

Closeout Notice Date 10-FEB-1999

Project Number C-36-X85

Doch Id 36338

Center Number 10/24-6-R8859-0A0

Project Director POTTS, COLIN

Project Unit COMPUTING

Sponsor NATL SCIENCE FOUNDATION/GENERAL

Division Id 3393

Contract Number CCR-9503863

Contract Entity GTRC

Prime Contract Number

Title IMPROVING REQUIREMENTS COMPLETENESS THROUGH INQUIRY-BASED GOAL  
REFINEMENT

Effective Completion Date 31-DEC-1998 (Performance) 31-MAR-1999 (Reports)

| Closeout Action:                                      | Y/N | Date Submitted |
|---|-----|----------------|
| Final Invoice or Copy of Final Invoice                | N   |                |
| Final Report of Inventions and/or Subcontracts        | N   |                |
| Government Property Inventory and Related Certificate | N   |                |
| Classified Material Certificate                       | N   |                |
| Release and Assignment                                | N   |                |
| Other   | N   |                |

## Comments

LETTER OF CREDIT APPLIES. 98A SATISFIES PATENT REPORT.

## Distribution Required:

|   |   |
|---|---|
| Project Director/Principal Investigator | Y |
| Research Administrative Network         | Y |
| Accounting                              | Y |
| Research Security Department            | N |
| Reports Coordinator                     | Y |
| Research Property Team                  | Y |
| Supply Services Department/Procurement  | Y |
| Georgia Tech Research Corporation       | Y |
| Project File                            | Y |

C-36-X85  
#1

**National Science Foundation**

**Final Project Report**

**Award Number 9503863**

**Improving Requirements Completeness through Inquiry-Based Goal Refinement**

**PI: Colin Potts**

**Georgia Institute of Technology, College of Computing**

**Part II Summary of Completed Project**

A strategy has been developed and documented for determining the requirements for systems used by individuals and small groups. Such systems often fail to satisfy the work needs of their users because the specifications on which the systems are based are not derived systematically from an analysis of the users' goals and so some goals are neglected or underemphasized in the stated requirements. The strategy involves analyzing the work domain in terms of actors (people's or organization's roles in the processes that go on as well as technical systems already in use), the goals attributed to those actors or which they are responsible, and the obstacles (situations or exceptions that arise to block goals). The analysis process involves selectively writing detailed scenarios of use of the current and/or envisaged system based on the goals and obstacles identified to that point, raising and recording standard issues concerning system use, and refining the models as a result. The approach has been developed in conjunction with other funded work involving NTT Software Laboratory and DARPA and has been validated on an internet-based workflow support system and a benchmark example, the collaborative meeting scheduler application. Because the systems under consideration are of a type that affects people's working lives and activities, contextual factors are often ignored that could render any formal models of goals and activity structures inappropriate unless the models and scenarios of use have been developed in conjunction with naturalistic workplace data. The requirements determination strategy, therefore, includes hooks to design-ethnographic data gathering and interpretation practices, and is described in terms of theoretical framework that owes much to qualitative research in the social sciences.

**Part III Technical Information**

Our investigation has integrated two strands of research: a rationalistic approach to requirements gathering that was intended at the outset, and a naturalistic approach that arose out of our concern that requirements gathering occurs in the context of real organizations and cannot be codified rigidly.

The rationalistic approach, as envisaged in advance, involves somehow identifying the goals of the principal actors in the work context that a proposed system is to support. These might be end-users, their management, the group or organization as a collectivity or external agencies that have a regulatory effect on the system. Methods for identifying goals are described in Anton's PhD dissertation (Antón 1997). Our main thrust, however, was

what happened next. If we assume that goals are apparent, known or derivable from information provided by stakeholders, we face the challenge of refining them by decomposition, addition, elaboration, filtering, combination, and eventually formalization into precise requirements for a computer-based system that can be implemented. The resulting strategy has been developed in conjunction with several other funded efforts, including a part of the DARPA EDCS program's MORALE project at Georgia Tech and corporate support from NTT Software Laboratory, Motorola Cellular Infrastructure Group. This work has led to a rationalistic requirements determination method called ScenIC (Potts 1999), early versions of which are described in earlier papers and reports (Antón 1997), (Antón and Potts 1998).

The overall structure of ScenIC was known before the current work started, but the strategy for directing the refinement process was lacking. Our emphasis has therefore been on the use of scenarios to ensure that the requirements gathering process covers the space of use possibilities. In this setting, coverage is an informally defined concept and cannot be measured objectively. We have paid most attention to the effects on system usefulness of exceptions, technical faults, non-normative user behavior, failure to adhere to organizational policies, and inherent conflicts among the goals. Our scenario elaboration strategy therefore is driven by a systematic analysis of "obstacles", those situations that block goals, however they may arise. A preliminary taxonomy of obstacle types and their likely defensive (prevention) and mitigation (recovery) strategies is described in the latest paper (Potts 1999). The approach has been applied to a real inter-organizational workflow system (Antón and Potts 1998) and is being refined by applying it to a set of benchmark application features for a collaborative meeting scheduler. (The latter example is common currency within the requirements engineering research community and is used in the most recent paper.)

