

**SOARS: A RESEARCH-WITH-EVALUATION STUDY OF A
MULTI-YEAR RESEARCH AND MENTORING PROGRAM FOR
UNDERREPRESENTED STUDENTS IN SCIENCE**

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SOARS: A RESEARCH-WITH-EVALUATION STUDY OF A MULTI-YEAR RESEARCH AND MENTORING PROGRAM FOR UNDERREPRESENTED STUDENTS IN SCIENCE

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EXECUTIVE SUMMARY

Introduction

This report is an evaluation-with-research study of the Significant Opportunities in Atmospheric Research and Science (SOARS) program. The goal of SOARS is to promote careers in atmospheric science research among students from underrepresented groups. It is hosted by the University Corporation for Atmospheric Research (UCAR) in Boulder, Colorado.

In early 2003, Dr. Thomas Windham, who was then the SOARS program's director, invited a research/evaluation team from Ethnography & Evaluation Research (E&ER) to conduct an independent, qualitative evaluation of the SOARS program. Periodic quantitative measures collected by SOARS indicated that the program was succeeding in recruiting students from underrepresented groups, encouraging their continued participation in the program, and in encouraging students' persistence in science, mathematics, engineering, and other related majors (Windham, Stevermer, and Anthes, 2004). Data collected by SOARS also indicated that the program was successful in promoting participants' enrollment in graduate programs in science. It was due to these positive outcomes that the SOARS program was recognized by a Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring in 2001. Dr. Windham had clear evidence of the success of this program. However, beyond providing quantitative data that proved SOARS' effectiveness, Dr. Windham was interested in documenting *why* SOARS was effective. Because quantitative studies can not answer questions concerning how the social dynamics, structure, or organization of programs may contribute to or limit their success, Dr. Windham chose to evaluate the SOARS program qualitatively and to include a research component that would address these issues. With the objective of helping SOARS not only assess its effectiveness, but also to identify the critical structural elements of the program and how they are articulated to support program objectives and produce positive program outcomes, a research team from E&ER undertook this evaluation-with-research study.

Initial funding from the SOARS program allowed the evaluation team to begin collecting data in summer 2003 as student participants, or protégés as they are called, began to arrive for the SOARS summer program. Independent funding was sought and secured from the National Science Foundation (NSF) to maximize the independence of the evaluation (NSF Proposal Number 0401704, "SOARS: Research-with-Evaluation of a Multi-Year Student Research and Mentoring Program for Students from Groups that are Underrepresented in Science"). The

evaluators wish to thank the NSF and Bernard Grant, Program Officer, in particular, for the support that made this work possible.

This report provides detailed descriptions of:

- SOARS' program objectives and origins of the SOARS program
- SOARS' current program design
- SOARS' leadership, staff and steering committee
- Protégé and mentor recruitment and selection
- Protégé and mentor matching
- Preparation and support for mentors
- Critical program elements, such as the research project, writing and presentation component, multi-mentoring structure, and protégé community
- Protégé gains from participation in SOARS
- Protégés' career aspirations and influences on protégés' academic and career goals
- Mentor gains, costs, challenges, and readiness to mentor again
- Suggestions for program improvements
- SOARS solicitation and responsiveness to formative feedback
- The evolution of SOARS over time and suggestions for expanding SOARS
- Suggestions for replicating the SOARS model

This report also discusses participants' observations identifying how SOARS' structural elements are articulated to support and give rise to positive program outcomes. The authors of this report hope that SOARS, the NSF, and other organizations promoting the full inclusion of people from as-yet underrepresented populations in the sciences will find this report useful in the development and refinement of their initiatives.

Objectives of this Qualitative Evaluation-with-Research Study

This study was guided by the question: "What factors contribute to, or serve to limit, the success of the SOARS program, and what relative importance do they play?" We included in this study analysis of structural, organizational and social components of the SOARS program.

Methods

We used both direct observations of official and informal SOARS events and minimally-structured, open-ended interviews to explore these research questions in detail. Over 100 hours of direct observation were conducted in 2003 and 2004, where the evaluators attended formal meetings of various groups, including the SOARS Steering Committee and SOARS administrative staff, training sessions for various SOARS participants, formal meetings for protégés, and other types of organized and impromptu gatherings of SOARS participants. The observations were documented with field notes, which were transcribed and considered by the research team in constructing and enhancing interview protocols and during data analysis.

In-depth interviews were minimally structured so that we could elicit participants' opinions and explanations, as well as their spontaneously-offered comments, narratives, and illustrations. In the 174 interviews conducted, we explored the experiences of the:

- SOARS student researchers (called “protégés”)
- SOARS research, writing, community, and peer mentors to the protégés
- SOARS directors and staff
- SOARS Steering Committee members
- UCAR managers

We asked all interviewees to discuss their views of what contributed to, or limited, SOARS’ successes. We also explored protégés’ career goals, and factors that influenced their ideas about possible future careers. We invited all interviewees to share their observations about the SOARS program and ideas about how to improve, replicate, and expand the program.

Findings

Overall, we found that SOARS has achieved its primary goal of increasing retention and participation of students from underrepresented groups in the atmospheric and related sciences. Our study revealed that 83% of protégés aspire to, are pursuing, or have already completed a graduate degree in science, technology, engineering, or mathematics (STEM) fields (47% in atmospheric and earth science, 38% in mathematics, engineering, and computer science, 7% in other sciences, 7% in other fields (UCAR, 2005c). Furthermore, 55% of protégés aspire to, or are already working in, research or academic careers in the atmospheric and related sciences (and in some cases, other STEM fields). In addition, another 14% of protégés aspire to shaping the future direction of their fields via careers in policy, administration, or outreach. Thus, two-thirds of protégés are pursuing careers where they are likely to have a “multiplier effect” and help further SOARS’ goal. Moreover, 94% of all protégés aspire to, or are already working in, STEM careers.

We conclude that the significant investments of time and money that SOARS makes in its protégés are essential to the program’s success. SOARS’ positive outcomes are due to multiple highly-articulated program features rather than any individual, specific feature. We found that a cohesive network of interconnected program elements function effectively to promote the goals of SOARS and to produce positive student outcomes. We list below structural elements identified as critical to SOARS’ success:

- ***Sustained Engagement***

SOARS offers a multi-year program to protégés, and encourages their involvement for a period of up to four years. Sustained engagement facilitates significant improvements in protégé understanding of and skills in performing authentic research as well as protégé professional and personal development.

- ***The Research Project***

Similar to the goal of other undergraduate research programs, SOARS seeks to engage undergraduates in authentic research with the objective of increasing protégés’ understanding of how real science research is accomplished.

- ***Multiple Mentors and Establishing Collegiality***

In the SOARS program, UCAR scientists volunteer to mentor an undergraduate or graduate student in an original research project for 10 weeks during the summer. The scientists (“research

mentors”) design the project and guide protégés in their research activities. Protégés are also assigned a “writing mentor.” Writing mentors support and coach protégés in formal writing assignments, including a report of their research project that is presented at the end of the summer. In addition to research and writing mentors, first-year protégés are assigned a “community mentor,” who helps new protégés adjust to Boulder and to SOARS. “Peer mentors” (returning protégés who have received mentor and leadership training) are also assigned to first-year protégés. Peer mentors serve to orient new protégés to the program and to Boulder and also support new protégés over the course of the summer. Thus, in tandem with research, SOARS’ program structure incorporates multiple mentors to facilitate protégés’ progress and success in the program. The multiple-mentor structure and interaction with protégés as young scientists and colleagues are critical factors in promoting student achievement and SOARS’ success.

- ***Focus On and Support of Protégés’ Professional Development***

Ongoing writing workshops, seminars on various topics, and organized protégé activities are other key components of the SOARS program designed to support protégés’ success.

- ***Peer Collegiality and Belonging to a Community***

Protégés live near one another in one apartment complex. This program feature encourages and supports the development of a tight-knit community and friendships that provide meaningful help and support to one another.

- ***Financial Support of Protégés***

Multi-year summer involvement, along with strong financial support communicate commitments that SOARS makes to protégés, and elicits protégés’ best efforts to live up to the high expectations placed on, and investments made in, them. As well, significant financial support is extended to protégés beyond the SOARS summers, including costs to attend conferences and graduate school.

- ***Holistic Support of the Protégé***

The original SOARS director, Dr. Windham, drew upon his expertise as a psychologist to design and implement program elements that address specific protégé needs and challenge protégés beyond their intellectual comfort zones. Dr. Windham believed that it was important to support protégés holistically to ensure that they would succeed and develop confidence rather than be overwhelmed and discouraged. Holistic support is achieved through multiple mentors, a collaborative and collegial learning community, and the SOARS community as a whole.

- ***Protégé Integration into Positions of Leadership within SOARS***

Dr. Windham also believed that it was important to empower protégés within the structure of the program so that they take on roles of leadership within SOARS, develop their leadership skills, and increasingly take “ownership” of it.

- ***Effective Signposting for Participants***

SOARS’ objectives, and the objectives specific to individual program elements, were carefully, clearly conveyed to all participants. Effective “signposting”—the systematic explanation to participants at each stage of an activity, what the goals, methods, and outcomes anticipated are in order to facilitate their optimization—was noted throughout the program.

- ***Institutional Support and Prestige***

UCAR, the hosting organization, has provided steady, visible and significant support to the SOARS program. This support from UCAR's upper-management has facilitated the prestige that this program has gained at UCAR and garnered high rates of participation of UCAR scientists and other employees. It is important to note that mentors volunteer their time and energy; UCAR does not "reward" mentors (through financial compensation or career promotion) for their participation.

- ***Encouragement of and Responsiveness to Feedback***

Formative feedback is continuously solicited from all program participants, and their input is duly considered and incorporated, as appropriate, into the overall SOARS program. Constant assessment of the effectiveness of program elements results in a dynamic program that is able to successfully adapt to changing circumstances and insights generated by participants' experiences. One outcome of valuing formative feedback is that it promotes participants' positive morale, as they better tolerate inherent "bumps" in their experiences knowing that, in the not too distant future, things can be "worked out."

Mentor and Protégé Observations on Gains to Protégés

Mentors and protégés alike identified many gains that protégés made as a result of their involvement with SOARS. Some gains that protégés' described are over-arching, while others refer to specific types of gains.

Over-arching gains to protégés include:

- Learning how science research is done
- Increased confidence as a result of engaging in hands-on research
- Insight into science careers, particularly in atmospheric science
- "Thinking like a scientist": developing patience and critical thinking skills
- Increased understanding of how scientists practice their profession
- Understanding science in political and global perspective

Particular types of gains from the SOARS experience are:

- Increased appreciation of relevancy of, and preparation to undertake, coursework
- Increased interest in and likelihood of going to graduate school
- Strengthened graduate school applications
- Enhanced presentation, writing, leadership, time management, computer, collaborative, and social skills
- Professional development
- Personal growth in confidence and responsibility
- "Becoming a scientist"
- Ongoing support from the protégé community and SOARS' director, staff, and mentors

Many of the student gains identified by this study are commonly reported in the literature. More unique to this program, however, are the stronger gains in peer and community collegiality engendered by peer mentoring, protégés' living arrangements in an apartment complex, protégé

leadership in training and seminars, and formal SOARS social events for protégés. Establishing a working, collegial relationship with the research mentor was also an important student gain found in this study. Gains in collegiality (with mentors and peers) and feelings of “belonging to a community of learners” are particularly important findings and were so prevalent as to be embedded in almost every aspect of the data. These gains, which coincide with other studies, are a significant factor in the retention and persistence of protégés from underrepresented groups in college.

