using a questionnaire that asks the instructor to reflect on how the instructional materials helped (or did not help) achieve her or his course objectives, and what changes to the materials could make the course more effective next time.
    - A single course may involve several instructors. For example, one member of our staff might instruct/coach students on issues involving a test design technique that she is particularly skilled with, while another staff member might be the resource for issues involving status measurement and reporting. In these cases, we will attempt to collect a retrospective evaluation from each instructor, but some instructors might have nothing to say about some of the learning units.
    - We will contact the students and their managers some time after the course, perhaps six months, asking them to assess in retrospect how the course has (or has not) helped the students in their work.

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Dallas, Texas 75265

We expect to develop questionnaires and other program assessment materials in collaboration with Dr. Kaner and perhaps with other companies or instructors who are working on this project. We understand that this project requires a degree of standardization across research sites.

We expect to develop custom activities that apply the BBST course materials to TI projects. Additionally, we expect to develop custom learning units (possibly in conjunction with Dr. Kaner) that follow the same structure as the BBST materials but address issues of significance to TI. In many cases, these materials will be proprietary. We expect to negotiate a nondisclosure agreement with Dr. Kaner and those of his students who work on the project that allows them access to our materials and the ability to publish honest summaries of our results, without disclosing proprietary details. In some cases, we expect proprietary instructional units to be generalizable in a way that yields free courseware on the same general topics, informed by our proprietary development but without disclosing our secrets.

We understand that we will not be financially compensated for participation in this project and that our expenses, including travel expenses will not be reimbursed. We are donating the significant labor and other expenses that will be involved in the assessments and their analysis. Texas Instruments has already provided support for the development of the black box software testing course. We will not make a commitment to give Dr. Kaner's team additional funds for the 05-559 project until his proposal is approved, but at that time, we will seriously consider his requests for support.

Texas Instruments

Signature: Susan Herman

Name: Susan Herman

Title: Manager, Product Life Cycle

Date: January 20, 2006

Vipul Kocher

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U.P.
India

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I understand that within this project, Dr. Kaner intends to expand his basic testing course and to develop a second course on software metrics. I expect our primary involvement to be with the testing course but I might get involved in the metrics course as well but the extent of the involvement may vary from the testing course.

I expect to publicize my work in this project. I understand that my publicity must give appropriate credit to the National Science Foundation, but I also expect that Dr. Kaner will help us write up descriptions of my work that would be published in channels our customers are likely to read.

Vipul Kocher

Regards,
Vipul Kocher

PerfTestPlus, Inc.
1285 Douglas St.
Palm Bay, FL 32909

To: The National Science Foundation
Regarding: CCLI grant application by Cem Kaner
Date: January 15, 2006
From:

This letter indicates our support for the project proposed by Dr. Kaner.

PerfTestPlus, Inc. is a small expertise based consulting company specializing in providing professional software testing services and training software testers. More information is available on our website at http://www.perftestplus.com.

We have reviewed the instructional materials that Dr. Kaner has published at http://www.testingeducation.org/BBST and it is our professional opinion that these materials are, hands down, the best available pre-packaged, general software testing educational material when used as intended – pay or free. PerfTestPlus is very excited about working with Dr. Kaner to evaluate the effectiveness of various delivery models for this course as well as assisting or enabling additional courses to be developed.

If the National Science Foundation awards funding to Dr. Kaner to extend these materials, we have agreed to collaborate in this project in the following ways:

- In the period 2006 to 2008, we will teach a course based on these materials at least three times
- In each case, we will evaluate the course and the instruction at several levels:
    - At the start of the course, we will advise students in writing that we are part of an international research project on the effectiveness of teaching software testing and that we intend to share their work products (such as exams and homework) and evaluations with other instructors after stripping their names and other information that could identify them or their company, and that we may publish research reports that quote briefly from their work products or their evaluations. We will advise students that they have the right to withhold their permission for us to use their data. We will not make any use of permission-withheld work products. We will encourage all students, especially students who are dissatisfied with the course or who find it difficult, to allow us to include their work in our studies.
    - We will collect student reactions to each instructional unit (a unit includes its associated activities)
    - We will collect instructor reactions to each instructional unit
    - We will collect detailed student evaluations at the end of the course using a questionnaire based on the Student Assessment of Learning Gains
    - We will collect a detailed instructor evaluation at the end of the course, using a questionnaire that asks the instructor to reflect on how the instructional materials helped (or did not help) achieve her or his course objectives, and what changes to the materials could make the course more effective next time.