The word "scenario" is interpreted very differently by different writers. With the widespread adoption of object-oriented design methods that start by analyzing "use cases", scenarios are becoming almost a fad in software engineering. To elucidate the concept and situate our use of scenarios within this larger community of practice, we have developed a framework for representing scenarios of different types (Antón and Potts 1999). This paper discriminates among scenario representations in terms of their underlying ontology and design objectives and selectively reviews a number of scenario representations.

Because the systems under consideration are of a type that affects people's working lives and activities, contextual factors are often ignored that could render any formal models of goals and activity structures inappropriate unless the models and scenarios of use have been developed in conjunction with naturalistic workplace data. Simply saying what an organization's or user's goals are is to slant the technical solution in a particular direction. We have therefore investigated both the theoretical underpinnings of ethnographically-informed design processes, and how such practices can be integrated smoothly into the rationalistic design methods that have been our primary focus to date.

Naturalistic methods are not simply attempts to incorporate new data-gathering techniques so that an essentially unchanged requirements determination process can proceed more effectively. Rather, they differ from traditional engineering methods by calling into question whether there is a real-world "problem" that the system will "solve," most fundamentally because the "real" world in question depends on decisions about which stakeholders to consult and how to interpret what they say and do (Potts 1997; Potts and Newstetter 1997). Although there has been much interest in adopting the methods of ethnographic research in requirements engineering and human-computer interaction design, the real impediment to doing so is that these are fundamentally inquiry methods, not design methods. To go from an analysis of what is the case to a set of requirements for a future

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In addition to the publications cited above and a number of informal presentations to the REFSQ workshop (Barcelona, 1997) and IFIP Working Group 2.9 (Requirements Engineering), the results of this and related work are being made available in the form of a tutorial that has already been given to academic and industrial audiences several times: CAiSE'97 (Barcelona, 1997), ICSE-98 (Kyoto, 1998), CEIRE'98 (London, 1998). It is also accepted for ICSE-99 (Los Angeles). In addition, software technology (ScenIC View) is being developed under the DARPA EDCS project MORALE. This, however, has not directly funded out of the current effort although it has been strongly influenced by the methodology.

## References

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C-36-X85

OMB Number 345-0058

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Arlington, VA 22230

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PI/PD Name and Address

Colin Potts  
College of Computing  
GA Tech Res Corp - GIT  
Atlanta GA 30332-0280

# NATIONAL SCIENCE FOUNDATION FINAL PROJECT REPORT

| PART I - PROJECT IDENTIFICATION INFORMATION |  |
|---|--|
| 1. Program Official/Org.                    | Frank D. Anger - CCR   |
| 2. Program Name                             | SOFTWARE ENGINEERING PROGRAM   |
| 3. Award Dates (MM/YY)                      | From: 03/96 To: 02/98  |
| 4. Institution and Address                  | GA Tech Res Corp - GIT<br>Administration Building<br>Atlanta GA 30332        |
| 5. Award Number                             | 9503863  |
| 6. Project Title                            | Improving Requirements Completeness through Inquiry-Based<br>Goal Refinement |

\*\* You are encouraged to submit your Final Project Report electronically \*\*  
\*\* through the NSF FastLane home page (www.fastlane.nsf.gov). \*\*

This Packet Contains  
NSF Form 98A  
And 1 Return Envelope

NSF Grant Conditions (Article 17, GC-1, and Article 9, FDP-11) require submission of a Final Project Report (NSF Form 98A) to the NSF program officer no later than 90 days after the expiration of the award. Final Project Reports for expired awards must be received before new awards can be made (NSF Grants Policy Manual Section 677).

Below, or on a separate page attached to this form, provide a summary of the completed projects and technical information. Be sure to include your name and award number on each separate page. See below for more instructions.

**PART II - SUMMARY OF COMPLETED PROJECT (for public use)**

The summary (about 200 words) must be self-contained and intelligible to a scientifically literate reader. Without restating the project title, it should begin with a topic sentence stating the project's major thesis. The summary should include, if pertinent to the project being described, the following items:

- The primary objectives and scope of the project
- The techniques or approaches used only to the degree necessary for comprehension
- The findings and implications stated as concisely and informatively as possible

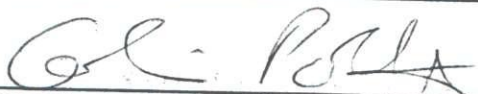
*See separate pages*

**PART III - TECHNICAL INFORMATION (for program management use)**

List references to publications resulting from this award and briefly describe primary data, samples, physical collections, inventions, software, etc. created or gathered in the course of the research and, if appropriate, how they are being made available to the research community. Provide the NSF Invention Disclosure number for any invention.