Gains in collegiality are also important because they foster other types of student gains, especially increased confidence to do science research. Establishing a collegial relationship with a research mentor contributed not only to protégés’ understanding of how science research is done, but also to their understanding of *what* scientists do and *how* they do it. Protégés experienced first-hand what it is to do real research. They learned that setbacks are a normal part of “real” research; that research can be slow, boring and tedious, and required temperamental attributes such as patience and perseverance. Some protégés learned that knowledge is constantly constructed, “facts” are subject to revision, and that “black and white answers” are rather rare. Learning instrumentation and laboratory techniques or how to write a formal, academic article and present one’s research provided protégés with direct knowledge of how scientists actually work. Importantly, working side-by-side with a research mentor also gave protégés the opportunity to assess how well the daily work of research fit their own conceptions of future careers and whether research would be “right for me.”

Protégés emphasized that gains in skills and increased understanding of science research as daily work led to strong gains in confidence to successfully take on the challenges of graduate school. They described the SOARS research experience and culture of inquiry as enhancing their preparation for subsequent undergraduate coursework, graduate school and careers in science (and contributed considerably to a graduate school application or résumé). The SOARS experience engendered in protégés the confidence to make choices about “next steps,” informing their decision-making processes regarding graduate school and possible careers. Thus gains from the research experience played an important role in protégés’ confidence and professional socialization and positively influenced their education and career goals.

Protégés’ also emphasized the personal growth they experienced as a result of SOARS. They talked about gains in leadership skills and how they wanted to “pass on” or “pay back” the benefits that they had received from SOARS by becoming mentors for others upon returning to their communities. Some protégés had already done so, or had otherwise assumed leadership roles back home—roles they had learned as SOARS protégés. In a few cases, protégés reported advocating for mentoring programs and/or SOARS-inspired program features in their universities’ academic programs. In all of these cases, protégés were promoting goals of SOARS by encouraging others to pursue science, to aspire higher than they otherwise would have, and to develop more supportive learning environments.

Suggestions for Replicating the SOARS Model

Several suggestions were made by SOARS program participants and UCAR managers to other organizations seeking to replicate the SOARS model. The structural elements of SOARS identified by participants as crucial to its success include the following:

- Deeply committed leader and staff
- High-quality, sincerely motivated protégés
- System of multiple mentors who value the program goals and have ample time to devote
- Multiyear program
- Good protégé-mentor matches
- Significant but achievable challenges for protégés
- Authentic, meaningful, and achievable research projects
- Professional development opportunities, including scientific writing and presenting
- Funding for protégés to present their research at professional conferences
- “Community” living arrangements
- Strong financial and institutional support
- Solicitation and incorporation of feedback

Recommendations

The evaluators have made several suggestions for the optimal success of SOARS. The evaluators’ suggestions are minor in nature, as the program works very well overall. Suggestions offered are generally encouragement to extend signposting within certain aspects of the program, including:

- Increased clarification of the role of the community mentor
- Increased attention to the role played by informal mentors
- Clearer signposting for the leadership training given to peer mentors
- Clearer signposting for protégés as to work expectations
- Clarification of norms for ongoing communication between mentors and protégés beyond the summer session
- Increased clarification of UCAR’s appreciation for employees that volunteer as mentors

In addition, we recommend continuing attention to aspects of the following program components:

- Refinement of the writing workshop
- Discussion of race issues protégés may face in their academic and professional careers
- Challenges of mentoring new versus returning protégés
- Recruitment and selection of protégés to boost SOARS’ success rates
- Diversity of the SOARS Steering Committee and staff
- Aspects of mentor training

Conclusions

SOARS is a highly successful program as measured by a number of different metrics. Qualitative measures indicate high rates of protégé retention in the program, protégé educational aspirations and progress in atmospheric and related sciences and mathematics, engineering and

computer science fields. Quantitative measures (both those SOARS has been tracking over the years and those we contribute in this report) indicate successes in protégé confidence and comfort interacting with scientists and other professionals, enhanced research, writing, and presentation skills, and sense of belonging among a community of peers. We also see indicators of a “multiplier effect,” in which protégés actively use leadership skills developed through SOARS to promote the aspirations and successes of individuals in their home communities and universities.

SOARS has also achieved unintended successes. Mentors cite numerous personal and professional gains from their involvement in SOARS. In addition, even protégés who have discontinued their participation in the program credit SOARS with increasing their career aspirations and skills.

SOARS is beloved by its participants, who see it as a highly successful and well-run program. Based upon engaging protégés in an authentic research experience and providing a structure that supports protégés’ success, SOARS successfully promotes retention of undergraduate and graduate protégés from underrepresented groups within the atmospheric and related sciences. Just as importantly, SOARS inspires participants’ loyalty and generosity, directly affecting the quality of the program, and its continued success.

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I. INTRODUCTION

This report is an evaluation-with-research study of the Significant Opportunities in Atmospheric Research and Science (SOARS) program. The goal of SOARS is to promote careers in atmospheric science research among students from underrepresented groups. It is hosted by the University Corporation for Atmospheric Research (UCAR) in Boulder, Colorado. In early 2003, Dr. Thomas Windham, who was then the programs' director, invited a team of social scientists from Ethnography & Evaluation Research (E&ER) to conduct an independent, qualitative evaluation of the SOARS program. Periodic quantitative measures collected by SOARS indicated that the program was succeeding in recruiting students from underrepresented groups and encouraging their continued participation in the program. Data collected by SOARS also indicated that the program was successful in promoting participants' completion of undergraduate degrees in science, mathematics, engineering, or related fields and their enrollment in graduate programs in science, as well as their aspirations to pursue careers in science, particularly atmospheric science research (Windham, Stevermer, and Anthes, 2004). It was due to these positive outcomes that the SOARS program was recognized by a Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring in 2001. Dr. Windham had clear evidence of the success of this program. However, beyond providing quantitative data that proved SOARS' effectiveness, Dr. Windham was interested to document *why* SOARS was effective. Because quantitative studies can not answer questions concerning how the social dynamics, structure, or organization of the SOARS program, or other aspects, may contribute to its success, Dr. Windham chose to study the SOARS program qualitatively. With the objective of helping SOARS to not only assess its effectiveness, but to identify factors important to its success, a team from E&ER undertook this evaluation-with-research study.

Initial funding from the SOARS program allowed the evaluation team to begin collecting data in summer 2003 as student participants, or protégés as they are called, began to arrive. Independent funding was sought and secured from the National Science Foundation (NSF) to maximize the independence of the evaluation. NSF Proposal Number 0401704, "SOARS: Research-with-Evaluation of a Multi-Year Student Research and Mentoring Program for Students from Groups that are Underrepresented in Science" was awarded, with Liane Pedersen-Gallegos, Ph.D. as Principal Investigator and Ginger Melton, Ph.D. as co-Principal Investigator and Project Manager. The overall goal of the evaluation-with-research was to, "Identify, categorize, and clarify the relative importance of factors that contribute to the success of the SOARS program, including its structural, organizational and social components." The evaluators wish to thank the

National Science Foundation, and Bernard Grant, Program Officer, in particular, for the support that made this work possible.

This report includes a description of the methods used to conduct this evaluation, findings from the analysis of all qualitative data collected (including 174 in-depth interviews with SOARS participants and over 100 hours of observation of major SOARS events), identification of various structural components of the program that contribute to SOARS success (or shortcomings), advice from all SOARS participants, and conclusions and recommendations offered by the evaluation team. The authors of this report hope that SOARS, the NSF, and other organizations promoting the full inclusion of people from as-yet underrepresented populations in the sciences will find this report useful in the development and refinement of their initiatives.

II. METHODS

To begin, Ethnography and Evaluation Research team members and the original director of SOARS, Dr. Windham, engaged in a series of conversations to discuss SOARS' objectives for the study and to coordinate an evaluation-with-research design. Dr. Windham recognized a need for insight into the social dynamics of the SOARS program in order to better understand its apparent successes and to address ways in which the program could be improved. Quantitative data that had been collected by SOARS staff since the inception of SOARS in 1996 indicated a high level of success, as measured by retention of protégés in the program, numbers of protégés who apply to and go on to graduate programs in the sciences, as well as word-of-mouth feedback collected at various points in the program cycle each year. It was determined that qualitative data would be useful at this point to aid in further identifying indicators of success/failure and understanding social dynamics that contributed to them.

Following the initial conversations with Dr. Windham, the evaluators conducted a series of observations of SOARS events. These observations continued for the greater part of the year in which data were collected, as the evaluators attempted to attend each type of SOARS' event. Analysis of the observations subsequently informed protocols that were developed for minimally structured, in-depth interviews with SOARS participants. Observations of SOARS events continued throughout the interview period.

Data Collection: Observations and Interviews

Qualitative research is used to study a phenomenon to establish its full range and to explore relevant aspects to the point of saturation. The objective of qualitative methods is primarily to discover the full range of issues under study, and to examine them in depth sufficient to place them in context. Quantitative methods (not used in this study) examine how much phenomena can be generalized, using statistical tests to validate hypotheses. Ideally, once the range and saturation of phenomena of interest are established via qualitative methods, quantitative studies are used to determine commonality and causal relationships.

Observation

Thirteen types of SOARS events were attended by research personnel on a total of 34 occasions, totaling just over 100 hours of observation. These observations informed the construction of the evaluation-with-research design and the content of the initial interview protocols (see Appendix). In addition, field notes taken by project personnel were useful at all stages of data collection and analysis.

All of the significant SOARS program events were observed during summer 2003 and for planning of the 2004 summer program. SOARS events were observed and field notes were taken during the summer when protégés were present, as well as behind-the-scenes after protégés had returned to their universities. All of the protégés who participated in the SOARS 2003 summer were observed at various program events throughout that summer, as well as at some 2004 summer events. All of the SOARS staff and Steering Committee were observed at their formal program meetings as well as at other SOARS events, along with some of the mentors. The formal field observations are detailed below (Table I. Field Observations). In addition to these

events, several informal observations took place before and after interviews in the work environment and protégé apartments.

Table I. Field Observation

Event Name	Dates	Attendees	Hours Spent Observing
Protégé Leadership Training	6/2/03, 6/3/03	All returning protégés, SOARS director, all SOARS staff	18
Program Orientation	6/5/03	All protégés, SOARS director, all SOARS staff	6
Welcome Reception	6/9/03	All protégés, SOARS director, all SOARS staff	2
Welcome Picnic	5/31/04	All protégés, SOARS director, all SOARS staff	2
Scientific Communication Workshop	6/19/03, 6/26/03, 7/10/03, 7/17/03, 6/17/04	All protégés, SOARS director, all SOARS staff	10
Protégé Seminar	6/19/03, 6/26/03, 7/10/03, 7/17/03, 6/17/04	All protégés, SOARS director, some SOARS staff	10
Colloquium Rehearsals	8/6/03, 8/7/03, 8/8/03, 8/11/03,	Some protégés and mentors, SOARS director, some SOARS staff	10
Dinner Event at Protégé Apartments	8/6/03	All protégés, SOARS director, some SOARS staff	3
Final Colloquium Presentations	8/13/03	Some protégés, some mentors, UCAR employees, SOARS sponsors	7
Recognition Celebration	8/14/03, 8/12/04	All protégés, many mentors, SOARS director, all SOARS staff	4
SOARS Staff Planning Meetings	9/24/03, 10/16/03, 11/7/03	SOARS director, all SOARS staff	11
SOARS Steering Committee Meetings	10/29/03, 2/17/04, 2/27/04, 3/9/04, 3/25/04, 4/29/04	Almost all committee members, SOARS director	13
WM Orientation Meeting	6/4/04	Many writing mentors, SOARS director, a SOARS member: communication facilitator	2
Protégé Feedback Meeting	7/27/04	All protégés, SOARS director, some SOARS staff	4
Totals: 13 events	34 days		102 hours

In-depth Interviews

The interview protocols and overall evaluation-with-research design were reviewed and approved by the University of Colorado's Human Research Committee (HRC) in keeping with federal regulations governing research involving human subjects. A major consideration of these federal regulations is the protection of participants' identities in the reporting of research

findings. Appropriate measures were taken to ensure all participants' confidentiality, and these precautions were described for participants in the consent forms they read and signed prior to being interviewed (see Appendix).