- A single course may involve several instructors. For example, one member of our staff might instruct/coach students on issues involving a test design technique that she is particularly skilled with, while another staff member might be the resource for issues involving status measurement and reporting. In these cases, we will attempt to collect a retrospective evaluation from each instructor, but some instructors might have nothing to say about some of the learning units.
- We will ask students and the instructor to allow us to contact them some time (perhaps six months) after the end of the course for feedback on the impact of the course on their work.

We have not settled on the details of the questionnaires. We expect to develop questionnaires in collaboration with Dr. Kaner and perhaps with other companies or instructors who are working on this project. We agree that the questionnaire we actually use will be subject to Dr. Kaner's approval and we understand that one of his reasonable objectives is a degree of standardization across research sites.

We are currently exploring several models for delivering the course to corporate clients. Over the course of this project we anticipate that we will be able to deliver the course 3 times using each of the two models below, for a total of 6 courses. We are not excluding the possibility of trying other models as well, but we are ready to commit to making every reasonable attempt to offer each of the models below at least yearly during this project.

- **Facilitated On-Line Model** – In this model, students will placed into groups of approximately 20 and assigned to a "Name Brand" facilitator to form an online classroom. The students will proceed through the class on their own time, but have due dates to turn in certain assignments that must be completed for a course completion certificate to be issued. The facilitator will review assignments and answer questions asynchronously throughout the week and will schedule at least 1 hour a week to answer questions and discuss course materials with the class as a whole in a live, online, chat setting.

- **Facilitated On-Line Plus Model** – This model is virtually identical to the Facilitated On-Line Model, except the students and the facilitator will meet face-to-face for one workshops on the course material, once at the start of the course, once at the end of the course and approximately monthly during the course. These workshops will include time for student questions and comments, instructor led and individual exercises and time for students to share their experiences implementing the course materials in their workplace. During all of these exercises, students are encouraged to work together and provide constructive, professional critiques of one another's material.

If it is necessary to enable him to understand what happened in our courses, we will also share proprietary materials with Dr. Kaner, but under a nondisclosure agreement that allows him to publish an honest summary but one that omits proprietary details. We will draft the nondisclosure agreement when and if it is needed but we have agreed in principle that it will allow him to present such summary data as is needed to give the reader an honest appreciation of the instructional issues and results.

We understand that we will not be financially compensated for participation in this project. We are donating the significant labor that will be involved in the assessments and their analysis.

We do expect partial reimbursement for reasonable travel expenses for at least some of the times when we travel to meet with Dr. Kaner and other researchers to discuss our results and next steps. However, we understand that Dr. Kaner's budget will be limited and that his prioritization of funds for reimbursing travel expenses will favor individual instructors (academic professors and unincorporated individual consultants) over corporations.

We understand that within this project, Dr. Kaner intends to expand his basic testing course and to develop a second course on software metrics. We expect our primary involvement to be with the testing course, though we are additionally interested in assisting in the development of any additional course material within our expertise.

We understand that Dr. Kaner is trying to develop an open source, free certification exam for software testers that would be based on the testing course and on other materials freely available on the Web. We believe that there is a significant need for a trustworthy certification of knowledge of the basic facts of testing and of the ability to apply the basic techniques of testing. We will decide on the extent to which we can assist with this work as we come to understand the details better how we could contribute. In principle, we believe that this is a worthy endeavor and that it should be supported.

We expect to publicize our work in this project. We understand that our publicity must give appropriate credit to the National Science Foundation, but we also expect that Dr. Kaner will help us write up descriptions of our work that would be published in channels our customers are likely to read. We also expect that Dr. Kaner will cosign some or all of these papers with our staff and that he will publicize our efforts in other ways, such as acknowledgements in publications or on his website(s).

PERFTESTPLUS, INC.

By: R. Scott Barber

Signed: 

Title: President and Chief Technology Officer

Date: 1/12/06

To: The National Science Foundation
Regarding: CCLI grant application by Cem Kaner
Date: January 15, 2006
From: Allen M. Johnson, Jr. Ph.D.

This letter indicates our support for the project proposed by Dr. Kaner.