*See separate pages*

I certify to the best of my knowledge (1) the statements herein (excluding scientific hypotheses and scientific opinion) are true and complete, and (2) the text and graphics in this report as well as any accompanying publications or other documents, unless otherwise indicated, are the original work of the signatories or of individuals working under their supervision. I understand that willfully making a false statement or concealing a material fact in this report or any other communication submitted to NSF is a criminal offense (U.S. Code, Title 18, Section 1001).

|   |               |
|---|---------------|
|  | <i>2/4/99</i> |
| Principal Investigator/Project Director Signature                                   | Date          |

**IMPORTANT:**  
**MAILING INSTRUCTIONS**  
Return this *entire* packet plus all attachments in the envelope attached to the back of this form. Please copy the information from Part I, Block I to the *Attention block* on the envelope.

# PART IV -- FINAL PROJECT REPORT -- SUMMARY DATA ON PROJECT PERSONNEL

(To be submitted to cognizant Program Officer upon completion of project)

The data requested below are important for the development of a statistical profile on the personnel supported by Federal grants. The information on this part is solicited in response to Public Law 99-383 and 42 USC 1885C. All information provided will be treated as confidential and will be safeguarded in accordance with the provisions of the Privacy Act of 1974. You should submit a single copy of this part with each final project report. However, submission of the requested information is not mandatory and is not a precondition of future award(s). Check the "Decline to Provide Information" box below if you do not wish to provide the information.

Please enter the numbers of individuals supported under this grant.  
Do not enter information for individuals working less than 40 hours in any calendar year.

|   | Senior Staff |      | Post-Doctorals |      | Graduate Students |      | Under-Graduates |      | Other Participants <sup>1</sup> |      |
|---|--------------|------|----------------|------|-------------------|------|-----------------|------|---------------------------------|------|
|   | Male         | Fem. | Male           | Fem. | Male              | Fem. | Male            | Fem. | Male                            | Fem. |
| <b>A. Total, U.S. Citizens</b>                      |              |      |                |      | 5                 |      |                 |      |                                 |      |
| <b>B. Total, Permanent Residents</b>                | 1            |      |                |      |                   | 2    |                 |      |                                 |      |
| U.S. Citizens or Permanent Residents <sup>2</sup> : |              |      |                |      |                   |      |                 |      |                                 |      |
| American Indian or Alaskan Native . . . .           |              |      |                |      |                   |      |                 |      |                                 |      |
| Asian . . . . .                                     |              |      |                |      | 5                 |      |                 |      |                                 |      |
| Black, Not of Hispanic Origin . . . . .             |              |      |                |      |                   |      |                 |      |                                 |      |
| Hispanic . . . . .                                  |              |      |                |      | 5                 | 1    |                 |      |                                 |      |
| Pacific Islander . . . . .                          |              |      |                |      |                   |      |                 |      |                                 |      |
| White, Not of Hispanic Origin . . . . .             | 1            |      |                |      |                   | 1    |                 |      |                                 |      |
| <b>C. Total, Other Non-U.S. Citizens</b>            |              |      |                |      |                   |      |                 |      |                                 |      |
| Specify Country                                     |              |      |                |      |                   |      |                 |      |                                 |      |
| 1.  |              |      |                |      |                   |      |                 |      |                                 |      |
| 2.  |              |      |                |      |                   |      |                 |      |                                 |      |
| 3.  |              |      |                |      |                   |      |                 |      |                                 |      |
| <b>D. Total, All participants (A + B + C)</b>       | 1            |      |                |      | 5                 | 2    |                 |      |                                 |      |
| <b>Disabled<sup>3</sup></b>                         |              |      |                |      |                   |      |                 |      |                                 |      |

Decline to Provide Information: Check box if you do not wish to provide this information (you are still required to return this page along with Parts I-III).

<sup>1</sup> Category includes, for example, college and precollege teachers, conference and workshop participants.

<sup>2</sup> Use the category that best describes the ethnic/racial status for all U.S. Citizens and Non-citizens with Permanent Residency. (If more than one category applies, use the one category that most closely reflects the person's recognition in the community.)

<sup>3</sup> A person having a physical or mental impairment that substantially limits one or more major life activities; who has a record of such impairment; or who is regarded as having such impairment. (Disabled individuals also should be counted under the appropriate ethnic/racial group unless they are classified as "Other Non-U.S. Citizens.")

**AMERICAN INDIAN OR ALASKAN NATIVE:** A person having origins in any of the original peoples of North America and who maintains cultural identification through tribal affiliation or community recognition.

**ASIAN:** A person having origins in any of the original peoples of East Asia, Southeast Asia or the Indian subcontinent. This area includes, for example, China, India, Indonesia, Japan, Korea and Vietnam.

**BLACK, NOT OF HISPANIC ORIGIN:** A person having origins in any of the black racial groups of Africa.

**HISPANIC:** A person of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race.

**PACIFIC ISLANDER:** A person having origins in any of the original peoples of Hawaii; the U.S. Pacific territories of Guam, American Samoa, and the Northern Marianas; the U.S. Trust Territory of Palau; the islands of Micronesia and Melanesia; or the Philippines.

**WHITE, NOT OF HISPANIC ORIGIN:** A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.

**National Science Foundation**

**Final Project Report**

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