We sought to interview all protégés, past and present, all mentors who participated in the SOARS 2003 summer program, a sample of pre-2003 mentors, all UCAR managers, and all SOARS Steering Committee members, directors and staff members. We were successful in interviewing 77% of the people contacted for an interview. In all, we interviewed 174 people, or 38% of the entire population of people who have ever participated in SOARS, and 79% of all protégés who have ever participated in SOARS.

Whenever possible, interviews with protégés were conducted in-person, otherwise protégés were interviewed by telephone. Most mentor interviews were also conducted in-person. The interview protocols were loosely followed, as the issues were discussed in a natural, conversational way, to the extent possible. Over the course of each interview, the interviewer tracked the answers given to ensure that the questions on the protocol were addressed, albeit in unique order and context. Interviewees were encouraged to include in the conversation all aspects of the issues they felt were relevant. In this way, the most comprehensive pictures of each interviewee's viewpoints were established. As new issues emerged in the interviews, they were noted and pursued in subsequent interviews to the extent they proved relevant and useful. Likewise, as particular questions proved to be of limited relevance in subsequent interviews, they were phased out. This method of interviewing is particularly in-depth and rich, capitalizing on insights as they emerge and establishing interviewees' offerings in context. It does not, however, produce data that are uniform or otherwise appropriate for statistical analyses. Instead, the interview data were analyzed according to qualitative data analysis techniques as described below.

Interview Populations and Samples

In qualitative studies, stratified sampling is most often used to select respondents to be studied. We have attempted to include every person in the smaller populations of interest in our study and we have used stratified sampling where the population of interest was sufficiently large to make including every person impractical. The stratification criteria used are discussed in the relevant sections below. See Table II (Interview Sample and UCAR/SOARS population) below.

Note that we asked mentors who had served in more than one capacity to speak to all of their roles. However, many of the evaluation questions were specific to the 2003 SOARS summer, so the majority of mentors' responses reflected this time period and the role they played then.

Table II. Interview Sample and UCAR/SOARS Population

Population type	Participants interviewed	Total population (sample)	% of total population interviewed
All protégés	69	87	79%
2003 protégés ¹	29	29	100%
Active protégés	16	22	73%
Alumni protégés	16	20	80%
Discontinued protégés	8	16	50%
All mentors	98	353(114)²	28% (86%)²
All peer mentors	14	15	93%
2003 UCAR mentors	60	74	81%
Pre-2003 UCAR mentors	24	264 (25) ²	8% (96%) ²
UCAR managers	24	41	59%
Steering Committee	12	13	92%
SOARS staff & directors	7	7	100%
Total participants³	174	458 (227)	38% (77%)

¹ Two protégés, who dropped out later that summer, are counted in the 2003 protégés and not in the discontinued protégés section of this table;

² Stratified sampling of the total SOARS mentoring population of 264 mentors was used to select 25 pre-2003 UCAR mentors who were likely to have quit mentoring to interview, 24 of whom were actually interviewed.

³ The totals in the Total Participants row are less than the totals from adding the vertical columns because a quarter of the participants held dual or multiple roles.

Protégé sampling method

Because SOARS is a program designed to benefit protégés we sought to interview all people who currently were, or had ever been, a SOARS protégé. All but two of the *new* protégés in the SOARS summer of 2003 were interviewed twice, once at the beginning of the summer and again after having completed their first SOARS summer. The two exceptions discontinued their participation in the SOARS program (one due to changing her major to a completely different, non-science, technology, engineering or mathematics (STEM) field even though she had performed exceptionally according to her mentors, and the other due to family issues) and were not interviewed a second time. *Returning* protégés were interviewed once (unless they were included in Peer Mentor interviews as well). See Table III (Protégé Sample Attributes) below about the demographic and SOARS status characteristics of the protégés interviewed.

Table III. Protégé Sample Attributes

	Total		Summer 2003 Protégés		Other Active Protégés	Alumni Protégés	Discontinued Protégés
	#	% ¹	New	Returning			
Total	67	98%	13	16	12	19	7
Women	43	64%	6	10	10	13	4
Men	24	36%	7	6	2	6	3
African Heritage	24	36%	8	5	3	6	2
Women	15	63%	4	3	3	4	1
Men	9	38%	4	2	0	2	1
Asian American²	4	6%	1	2	0	1	0
European²	5	7%	0	1	1	2	1
Latino/a	22	33%	4	4	6	7	1
Women	14	64%	1	2	5	5	1
Men	8	36%	3	2	1	2	0
Multiracial	2	3%	0	2	0	0	0
Women	1	50%	0	1	0	0	0
Men	1	50%	0	1	0	0	0
Native American	9	13%	0	2	2	3	2
Women	4	44%	0	1	1	1	1
Men	5	56%	0	1	1	2	1

¹ Percentages do not add up to 100% due to rounding errors.

² All EuroAmerican and Asian American participants have, so far, been women.

Mentor sampling method

All protégé 2003 Peer Mentors were invited to focus groups. Seven peer mentor focus groups were conducted. All 2003 UCAR Mentors were also invited to be interviewed. In addition, we sought to understand differences between mentors who had long tenures of mentoring and those

who had only mentored once or twice. To do this, we first sorted all pre-2003 mentors by mentoring status:

- “Committed mentors” were defined as those who had been SOARS mentors for 3 or more years.
- “Involved mentors” were defined as those who had been SOARS mentors for 2 years, during 1996-2001 for writing mentors or community mentors or 1996-1999 for research mentors.
- “Past mentors” were defined as those who mentored only one year during 1996-2001 for writing mentors or community mentors or 1996-1999 for research mentors.

These delineations were chosen because the mentor tenure data indicated that research mentors commonly had “gaps” of a couple of years between the SOARS summers when they were mentors, while writing mentors and community mentors were much less likely to have such gaps. In addition, interview data on the significant “time cost” for research mentors led us to believe that research mentors might choose to take more time off from mentoring than would writing mentors and community mentors.

Since we had already interviewed 35 of “committed mentors” (53% of the population) through the UCAR manager, Steering Committee, SOARS staff, and 2003 UCAR mentor samples, we chose not to interview any additional committed mentors. We chose a stratified sample of 25 pre-2003 mentors, as per the research proposal. We decided to select 20 “Past” mentors to explore why some mentors appeared to never return as SOARS mentors. We also chose to interview 5 “Involved” mentors to learn whether they might also have dropped out of mentoring.

- First, we identified all “Past” and “Involved” mentors for whom we could find contact information in the UCAR directory (which made contacting them feasible, plus they were more likely to be mentors who chose not to mentor again, rather than being mentors who would choose to mentor again, but had left UCAR).
- Next, we used the mentor role (research mentor/writing mentor/community mentor) and gender and race demographics to select a sample to invite for interviews. When two or more people had similar demographic makeup, a random number generator was used to select the candidates to be interviewed. If the candidates declined to be interviewed or did not respond after 3 contact attempts, replacement candidates were invited.

See Table IV (Mentor Stratified Sample Attributes) below for the demographic and SOARS status characteristics of the mentors interviewed. We intentionally sought to speak with additional “past” mentors from underrepresented groups. Thus, the ratio of women to men mentors in the interview sample slightly over represents the overall SOARS mentor population (which was 46% females to 54% males), as it probably also does for racial minorities (data on the mentors’ racial identity were unavailable from UCAR).

Table IV. Mentor Stratified Sample Attributes

	Total	%	Mentor Role		Community Mentor	Multiple	Peer Mentor
			Research Mentor	Writing Mentor			
Total mentors	98		29	21	17	17	14
Women	49	50%	11	13	8	9	8
Men	49	50%	18	8	9	8	6
EuroAmericans	67	68	25	27	12	--	1
Racial minorities	31	32	4	4	7	3	13

UCAR manager sampling method

We invited all UCAR managers to participate in focus groups (Presidents' Council, NCAR directors, UOP directors, and Other UCAR Management Committee). We conducted focus groups of Presidents' Council, female Other UMC managers and male Other UMC managers. However, we were unsuccessful at setting up focus groups with NCAR directors and UOP directors (due to difficulties in obtaining responses to the interview request and coordinating schedules), so we requested individual interviews based upon a stratified sample. We invited half of the NCAR Directors and UOP Directors, half of whom had been SOARS mentors and half of whom had not, to individual interviews.

Steering committee sampling method

All 2003 Steering Committee members were invited to participate in a focus group. Eight of the 13 members participated in the focus group, three were interviewed individually, and all 13 were observed in the 2003-2004 Steering Committee meetings.

SOARS staff sampling method

The entire staff was invited to participate in a focus group, which yielded so much valuable information that we decided to also invite them to individual interviews. Both the founding and current directors were interviewed.

Interview Response Rate

The response rate of the protégés, mentors, and others involved in the program to participating in this study was excellent: 77 percent of the people that we invited to be interviewed were interviewed. Only two protégés (3% of the protégé population), three mentors (3%), and one manager (4%) declined to be interviewed. There were, however, five additional mentors and 13 managers who implicitly chose not to participate, by not responding to our request for an interview. Similarly, a small number of people were either "unreachable," that is the available contact information was incorrect: seven discontinued protégés (for whose information we searched via SOARS, other protégés, and public and university phone directories) and one active protégé (for whom we also diligently searched), and seven mentors. Lastly, some interviews never took place due to scheduling conflicts (6% of protégés, 12% of mentors, and 8% of managers).

Data Analysis

All interviews were tape-recorded, with the prior knowledge and consent of the interviewees (in keeping with federal regulations and HRC oversight). The resulting audio tapes were labeled with code names as one measure of ensuring the anonymity of participants. The tapes and all related interview materials were kept in a locked office and were available only to research personnel. At the conclusion of the study, the tapes will be destroyed. All related materials (e.g. interview transcripts) have been accorded similar security precautions.

Tape-recordings of interviews and focus groups were transcribed verbatim into a word-processing program and submitted to *NVivo*, a computer program that allows for the multiple, overlapping, and nested coding of a large volume of transcribed documents to a high degree of complexity. Each transcript was searched for information bearing upon the research and evaluation questions. Text segments referencing issues of different type, or perceived importance, were tagged by code names. There were no preconceived codes: each new code name referenced a discrete idea not previously raised. Because answers to the same question were often not of the same character, or did not cover the same set of issues, codes were never developed on the basis of the questions asked, but always by the nature of the responses given. Information was given both in answers to questions, and in more spontaneously-offered comments, narratives, and illustrations. The emotional emphasis with which some points were made was also coded in addition to the content of the point. Interviewees often made several points in the same sentence or speech segment: each was separately coded. Information was commonly embedded in speakers' accounts of their experience rather than offered in abstract statements. This allowed transcripts to be checked for internal consistency between the opinions or explanations offered by informants, their descriptions of events, and the reflections and feelings these evoked.