I am the chair of the Computer Science Department at Huston-Tillotson University. I have extensive experience in teaching software testing dating back to the 1980s when I was with IBM. Currently, at Huston-Tillotson University we will have three courses where software testing is taught. We will have one course in Software Testing and two courses in Software Engineering where software testing is a key component starting in the fall of 2006.

I have reviewed the instructional materials that Dr. Kaner has published at http://www.testingeducation.org/BBST. This material is professionally done and will be quite useful in my classes. In fact, I have already successfully used some of this material and this project will allow me to expand on that use.

If the National Science Foundation awards funding to Dr. Kaner to extend these materials, we have agreed to collaborate in this project in the following ways:

- In the period 2006 to 2008, I will teach a course based on these materials at least twice
- In each case, I will evaluate the course and the instruction at several levels:
    - At the start of the course, I will advise students in writing that this course is part of an international research project on the effectiveness of teaching software testing and that I intend to share their work products (such as exams and homework) and evaluations with other instructors after stripping their names and other information that could identify them or their company, and that we may publish research reports that quote briefly from their work products or their evaluations. I will advise students that they have the right to withhold their permission for us to use their data. I will not forward or make any use of permission-withheld work products. However, because the evaluations are submitted anonymously, if a student submits one, the research group will share it and use it. I will encourage all students, especially students who are dissatisfied with the course or who find it difficult, to allow us to include their work in our studies.
    - I will collect student reactions to each instructional unit (a unit includes its associated activities)
    - I will note my instructor reactions to each instructional unit as I teach the course
    - I will collect detailed student evaluations at the end of the course using a questionnaire based on the Student Assessment of Learning Gains
    - I will provide a detailed instructor evaluation at the end of the course, using a questionnaire that asks the instructor to reflect on how the

instructional materials helped (or did not help) achieve my course objectives, and what changes to the materials could make the course more effective next time.

- A single course may involve several instructors, or an instructor and several teaching assistants. In this case, I will collect reactions from each instructor / TA to the instructional units they worked on, and I will collect end-of-course reflections from each of them, with the understanding that they may leave some parts of that questionnaire blank because they weren't sufficiently involved in it.
- I will ask students to allow us me contact them some time (perhaps six months or a year) after the end of the course for a reflection on the value of the course and the extent to which the lessons in this course helped them in later courses or other work.

We have not settled on the details of the questionnaires. I expect to develop questionnaires in collaboration with Dr. Kaner and perhaps with other companies or instructors who are working on this project. I agree that the questionnaire I actually use will be subject to Dr. Kaner's approval and I understand that one of his reasonable objectives is a degree of standardization across research sites.

I expect to offer this course under many different structures including the same structure as Dr. Kaner has offered it at Florida Institute of Technology. In some cases, students will watch lectures before coming to class, possibly take a quiz at the start of class, and then participate in an in-class activity. I expect to use a mixture of activities developed by Dr. Kaner's lab and activities that I already use or that I develop over the next few years. I expect to base many of the application activities on the taxonomy of activities and collection of examples that are developed as part of this research. I will share descriptions of the activities with Dr. Kaner and grant permission for their inclusion in the free courseware.

I understand that I will not be financially compensated for participation in this project. I am donating the significant labor that will be involved in the assessments and their analysis.

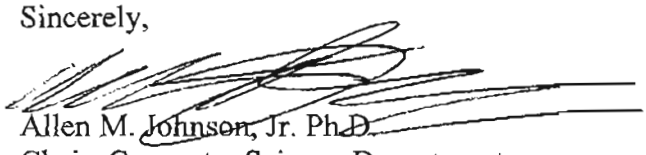
I expect reimbursement for reasonable travel expenses when I travel to meet with Dr. Kaner and other researchers to discuss our results and next steps. I understand that his travel budget will be limited and that it may not stretch to cover all of my expenses.

I understand that within this project, Dr. Kaner intends to expand his basic testing course and to develop a second course on software metrics. I expect my primary involvement to be with the testing course. I have some interest in the software metrics course as a part of my software engineering course

I understand that Dr. Kaner is trying to develop an open source, free certification exam for software testers that would be based on the testing course and on other materials freely available on the Web. I believe that there is a significant need for a trustworthy

certification of knowledge of the basic facts of testing and of the ability to apply the basic techniques of testing. I will decide on the extent to which I can assist with this work as I come to understand the details better how I could contribute. In principle, I believe that this is a worthy endeavor, that it might help some of my students get appropriate jobs, and that it should be supported.

Sincerely,



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