As the individual interviews were coded, the vast majority of them were then reviewed and double-coded by a second analyst. In all, the interviews were initially coded by one of two analysts and a third analyst reviewed and double-coded interviews already coded by the other two. Any resulting additions or modifications were discussed by the second coder with the original coder, or even between all three of the analysts, and agreement reached for final coding. In this way, inter-coder reliability and continuity across interviews was maintained as a single analyst reviewed interviews coded by the other two. A total of 8,700 codes (4,366 in the protégé interview codebook and 4,334 in the mentor/staff/steering committee/manager codebook) discrete codes were created to note and describe segments of the 174 interviews.

Once the interviews were coded and double-coded, each codeword was revisited and grouped with other, related, codes into "parent codes." Each parent code represented a collection of discrete sections of interview data across both sets of interviews (the protégé codebook and the mentor/staff/steering committee/manager codebook). Parent codes were then analyzed at another level, relating groups of them into "domains." Groups of codes which cluster around particular themes were given domain names and a branching and inter-connected structure of codes and domains was incorporated into a code book which, at any point in time, represented the state of the analysis. Domains, like parent codes, reflect either research questions that informed the interview protocols or issues that emerged, unanticipated, from the interviews. For

example, the parent codes “education goals, progress, successes, and challenges” are located in the domains “career aspirations, motivations, interests.” Each parent and each domain have a tag, or code, of their own, and any given code word may be tagged with multiple parent and domain designations. These parent and domain tags were then entered into a spreadsheet so that individual codes, parent codes, and domain codes could be sorted in various ways.

We then sorted the codes according to “catalogues,” or characteristics of interviewees. For example, we sorted protégé responses from mentor responses. The resulting groupings of codes by parent, domain, and catalogue served as a guide for the next level of analysis. We regularly referred back to the original interviews, re-reading sections, keeping the interviewees’ voices alongside ever higher levels of analysis.

A Few Words on Terminology

It is helpful to the reader to understand how we have used some particular terms in this report.

We refer to all of the research, writing, and community mentors as “UCAR mentors,” when in fact some of the mentors were located in other labs at other sites. To list these labs and sites specifically would compromise anonymity.

We have used the terms “interviewee” and “respondent” interchangeably, referring to the group of people interviewed as they spoke to particular issues. We use both terms in order to provide the reader with a less monotonous read, and hope that it does not cause any confusion.

This study is evaluation-with-research, and as such, contains elements of both program evaluation and more in-depth research. The overall work is variously referred to as “evaluation,” “research,” and “study.” These terms all refer to this same body of work.

We have alternated the use of “he” and “she” throughout the report to provide gender inclusive language and to aid in protecting interviewee anonymity in a non-cumbersome way. We have taken the liberty of alternating the references to “he” and “she” in quotes as well. Where there is a meaningful gender difference, we report it clearly. Otherwise, gender-neutrality is intentional.

We have shortened a couple of key terms in order to facilitate the narrative flow. The mentors who work with protégés on their writing are referred to as simply the “writing mentors” in this report. However, their official title is “Writing and Communication Mentor.” Similarly, we delineated four categories of protégés in the SOARS program, based upon their level of participation in SOARS at the time of the interview:

- “New” were first-year protégés
- “Experienced” or “returning” protégés were those who had participated in two or more SOARS summer programs, whether they were on site the year of the evaluation or not present, but were eligible to return to active participation in subsequent summer programs
- “Alumni” were those who had received a graduate degree and had thus finished their tenure with the SOARS summer programs

- “Discontinued” were those whose affiliation with SOARS had been terminated either out of choice or by failing to meet program requirements

We have deliberately listed all four protégé categories in tables where it is helpful to distinguish between them. Most often we refer to either the “new,” first-year protégés or the “returning” protégés since we interviewed all of them, while interviews from the other categories of protégé were most helpful for historical and comparative purposes. These other two categories—“alumni,” and “discontinued” protégés—while less often discussed, are clearly designated when references are made to them.

Dr. Thomas Windham is referred to as “Tom” in several quotes, and Dr. Rajul Pandya as “Raj.” Dr. Windham was the original SOARS director, succeeded by Dr. Pandya at the end of the first year in which we conducted this study. Protégés, scientists, and staff were all on a first name basis with one another, hence the familiarity expressed in the interviews.

Often, when we refer to procedures or practices in the program, we are referring to them in their state in 2003-2004, the period of our observations. Because SOARS is continuously evolving in response to feedback from protégés, mentors, staff, and the Steering Committee, and even from insights gained from this study, procedures as they are described in this report may differ somewhat from current practices.

Counting conservatively, we have directly quoted about 70% (149 people) of the interviewees in this report. Not everyone in focus group interviews can be identified for this count, so it is possible that more than this number have indeed been quoted (we did not include any quotes taken from focus groups in this count). A minimum of 57% (37) of the protégés were quoted (some from each of the categories of protégés listed below), and 70% of the group comprised of UCAR managers, and SOARS mentors, directors, staff, and Steering Committee members were quoted (112). This breadth of inclusion when quoting individuals helps to ensure that we have painted an inclusive picture.

The Use and Avoidance of Numbers in this Report

The great advantage of using qualitative methods is discovery. The SOARS program has a history of good record-keeping in which the numbers of protégés who continue in their study of atmospheric science as undergraduates and of those who go on to graduate school are tracked. These measures are important and reflect the success of the SOARS program. However, they do not reveal the social dynamics that contribute to, and perhaps inhibit, SOARS’ successes. In the course of a qualitative study such as this one, in which methodical, in-depth interviewing is conducted, interviewees’ statements are carefully established in context and pursued in subsequent interviews to establish trends in and relationships between interviewees’ thoughts. When carefully treated in this way, statements are not anecdotes to be considered casually, but become data to be catalogued, investigated, and compared. Interviews averaged about an hour in length, and efforts were made to maintain a conversational tone, as opposed to a question-and-answer tone, in order to facilitate interviewees’ natural flow of thought and to maintain the interviewees’ context. Conversational-style, in-depth interviewing more naturally retains context and relatedness of ideas, with a focus on the interviewees’ frames of reference.

We have included a few tables with descriptive statistics on those occasions when we have met the criteria for simple, descriptive statistics, such as asking every person in a population the same question, and accounting for context in the coding and subsequent analysis. Only when we were sure we met these criteria have we presented numbers of interviewees' answers in tables. For the most part, we carefully avoid numbers in our reporting. Instead, we have indicated in broad terms such as "many," "most," "several," or "a few" the relative strength of interviewee input. It is more important to convey the issues discussed in context than to delineate weighting of agreement between interviewees. However, we do identify patterns of thoughts, indicating relative agreement or diffusion of opinion where they are apparent. As a rule, when we provide bulleted lists of findings, we order them from most commonly to least commonly found. However, the reader is cautioned not to place too much weight on this ordering, nor consider it to represent statistical significance.

We take care not to lose sight of the fact that insights and exceptional observations interviewees make are, by nature, uncommon. When we discovered insights or other unexpected ideas, we pursue them in subsequent interviews, but because they sometimes appear after a considerable number of interviews had been conducted, we cannot accurately determine how much agreement there truly was among others in the population. For this reason, we believe that the indications given in this report of commonality of opinions is generally *understated*.

III. BACKGROUND ON THE SOARS PROGRAM

Origins of the SOARS Program

This chapter explores why and how SOARS came into existence, including the initial inspiration and vision for the program, startup experiences and challenges, and the current context in which it exists.

Inspiration for the Program

The spark for the SOARS program came during a discussion about how to increase the number of people from underrepresented groups in the atmospheric and related sciences. The idea of a multiyear program that provided continuity of experience was suggested a person who later became a SOARS Steering Committee member. The idea was embraced by Dr. Richard Anthes, President of UCAR, and Edna Comedy, the past Human Resources director of UCAR and Dr. Neal Lane, the past director of the National Science Foundation (NSF). Exploring the concept, Lane spoke with the mentors of UCAR's Summer Employment Program (SEP) and asked its students what would encourage them to seriously consider a career in the atmospheric sciences. They replied: a multiyear program that offered competitive salaries and support for graduate school.

Initial Program Vision

The NSF Program Director invited UCAR to submit a proposal, which Rick Anthes and Edna Comedy wrote, along with the help of several upper-level UCAR managers and the SEP director. SOARS was designed to be a competitive, rather than remedial, program. Its mission was and still is to take students who are the "cream of the crop" and produce leaders of prestigious atmospheric and related science organizations as well as role models for future members of underrepresented groups. The founders believed that four years of comprehensive support were necessary for students to really learn what research entailed, and for mentors to establish a long-term relationship with the students and help them enter graduate school and complete their Master's degrees, at which point they were believed to be sufficiently independent and self-motivated to continue on their career path, as Rick Anthes, explains:

I got the idea of a four year program, four summers, *plus* activities during the year. ... They would come back after the first year for three more summers, and the idea there was to really develop a long term relationship with the students and get them into graduate school: get them at their junior year as an undergraduate, support them through the two years when they're actually making choices to go into graduate school and then support them for two years in graduate school. My idea was, that would get them to a Master's degree and then at that point then they'd be on their own. ... So the idea was sustain four years of support, carry through the school year, help them find schools, get them in atmospheric science departments, work with them during the year, establish basically a life-long relationship with them. They would come back here and get to know us better, because in 10 weeks you just can't get to know this place.

The SOARS founders' vision also included research and writing mentoring, career advising, summer activities, partial graduate school financial support (up through the award of a Master's

degree), and comprehensive and year-round support. In 1996 the NSF awarded UCAR a five year grant to implement the SOARS program.

Startup Experiences and Challenges

The founders felt strongly that a full-time director was needed to run the program, recruit students, match students with mentors, support students through their summer research experiences as well as year-round, and advise them on academics and selecting and gaining admission to graduate schools. Because the NSF did not believe a full-time director was needed, UCAR funded the position itself. Thomas Windham, a Ph.D. psychologist with years of experience in the field of education and a proven record of working with young people, was hired as SOARS Director to fulfill the program's mission. In addition to his having a deep commitment to the program goals, Dr. Windham's being African American was viewed as beneficial in supporting and encouraging students from racially underrepresented groups.

SOARS began its first year with a wave of publicity throughout UCAR that promoted and explained the program's unique features. These innovative features were framed as befitting a leading-edge institution such as UCAR.

SOARS was built upon the foundations of UCAR's predecessor program, SEP, which worked to SOARS' advantage. The SEP Director and participants had already surmounted the hurdle of convincing people that diversifying the science pipeline was important for the discipline and for UCAR. Nevertheless, SOARS' greatest startup challenge was to convince UCAR scientists and other employees that the program was important and worth their time to volunteer as mentors:

I think it took several years for the organization as a whole to become aware of SOARS. So, I don't think that, that welcoming environment [for protégés] existed in the first couple years. Certainly the people who they came in direct contact with were very welcome because they were self-selected—they were volunteering to be mentors, volunteering to be involved. At the director level, we were encouraged to be involved with some SOARS events, and I tend to do that. Not everybody does, but then over time, the staff has become much more aware of SOARS. There still would be circles in which they wouldn't be very welcome. I think so, it's not, nothing personal, it's just like [the scientists] don't want to be bothered. They're very busy, and so I think that SOARS has found its niche, has found how to fit into the organization and hasn't forced itself into some of those corners where maybe it wouldn't be so welcome.

The remaining startup challenges faced by SOARS were logistical in nature, such as finding and setting up furnished apartments for the protégés.

Program Host Organization and Location

SOARS is hosted by UCAR, a premier national atmospheric science research organization. As a non-profit consortium of over 100 university members and affiliates, "UCAR's mission is to support, enhance, and extend the capabilities of the university community, nationally and internationally, understand the behavior of the atmosphere and related systems and the global environment, and to foster the transfer of knowledge and technology for the betterment of life on

Earth” (UCAR, 2005a). Included within the umbrella of UCAR are two other groups, the National Center for Atmospheric Research (NCAR) and UCAR Office of Programs (UOP).

UCAR is located in Boulder, Colorado, at the base of the Rocky Mountains, along with several other atmospheric research institutions. Boulder itself is a predominantly white and socio-economically high status small city. Although the city is politically liberal, it still experiences racial and class strife.

IV. CURRENT SOARS PROGRAM DESIGN

Since its inception in 1996, SOARS has continued to evolve. At the time of writing this report, in 2005, the program is viewed as mature yet organic, and evolving to meet changing participant needs. This chapter explores the program's goals, participants (anyone involved in the program), elements, funding, marketing, logistics, and philosophical framework.

Program Objectives

SOARS' formal goal is: "To help retain and eventually increase the number of participants from underrepresented minority groups in the atmospheric and related sciences" (Windham, Stevermer, and Anthes, 2004). This goal is well known among the program's participants and UCAR management. In contrast, SOARS participants and upper-level UCAR managers had broad and diverse ideas about the program's informal goals:

- To foster protégés' interest in and understanding of a scientific research career and success in pursuing a graduate degree in science (especially through the challenging transition from undergraduate to graduate education)
- To fully support and prepare protégés to succeed in a science career through building their research experience, scientific knowledge, communication and computing skills, and professional networks
- To challenge protégés beyond their comfort zone and encourage "inspired protégé performance" as they work hard and adjust to the program, environment, and people, and yet have fun too
- To enhance protégés' self-confidence, self-awareness, and sense of capability in their careers and the real world

In addition, protégés discussed the following informal goals:

- To build a diverse and supportive scientific community of protégés
- To build a community of protégés who will later serve as mentors and leaders in the scientific community and, for some, beyond
- To be the best program in the country and produce well-rounded, high quality protégés who appreciate their career potential and opportunities
- To build protégés' life experiences and sense of responsibility

Additional informal goals discussed by the SOARS director, staff and Steering Committee were as follows:

- To produce the "cream of the crop" who will become the leaders of national science organizations by empowering protégés, fostering intentional action, and building their leadership skills
- To increase protégés' scientific literacy and produce more informed citizenship
- To promote protégés to become bicultural—retaining their cultural ways while learning the culture of science as it is practiced today—and learning how to be a scientist in its broadest sense
- To promote true appreciation for diversity in the culture of science

As the current SOARS director points out, the aim of the program is for participants, and science culture more broadly, to go beyond being “colorblind” to an appreciation of diversity and its contributions to science itself:

We have to move beyond aiming for “colorblind.” Celebrating diversity would be better, but even that isn’t enough. We need to get to where we believe that diversity makes better, more creative, more insightful, more robust, more relevant science and we look for and manage diversity toward that end.

One significant difference between the various SOARS participants’ perceptions of the program’s informal goals is that mentors emphasized SOARS’ goal in producing research scientists while other groups focused on SOARS’ efforts to produce high quality leaders.

Very few concerns related to the program goals were mentioned in the interviews, although the most commonly mentioned concern brought up by a few protégés was a sense of discomfort with SOARS’ focus on underrepresented groups. These protégés felt it “marked” them as “people-of-color scientists” rather than just “scientists.”

Program Participants

Many different groups of people are involved in the SOARS program, all of whom contribute to its success. Naturally, the program would not exist without its sponsors. The NSF provided the original grant for SOARS and continues to fund the majority of the program. Other funding agencies, which have varied somewhat over time, have also provided significant levels of funding, including: U.S. Department of Energy, NASA Goddard Space Flight Center, NASA Living with a Star Program, NOAA Office of Global Programs, NOAA Oceans and Human Health Initiative, and the Cooperative Institute for Research in Environmental Sciences at the University of Colorado. In addition, NCAR divisions and initiatives have supported the program.

UCAR is also a highly active host. The UCAR President and Human Resources Director wrote the NSF proposal for the SOARS program. UCAR pays the SOARS Director’s salary and provides the physical office and lab space for the SOARS director, staff, and protégés. In addition, UCAR shares its communication, information technology, and human resources infrastructure with SOARS. In addition, SOARS receives support from UCAR’s legal counsel, photographer, and people who help edit and layout the SOARS newsletter and abstract publication. Although UCAR provides many resources for SOARS, the SOARS program operates independently, only providing UCAR managers with an annual update on the program’s progress. However, UCAR support is readily available, particularly from UCAR’s President and managers however, if SOARS needs it.

SOARS’ program participants include the protégés, mentors, and SOARS director, staff, and SOARS Steering Committee:

Protégés

New protégés are undergraduates from the fields of geoscience, physics, engineering, computer science, or mathematics. Returning protégés are undergraduates or graduate students who may attend up to four SOARS summers if they have not yet received their Master's degree.

Mentors

There are four different types of SOARS mentors: research, writing, community, and peer mentors. UCAR employees volunteer their time and UCAR labs provide computers and other resources needed for the protégés' summer research projects. Some mentors are employed by neighboring science laboratories or protégés' graduate school departments. Returning protégés serve as peer mentors to new protégés.

SOARS director and staff

In addition to the director, there are three year-round staff members, one of whom works half-time, one 80% time and the other full-time: one person manages the budgets, another handles the program logistics and is the point-of-contact for the participants, and the third person creates the SOARS newsletters and abstract publication and maintains the SOARS website (<http://www.ucar.edu/soars/>). In addition, there are three contract positions: leadership and peer mentor training facilitator, writing component facilitator, and computer programming consultant.

SOARS Steering Committee

The Steering Committee typically consists of 13 members, most of whom represent the various UCAR divisions and often hold high status positions, such as senior scientists and directors. Other Steering Committee members include the SOARS Director, UCAR's President, UCAR's Education and Outreach Director (the division under which SOARS is housed), and two alumni protégés.

Program Elements

The multiyear SOARS program includes several unique and important features (Windham, Stevermer, and Anthes, 2004). "Protégés," as Dr. Windham entitled the students, conduct authentic research projects with the guidance of a research mentor at UCAR, a renowned national lab, or other national laboratories. In addition, protégés work with the guidance of a writing mentor to author a potentially publishable scientific paper and give a formal, conference-style presentation to an audience of scientists and other UCAR employees. Protégés are also supported by community mentors who facilitate the social adjustment of new protégés and help to ensure their practical needs are met, and returning protégés who serve as peer mentors, providing orientation, encouragement, and moral support to new protégés. The programs' key features, which also include professional development in communication, leadership, and computer programming, are summarized below:

Multiyear program

SOARS is a multiyear program in which protégés may return for up to four (not necessarily consecutive) 10-week summer sessions or until they have received a graduate degree. The protégés are not only supported during the summer, but also year round by the SOARS director, staff, mentors, and protégé community.

Multiple mentors

Each protégé has multiple mentors. New protégés are assigned research, writing, community, and peer mentors. Returning protégés typically choose their own research mentors and either select or are assigned writing mentors as well.

Writing component

Protégés participate in a weekly, two-hour writing workshop, receive writing mentoring, and complete writing and presentation assignments, including: a research proposal, practice presentations, a research paper and abstract, and a colloquia presentation.

Leadership and peer mentor training

At the beginning of each SOARS summer, protégés participate in a two-day leadership training workshop that they help design, which emphasizes self-efficacy and how to be an effective leader and peer mentor within the SOARS culture and the broader scientific community. In addition, protégés share best practices and discuss challenges at a mid-summer peer mentor meeting.

Protégé seminars

Protégés participate in weekly, two-hour seminars on various topics that have been selected by protégés. The returning protégés organize and facilitate the seminars on such topics as applying to graduate school, exploring careers in policy, and creating a conference poster.

Computer training and support

At the beginning of each SOARS summer, protégés are offered a computer programming workshop that covers the most common languages used in UCAR's research projects. An expert in computer sciences is also available to consult with protégés throughout the summer about their individual programming needs.

Formal social events

SOARS organizes some formal social occasions, such as the Welcome Orientation, an event for protégés to formally meet their mentoring team, which is attended by all protégés and their mentors and the SOARS director and staff. The director also hosts a social event for all protégés and the SOARS staff, typically at the director's house or another more personalized setting. At the end of the summer, SOARS gives a Recognition Celebration, open to all participants in the SOARS program, where protégés reminisce about their summer experience and give thanks to their mentors and fellow protégés and the SOARS director and staff.

Housing community

All protégés whose research projects are conducted at (or near) UCAR are housed together within one completely furnished, apartment complex. Two protégés live in each apartment, which has two bedrooms. The apartments are located near one another.

Financial support

SOARS offers students a competitive salary (relative to other summer employment possibilities), free housing and utilities, graduate school support (if needed), and free travel to and from

professional conferences and their research site (which is typically at UCAR, but is sometimes “in the field”).

Communiqués and publications

SOARS produces a biannual newsletter celebrating the activities and accomplishments of the current and alumni protégés, protégés and their mentors, and SOARS director. At the end of each summer an abstract publication, *Earth Wind and Sky*, is produced, which includes the abstract of every protégé’s research manuscript.

Program Size Limitation

Since its inception, the number of protégés in each new cohort has increased from 13 to 29. The greatest number of protégés participating in any one SOARS summer has been 29. More than a quarter of this study’s participants discussed the idea that SOARS has a natural size limitation, beyond which the program effectiveness would be compromised. The ideal number of protégés that they suggested ranged between 20-30 protégés. Above that, the amount of personalized attention each protégé could receive from the SOARS director, both during the SOARS summer and year-round, would be reduced too much. In addition, more than 30 protégés would strain the program’s ability to find volunteer mentors at UCAR and other participating institutions. It also would increase the pressure to have mentors volunteer more frequently, and thus increase the risk of burning out mentors. UCAR’s pool of available mentors is estimated at 300 scientists and 1200 total employees. Thus, roughly 10% of UCAR’s scientist population and 7% of its non-scientist population mentor SOARS protégés each summer.

It is highly likely that a minimum number of protégés exists as well, to ensure the program can effectively foster a protégé community, although this was not discussed in the interviews.

Comparison to Other Programs

SOARS is unique, relative to other undergraduate research experience (i.e., REU) programs, in that it is multiyear, emphasizes mentoring, offers year-round support, provides financial support for graduate school, and provides significant personalized interaction and professional development. Like students in other strong REU programs, SOARS protégés conduct real research projects rather than perform menial labor as can happen with some undergraduate programs. SOARS is also reported to be much more structured and organized than other undergraduate research programs, including its predecessor program, SEP. However, the tradeoff made to accommodate all the professional development and greater program structure is that less of the protégés’ time is spent conducting research than in other summer undergraduate research programs.

Program Costs

SOARS is a complex program that invests a lot of time, attention, and money in each protégé. The President of UCAR reports that others have criticized SOARS for being too expensive, but he and some other upper-level UCAR managers staunchly support the value gained from the expense. They argue that it is absolutely essential to comprehensively support the protégés and that the program is worth it, well justified, and has no waste. It currently costs \$45,000 to support one protégé for one year, which includes about 30% overhead, the director’s salary paid by UCAR and the value of mentors’ time. The actual cost per protégé born by external funders is

about \$35K to cover program expenses and provide salary, housing, and travel for the protégé. These expenses include the writing workshop and leadership training and their facilitators, the computer programming consultant, and the costs of the website, newsletter, abstract publication, program brochure, protégé apartments, books and journals, office supplies and expenses, recruiting travel, advertising, and staff salaries.

Program Marketing

The SOARS director does the vast majority of program marketing, to gain and maintain sponsors, recruit protégés and mentors, and garner continued UCAR support. Key marketing tools include the SOARS brochure which describes the program, the *Earth Wind and Sky* publication of protégé research paper abstracts, and the SOARS newsletter which describes protégé, mentor, and program accomplishments. In addition, SOARS leverages UCAR's "Staff Notes" newsletter to disseminate articles about the program and its participants as well as UCAR's broadcast email lists to send out requests for volunteer mentors.

Protégés also help market SOARS, informing fellow university students about the program and encouraging them to apply. They serve the same function when working at SOARS' conference booths. Even some SOARS mentors play a similar promotional role, ensuring that their bosses and colleagues are familiar with the program and its successes and encouraging their colleagues to volunteer as mentors. Similarly, some university professors actively promote the SOARS program to their students and encourage them to apply.

Program Logistics

The program's logistics throughout the year are formidable. Yet the complexities of SOARS' off-season work, which occurs when protégés are not present for the 10-week summer, is little known and understood by most SOARS participants. However, they do credit SOARS as operating very smoothly overall.

The SOARS director and staff have a large number of complex, time consuming tasks in the off-season, such as:

- Obtaining funding
- Outlining internal and external contracts
- Managing the budget
- Evaluating feedback from the previous summer and enhancing the program
- Creating the *Earth Wind and Sky* abstract publication, biannual SOARS newsletters and articles for UCAR's *Staff Notes*
- Recruiting potential protégés
- Processing potential protégé applications
- Selecting protégés
- Recruiting mentors
- Matching protégés with mentors
- Maintaining the protégé database
- Managing the SOARS website
- Collaboratively planning the leadership training and writing workshop with protégés
- Organizing protégé travel to conferences and their summer research sites or field trips

During the SOARS summer, the SOARS director and Staff work intensely for long durations to fully support the protégés, which includes managing additional logistical challenges that arise regarding travel, apartments, and resources.

Philosophical Framework

A central philosophy that informed Dr. Windham's approach to SOARS was based on the descriptive psychology work of Dr. Peter Osorio. Dr. Osorio was concerned with how the "whole person" exists within settings. Dr. Windham combined this framework with a strategy of John Wooden's (basketball coach for the University of California at Los Angeles): "Given this talent, what's the best way to win?" Thus, Dr. Windham sought to deeply understand where protégé's abilities and talents lie and, capitalizing on his knowledge of what scientists need to be successful, to shape the program to best give protégés those experiences. In addition, he assumed that "where protégés are at" varies continuously. This philosophical framework drives SOARS' flexibility as a living organism, evolving according to who protégés are at any given time and what they feel the program needs to be. While protégés are encouraged to shape SOARS to meet their needs, the SOARS director and staff insist upon the existence of the program's core elements and philosophies.

With lofty goals of creating the ideal society where all people can thrive and perform at their best, the SOARS director and staff have shaped the program to be a kind of "liminal" experience. When protégés arrive for their SOARS summer, they are welcomed into the embrace of SOARS and transitioned out of the harsher, more competitive norms of their educational and societal cultures. New protégés are immersed and inculcated into the SOARS culture, a collaborative yet intense learning community, by returning protégés and the SOARS director and staff. All protégés are viewed as rising stars. Protégés strive, embraced by the supportive and empowering culture of SOARS, to work beyond their comfort zone and achieve the high expectations laid out before them. Mentors learn in the mentor training how to facilitate this type of growth:

He [Tom] has a chart that says that very thing—I've forgotten what the X and Y axes are, but it basically says, "You try to keep the SOARS student just outside of the comfort zone but not into the stress zone," so that they can be successful but they'll grow. Well that's part of the mentor training, going over that to make sure that everybody understands that you have a dual duty here; you're not just a baby sitter. You're supposed to push a little bit, but not push so much that you lose a valuable potential candidate for the community.

Protégés pursue individual excellence through supportive collaboration with colleagues and individualized attention and advising by their mentors and the SOARS director and staff. Setbacks and difficulties are treated by the SOARS director as normal and protégés are only required to reflect upon and learn from them. Excellence becomes redefined as creative collaboration with colleagues in addition to superior scientific work:

It's not redefining the part about excellence...excellence towards that task includes, yes, the precision, yes, the well-designed experiments, yes, all of the knowledge base, the careful analysis and *also* the benefit of minds that feel welcomed into a creative process. Two heads are better than one, it's that sort of thing but it's loosening up that norm of

competitive, conventional education. That really is counter cultural for a lot of the young people who come into SOARS, counter cultural in terms of their root cultures but they've been acculturated into it. That's what [SOARS] success and excellence means—trying to loosen up that knot a little bit so that their collegial networks are based also in trust and creative spontaneity and sharing and generative collaboration as well as knowing who has the information about such and such.

In SOARS, as well as life in general, protégés are encouraged to manage their careers with intentionality and to take responsibility for achieving their career goals, as Dr. Windham explains:

When they [the protégés] come in here, whatever happens to them while they're here, ...while they don't totally *make* it happen, they're responsible for what they do with it. ... If there is a definition for a person in descriptive psychology, it's that a person is... We distinguish people from other living organisms—that they may engage in reflexive action or even deliberate action. ... So that's where that's coming from. This is what a person is, you're a person. So it's all about empowering, and it's all about helping the protégés recognize that the most influential attribute in their lives is themselves.

Protégés are also empowered to define their own peer mentoring roles and responsibilities as well as the content of their leadership training, professional development seminars, and computer training workshop during the SOARS summer, as two SOARS staff members explain:

For me, what I see is that the peers take on the responsibility for mentoring the new protégés coming up; it's their thing when they do the graduate school presentation; it's their thing when they do the workshops for computers; it's their thing when they are peer mentored to write—that's their daily work. They're given the power to be who they are striving to be. And I think that that has a lot to do with Tom's philosophy, about empowerment and how that empowerment is going to bolster you in your education.

At the end of the intense, supportive, and empowering summer research experience, protégés transition out of the SOARS culture and back into the harsher realities of their universities and society. By this time, though, they are not alone—they have become members of the SOARS community and benefit from its support throughout the year.

UCAR Relationship with Soars

SOARS is hosted by UCAR, and therefore is affected by and has an effect upon UCAR's resources, goals and cultural values. How is the program perceived by UCAR's upper-level managers and its SOARS participants? To what extent do they feel the program aligns with UCAR goals and is worthy of their investment? We consider these questions in this section.

Program fit with UCAR goals

According to upper-level UCAR managers, the SOARS program is well-aligned with UCAR's goal of serving the broader atmospheric community. Education and outreach are an intrinsic part of UCAR's mission and hosting the SOARS program is seen as an important component in fulfilling that goal. This alignment is understood by UCAR employees as well:

Because we're funded by NSF, we're the national center [for atmospheric research], there's an expectation that what we do here is shared with the rest of the community—the scientific community and also the public. And that's encouraged and required to a certain level.

UCAR welcomes and supports visitors and encourages and recognizes (but does not always directly reward) employee involvement in education and outreach activities. There is, however, variation across UCAR divisions regarding how managers weigh employees' SOARS mentoring activities on their annual performance evaluations. For example, UCAR has a policy of assessing tenure track scientists' involvement in education and outreach as part of their merit and promotion reviews, as a way to encourage scientists' participation although it does not make this formal across the organization:

I think there's a much greater recognition of the value of these contributions, and in the national sense of we just have to do this. Well it's an intrinsic part of our mission. And, I'm not sure it happens in SOARS, but when our scientists speak at teacher workshops for example, there's a process in place that will produce a letter of thanks from the director of education outreach that will be to the individual scientist and then copied to the supervisor and the director. I have a whole stack of these that come in just before merit evaluation time. So that mechanism works, I'm not sure that's instituted for SOARS mentors. ... But I think we've made a lot of headway in terms of stressing the importance of these kinds of contributions.

Participation in SOARS provides a readily available, prestigious avenue by which employees can meet education and outreach requirements for grants. In addition, some upper-level UCAR managers actively encourage their employees to participate in SOARS. There is also, as one manager reported, some upper-management pressure on UCAR divisions to contribute mentors to SOARS.

According to UCAR's President, employees who mentor for SOARS are expected to spend five to 10 hours per week, at the most, mentoring, which is to be done in addition to their regular duties. However, a few UCAR managers rebalance their employees' workload to accommodate their SOARS mentoring time.

Program fit with UCAR cultural values on mentoring

SOARS and UCAR share a general value placed on mentoring. However, UCAR culture has not historically emphasized mentoring—especially for Ph.D. scientists, who are believed not to need mentoring and thus look unfavorably upon mentoring. Within the last six years UCAR has begun shifting perspectives to increasingly value mentoring. Study participants describe a UCAR culture that is becoming less individualistic and competitive and more appreciative of interdisciplinary work, collaboration, and mentoring (whether formal or informal). Some indications of this change are the creation of a Leadership Academy for new and future managers as well as peer mentoring groups which have emerged for software engineers and administrators. Furthermore, UCAR just created an annual mentoring award that is considered very prestigious to win.

Most study participants attributed UCAR's cultural shift toward mentoring to the efforts of Tim Kileen, Director of NCAR, although some believe that SOARS has validated, if not directly influenced, the change. Regardless, Dr. Windham is seen as UCAR's mentoring and diversity expert and has been invited to share his knowledge and wisdom with UCAR peer mentoring groups. There is still resistance, as there is to any cultural change, by scientists who dislike the idea of "forcing" senior scientists to mentor junior scientists, although new scientists today seek out informal senior scientist mentors. Another criticism is that "mentoring" implies a hierarchical model, which is believed to be unsuitable for professionals, versus "coaching" one another—a more "lateral" concept. Thus, one area of opportunity is for UCAR and SOARS to work more closely towards their shared mentoring goals.

Program fit with UCAR diversity efforts

Managers and SOARS participants believe that SOARS' mission to retain and increase the numbers of people from underrepresented groups aligns well with, and has the potential to benefit, UCAR's goal of diversifying its workforce. Reflecting broader societal issues, UCAR's scientist population is primarily white male, especially the upper-level scientists and managers. However, UCAR is actively pursuing demographic changes, with increased efforts to diversify its workforce in terms of gender and race. SOARS participants believe that UCAR management's and employees' efforts to increase gender diversity are beginning to pay off, with more women scientists being hired and promoted to higher levels of seniority. In addition, the work environment has become more welcoming to women scientists in recent years. However, several female and some male SOARS mentors also reported that gender challenges remain for women working at UCAR (especially at higher levels), such as work climate, life balance issues, cultural norms of communication and emotional expression, and retention. UCAR faces even greater challenges in trying to achieve and sustain racial diversity throughout the organization. While study participants who are racial minorities report they do not experience overt racism at UCAR, they have experienced problematic misconceptions and assumptions. Furthermore, some racial minorities and women feel frustrated at the pace and form of UCAR's diversity efforts, including the fact that UCAR does not have a person in Human Resources who is dedicated to diversity goals. Having experienced what it is like to be a member of a racial minority or a woman in the sciences, these employees are uniquely positioned to coach protégés on succeeding as scientists despite the challenges they will face as members of underrepresented groups. As will be discussed later, the desire to help protégés overcome societal barriers is also a strong motivating factor in choosing to volunteer as a mentor.

UCAR perceptions of SOARS

Overall, UCAR managers are highly enthusiastic about the program, valuing its goals and outcomes. They believe SOARS has become an integral part of the UCAR culture, and that it is part of a shared vision. Many upper-level UCAR managers are strong advocates of SOARS:

Everybody has those same goals, it's all motherhood and apple pie, and cheddar cheese, but the difference with this is that Tom crafted the implementation in a way that is just wildly successful...

One manager proudly reported that the rate of SOARS' students going to graduate school in science is much higher than that of undergraduates participating in REUs. Many managers

inform their employees of SOARS' yearly call for mentors, with some managers actively encouraging their employees to mentor:

[In] my role as a division director here at NCAR, I certainly try to encourage my staff to participate in the SOARS program, because I do think it's been a very successful and useful program. And I myself have participated.

Managers report that employees are aware of the program and its success and speak very positively about the program. Perhaps the best measure of upper-level UCAR manager support for SOARS is their active participation rate in the program—over a third have been SOARS mentors and 30% of UCAR managers have mentored more than once.

When upper-level managers were asked about their hopes for the SOARS protégés, they replied that they would like protégés to learn how science is done, appreciate its importance and relevance, believe they can be successful scientists, and choose science as a career path. They also hope SOARS will ultimately help UCAR diversify its own workforce.

SOARS mentors also had a very positive perception of the program, with over two-thirds of the mentors volunteering comments to the effect that SOARS is a “great program,” “very effective and well-run,” “high quality and successful,” “near-perfect,” “a showpiece” “a once-in-a lifetime opportunity for protégés” and “a deluxe program.” Many expressed wishes that, as students, they could have participated in a program like SOARS:

It's just such a great program. I love it. ... It's an awesome experience and I'm glad I'm a part of it, and I wish I had it going to school. Boy, I really wish I did.

Managers, the SOARS director, staff, and Steering Committee, and mentors expressed beliefs about the importance of and need for the program. They felt it was needed to encourage people of color into careers in the atmospheric and related sciences, which would also benefit science as a whole because there would be increased diversity of thought:

I think that science is a creative activity and everybody's creativity is different and the more different types of creativity—I think our creativity is innate and it's also influenced by the culture and the family and the gender and everything else we grow up in; so the more different creativities we have looking at things, the more likely we'll find great solutions—new things. That's why I think you want diversity—because different people bring different perspectives and they see different things...

Interviewees also felt SOARS was needed to reduce barriers experienced by racial minorities and to increase awareness of career possibilities, confidence, and aspirations. This in turn would stem the education pipeline losses, facilitate a cadre of role models, and help achieve racial parity in science relative to the overall population.

A few UCAR managers and mentors expressed reservations about the program as a whole, with broad questions related to the cost versus outcome. According to one manager, SOARS mentors expend significantly greater time mentoring protégés than they spend with their other interns.

Furthermore, because protégés have multiple mentors, fewer students can benefit from the program. The high per protégé cost that limits the number of students benefiting from SOARS prompted their questions, “Is it worth it?” “Is it better to invest large amounts of money in a few protégés or to spread the financial resources across more people?” “Which method will ultimately have the greatest effect on increasing and retaining members of underrepresented groups in the sciences?”

V. SOARS LEADERSHIP, STAFF, AND STEERING COMMITTEE

SOARS Leadership

Dr. Windham is very highly regarded by UCAR mentors and managers and the SOARS staff and Steering Committee (more than 80% of these interviewees volunteered their praise of him) as a capable and strong leader:

He was just spectacular, he had a wonderful vision, he got all the mentors—the workshop that he gave it was two days on mentoring and it was really inspirational. So it was vision, expertise, inspiration, practical, pragmatism, the ability to get everybody on board. Whatever he was doing it was successful because the program became—it was just great. ... I mean, he's got the culture and he's got the moxy, and he's got all that as well as the scientific credentials and the administrative ability, and the managerial ability, I think it's a real, it's just a fabulous combination. And he's such a nice person.

In particular, interviewees valued his passion and dedication to SOARS, its goals, the protégés, and for equity in education:

First of all, Tom has a passion for education. He knows that will open most, if not all, the doors. For anybody. What I have sensed about Tom is that Tom continues to be a young person at heart. He hasn't lost that capability to imagine what a protégé is going through. He also though has a sense of what a protégé needs to do in order to accomplish that. But he gives them the opportunity to make the choice. I have often wondered in the past how many people could actually really truly relate to all those different arenas. I think it takes a special person. Because Tom can sit down, and he can dance and he can manage to facilitate a contract. There's that. He can open his home. He'll open up his home for protégés to come in and make barbeque—I'm really seriously saying I don't know how many people would really do that. I think about that for the new director and I'm going "Tom has just opened up his life to this."

Interviewees described Dr. Windham's "remarkable" ability to relate to people and build connections, his honesty and natural, relaxed, personable, and social style that sets people at ease. Not surprisingly, he is also reported to be well-liked nationally and very skilled at networking and fundraising. He is seen as powerful and "cool" at the same time, wise and humorous. Some interviewees also mentioned the benefit of Dr. Windham being a racial minority himself:

Probably lots of people could do that job, but Tom brings some incredible skills and the fact that he's a minority. I don't mean to sound racist or anything else, but I think a lot of these kids relate to him at lots of different levels, from the very respectful, professional capability that he brings, that he may know a little bit about their life story, since he himself is from a minority group. So yeah, I think a lot of people could do that job—I think Tom in particular does it extremely well.

Highly valued qualities of Dr. Windham that non-protégés uniquely mentioned included:

- Respecting protégés—not talking down to or patronizing them
- Rigorously upholding expectations for student behavior while having the wisdom to understand the multiplicity of facets facing protégés in their unique life situations
- Giving protégés the benefit of the doubt (“cutting them slack” when appropriate)
- Meeting with individual protégés one-on-one twice a week over breakfast or lunch
- Regularly attending the weekly writing workshop
- Managing problems raised by mentors or protégés in their mentoring relationships
- Making opportunities happen for protégés at universities
- Facilitating field research opportunities
- Finding a new research mentor for protégés who perceived a poor disciplinary fit

Protégés also told us they held great respect for Dr. Windham. They deeply valued his support, friendship, and constant efforts to make the protégés’ experience at SOARS successful. The protégés described Dr. Windham as supporting and guiding them in a wide variety of ways, including comforting them in their initial transition to SOARS, providing career information and advice, and mediating conflicts among protégés. In addition, Dr. Windham also had a well-connected network within UCAR and among SOARS’ mentors, thus was a terrific resource in helping protégés to establish connections of their own.

Protégés deeply appreciated Dr. Windham’s approach to social interaction and mentoring, with some attributing the success of the SOARS to his personality and social skills. They described him as humorous and very friendly with everyone. Dr. Windham was seen as nice and approachable, as well as frank, direct, and open with people. He was an important person, but he was also warm and respectful.

Several protégés told us that Dr. Windham expressed deep, personal concern for their well-being, and he developed genuine personal connections with them based upon this:

Tom just really cared about, deeply, deeply cared about, the protégés. The protégés had a tremendous sense of trust in Tom—felt very safe with him, that they could talk with him about anything. Tom was really helpful in talking to them about professional things, about personal issues in their lives.

Protégés described Dr. Windham as serving as a supportive “safety net,” looking after and caring for them, especially with regard to their mentoring relationships. Protégés appreciated that Dr. Windham would listen to their concerns and was timely in his response to supporting them through their problems. Many protégés relied upon Dr. Windham for personal help or support:

Sometimes when I have a problem I just go to his office and he just tells me, “Oh.” He talks to me and tells me how to solve my problem, or how to look for the answer. So he doesn’t tell me what’s the answer to the problem, he just tells me how to solve it. So he taught me how to solve my problems, in a certain way.

Dr. Windham was described as perceptive to individual needs and group dynamics:

Tom is incredibly perceptive ... almost to the degree where you just don't even want to be in the same room with him, because he can tell. I'll just be fine with everybody, and he'll walk up to me and be like "What's wrong?" I'm like "Nothing. Nothing's wrong." But he'll know. He'll know there's something wrong with me. I think that's just something that is rare to find. I don't think I've found anybody that's as perceptive as Tom is. And he uses that for our benefit, because he knows if something's going okay and if it's not. He wants to fix it.

Participants suggested that Dr. Windham's background in psychology contributed to his ability to interact well with people and establish a positive social dynamic within SOARS. They suggested that this background enhanced Dr. Windham's ability to understand the cultural and social interaction of protégés and mentors:

I think because he had a background in psychology, he was really like, hash out group dynamics and how are everybody getting together. Because that's his thing. Mentoring people, getting together, people fitting together, everyone sort of being supportive of each other. That's his thing.

Protégés described how Dr. Windham led by example and promoted a notion of leadership in which the facilitator gives others the power to lead themselves, rather than issuing commands or authoritative directions:

[Tom] didn't take an approach where he was the leader and we were the soldiers. Or where he was a commander and we were the soldiers. He took more of a facilitator role, and that's important and that's, again, a very delicate balance. It takes a very special person to know how to do it.

Protégés recognized Dr. Windham as a role model and tried to emulate his social skills and motivation.

Throughout the interviews, we were continually surprised about how often SOARS participants of all types quoted Dr. Windham's philosophies and advice. Dr. Windham was known to give advice in the form of mantras, which left an impression upon some mentors and protégés (i.e., one frequently acknowledged mantra voiced to protégés was, "Plan your work and work your plan").

There were a limited number of observations noting a challenge or obstacle involving Dr. Windham. His strength of conviction that was so highly praised may have contributed to the few suggested improvements offered for his benefit: to try to be consistently open-minded and to avoid taking criticism too personally.

A few protégés told us they were intimidated by Dr. Windham and hesitated to approach him.

Leadership Change

Interviewees were understandably nervous about the change in SOARS directors, but also demonstrated faith in the process and managed their anxieties well. They believed it was important that the SOARS director be a person-of-color, since this would better enable a director to understand the issues protégés face and enable him to serve as an accomplished role model for protégés. Additional qualities interviewees cited as important in a new director (prior to the announcement that Dr. Pandya was chosen) included:

- Have knowledge of the social environment the program is designed to improve
- Be devoted to the program (“give your life to this program”) and its cause
- Have a true passion for SOARS, so that work with SOARS is a joy
- Have knowledge about non-profit organizations and or academic budget issues
- Be able to communicate and get along with funding agencies
- Be able to promote SOARS within UCAR and various communities
- Foster good relationships with UCAR management
- Be a “go-getter”
- Be sufficiently familiar with the SOARS program
- Have a proven record of good communication and work with young people
- Be able to foster good relationships with the protégés
- Be a good listener, be sympathetic but not gullible
- Have high expectations of protégés as professionals

Protégés also hoped the new director would:

- Retain the high level of personal interaction with protégés practiced by Dr. Windham
- Keep the funding for the program
- Build trust and friendship with the protégés

The new SOARS director, Rajul Pandya, began his tenure toward the end of our data collection. Because we have a limited number of comments from interviewees, there is not enough evidence to determine any conclusions with regard to Dr. Pandya’s role within SOARS. However, the transition of Dr. Pandya as the new SOARS director was generally regarded as smooth and successful. We heard phrases such as “I’m very pleased with Rajul’s leadership so far,” “he is doing an exemplary job,” “he has risen to the challenge incredibly well.” Interviewees also approved of Dr. Pandya’s science background and research experience, his facilitation of a candid discussion of race and his ability to unite mentors in their thinking. He has also demonstrated open-mindedness toward improving the program and a realistic understanding of protégé maturity and development as young adults.

Observations by some protégés indicate that the character, leadership style, and scientific background of Rajul differ from those of Dr. Windham. These differences were embraced and appreciated by protégés, and found to be a positive, productive factor in the continual development of SOARS. A limited number of observations noted that Dr. Pandya interacted with the protégés in a mellow, friendly, and comfortable way. He was appreciated as a funny, intelligent speaker and because of his background as a scientist. A few protégés expressed a

preference for Dr. Pandya's character and leadership style over Dr. Windham's, finding him more approachable and less intimidating than Dr. Windham.

Staff

The SOARS staff is comprised of five people whom we observed to care deeply for the protégés as individuals and to be very passionate about and committed to the program. The staff members are intent on making a difference in the lives of underrepresented people in the sciences:

My personal motivation is just a lifelong commitment to alternative forms of education, and individuals and populations who generally are marginalized out of the opportunities, so that's just a lifelong thing of mine.

SOARS staff members serve five distinct roles:

- A full-time logistical coordinator, database manager, and front line person
- A half-time publications and website (recruiting and community building tools) academic and career advisor, and additional front line person
- An 80% time budget person
- A full-time, partial year leadership training and peer mentoring facilitator and philosophical sounding board to the SOARS director
- A full-time, partial year writing and communication component facilitator and writing mentor trainer

The two young front-line people—racial minorities themselves—have extroverted personalities and have developed close relationships (sometimes even personal friendships) with the protégés. They serve as intermediaries in the event that protégés have any issues for SOARS staff members' attention, and as SOARS' eyes and ears to ensure protégé well-being. They do, however, still maintain professional role boundaries, not engaging in anything beyond limited social interaction.

All staff members are expected to attend official SOARS events. At times, the staff's work extends beyond work hours, particularly when participating in SOARS events or helping protégés with personal or interpersonal crises. The staff perceives their group to be divided into two personality types that they believe complement one another: two members plus Dr. Windham were seen as more philosophical and visionary, while the other three were considered more action- and detail-oriented.

Dr. Windham often traveled in his fund-raising efforts, leaving the staff to implement his ideas on their own. When he and the staff did interact, their relationship reflected the SOARS values of community and collaboration and their communication style was that of open dialog and active listening. We observed the staff interacting with familial-like comfort, speaking honestly, directly, and teasingly, as they shared diverse perspectives fairly freely most of the time. However, we also observed that the newest, youngest staff member did not appear to have full membership in the group, as her statements were at times (unintentionally, it appeared) ignored or interrupted.

The staff members' greatest challenge was that, while the service-provider role is emotionally rewarding, it can also be draining, especially when their great logistical and supportive effort does not appear to be appreciated:

It's like service work, it's both rewarding and draining; great, and occasionally frustrating when you feel like you've given so much to something, and every now and then you feel like you're not getting a return. But actually I would have to say that's pretty rare, particularly when the protégés are here—actually here physically in Boulder. You really do get a sense that they don't get it all the time, what you're doing, but they appreciate what they can see.

Lack of awareness of the SOARS staff members' work was very common among SOARS participants. After all, the prevention of a problem, albeit through intense effort, keeps something from developing into an obvious issue. Only about five percent of the mentors, managers, and Steering Committee members discussed the excellent and important work of the SOARS staff. Similarly, while protégés highly valued the SOARS staff, they had little understanding of the “behind the scenes” effort that is necessary to run a program like this so smoothly:

I think the most challenging part isn't working with the protégés themselves, it's working with the protégés on paper. So all the paperwork that goes into, all the details that go into getting them here—that's the hard part.

As a SOARS staff member explains:

They really don't, can't perceive what we sometimes go through in order to facilitate what their needs are. And I know sometimes that can be a bit frustrating. They don't have a clue, [like] if they don't respond back to an email, how impacting that is for us in order to facilitate, let's just say for instance, a trip. Or even grad school funding, or things like that. I think that they've a valid inability to understand what goes on within our group, in order to get from A to B for them. And I don't think that they should necessarily have to know that though, but that can be a struggle sometimes.

In addition, as another staff person put it, managing SOARS logistics is akin to running a “one room school house” for protégés who bring varied knowledge, experiences, situations, and needs to the program. Besides knowing that most of their efforts remain invisible to the SOARS community, staff members' only other regret was that they wanted more time to get to know the protégés better.

The SOARS staff members reported receiving gains that far outweighed the challenges they faced. In particular, they deeply enjoyed interacting with the protégés and felt satisfaction when they perceived they had made a difference, such as when helping protégés develop professionally, through advising:

The thing that I enjoy most about my job is when the protégés are here and when we get a chance to just talk to them and ask: “How are you doing?” I think a lot of times there are resources that they don't know about or options that they don't know about or I have a

perspective that they don't have. So if I can just say "Oh, you know..." in casual conversation, "Have you tried this? Have you gone here? Have you done this?"

The staff members also felt rewarded when protégés gained through the SOARS program:

Just, seeing them succeed. You get to know them obviously, between the interaction and, the lunches or whatever, so you get to know some of them really, really well. But to see them succeed, personally on that level, that these are people we know and are friends with, or at least have invested in personally. It's when they do the good things. When they get that Master's, when they get that co-author citation, when you see how proud they are after their colloquium presentations.

I'd have to follow up with that and say, it's meeting them when they come back May, June, of their second year. I mean I love seeing the progress over the summer, and I love seeing it over three, four years, whatever, but the way my role is affected anyway, is between the first and second year—that's the big differential.

In addition to delighting in protégés' final colloquium or conference presentations, graduate degrees earned, or co-authored publications, staff members felt joy when observing the strength of the protégé community:

Another satisfying thing that just came to my mind, which is probably more towards the community aspect of things, but when you see the protégés out in a group together, ...and the real, sincere appreciation of all of them together, and how it seems to me that they really are invested in each other. It's not just the SOARS program, I mean they're invested in each other's lives, and that is really neat.

Protégés' experiences with the SOARS staff were overwhelmingly positive. When asked about their interaction or relationships with the SOARS staff, participants spoke highly of their friendliness and helpfulness. Several described the staff as friends. Though they often did not fully understand the tasks and role of the SOARS staff, protégés told us they felt the staff to be an integral part of the success of SOARS and suspected a high level of behind-the-scenes responsibilities.

Several protégés told us how SOARS staff members facilitated a smooth transition into the SOARS program and prepared them for their summer in Boulder. The SOARS staff provided information, answered questions, alleviated concerns, and helped to organize travel plans. After the protégés' arrival in Boulder, the SOARS staff helped them settle into their apartments and finalize further organizational or logistical needs. Protégés' valued the staff being so organized and efficient.

Protégés often had little contact with the SOARS staff during the summer, but protégés were aware of the availability of the SOARS staff for support at any time:

Well we don't really get to see them much because we all need to get our research done ... but they always let us know they're out there whenever we need

help. Just call and they're available all the time. ... [T]hey've been helpful, because they know that we are here to learn and ... they try to make us feel as comfortable as possible and make it a nice experience.

Protégés told us the SOARS staff was thorough and responsive to questions or concerns. Often they would deliberate with protégés about potential solutions to a given problem. Protégés valued the staff members' friendliness and were impressed by their genuine desire to make the protégés feel comfortable and supported:

Oh. They're wonderful. They are absolutely wonderful. ... [T]he SOARS staff, they're so down-to-earth, and they're really just excellent. So that it helps the program a whole lot, because they're really that good, and you can go and speak to them about anything. And they'd be willing to help with anything.

A few protégés told us they wished they had more personal interaction with the staff. Others appreciated how the SOARS staff helped incorporate protégé feedback into the program.

Steering Committee

The Steering Committee is comprised of 13 participants (this number varies over time), including two SOARS alumni protégés, Rick Anthes, who is the president of UCAR, and scientists or directors representing most of UCAR's divisions. Steering Committee members expressed satisfaction with the committee composition.

For one protégé, serving on the committee was a dream come true, enabling him to continue participating in SOARS and inspire other students to live the SOARS mission:

After my first year, I learned how wonderful [SOARS] is, and I came back for my full four year term—just shows that I really felt something strong about the program. ...I was so excited and didn't hesitate a minute to accept the offer to be on the Steering Committee, when Tom invited me. ...I just definitely want to be involved in SOARS as long as—because it really means a lot to me and the students that I've met in the program, either from being a fellow protégé, or going back and meeting the students this year. They inspire me and I hope that I can inspire them, and I hope that they can fulfill the mission that I see from SOARS.

All of the Steering Committee members expressed deep commitments to the promotion of diversity. Responsibilities of the Steering Committee include:

- Meeting about four times a year to select among new protégé applications
- Make decisions regarding potential protégés' applications
- Match protégés (primarily new ones) with research mentors
- Make improvements to SOARS

The Steering Committee's primary goal is to ensure that all aspects of the program serve the needs of the protégés as much as possible. They are concerned that protégés have an authentic research project, that research mentors empower the protégés and further protégés' career

development, that protégés learn how to manage the mentoring they receive, and that protégés are accepted into good graduate schools and programs. Steering committee members were observed to eagerly and caringly receive news from the director about the status of individual protégés. They were interested in learning when protégés were accepted into graduate school, received fellowships, and when and why protégés were struggling.

Relatively little time commitment is required to fulfill these duties each year, with the exception of a large time expenditure of two to four daylong sessions needed to select protégés. Most of the Steering Committee members have worked together for many years, and have a very good, respectful working relationship with one another. Turnover of the members happens infrequently. They view SOARS as a family, and highly value their membership in it. Dr. Windham reported highly valuing the “willing collaboration” of the Steering Committee members, seeing the committee as “truly a community” where people interact “authentically,” creating an environment promoting “freedom [of speech] and ease of speech,” so that the “action is in the room, not in the parking lot.”

VI. PROTÉGÉ RECRUITMENT AND SELECTION

Protégé Recruitment Process

SOARS is actively marketed to potential protégés through several methods. The directors, a staff member or two, and some protégés take turns staffing the SOARS conference booth at key student conferences such as the American Indian Science and Engineering Society (AISES) and Society for Advancement of Chicanos and Native Americans in Science (SACNAS). They showed students the biannual SOARS newsletter that features articles about protégés and mentors, the *Earth Wind and Sky* publication of protégé research abstracts, and the SOARS program brochure, which the staff valued as good marketing tools at these events. SOARS also recruits via the National Society of Black Physicists' student organization and via mailings and visits to both tribal colleges and historically black colleges and universities (HBCUs). In addition, professors around the country who know and value the SOARS program recruit students, encouraging them to apply.

Protégés reported finding out about SOARS through a range of different ways. Most commonly, protégés discovered the SOARS program by the following means (listed from most frequent to least):

- Home universities, professors, and advisors
- Other internship and research programs
- The efforts of Dr. Windham (often at SOARS promotional booths)
- The SOARS website, often found while searching for internships
- Acquaintanceships with other protégés at home universities
- SOARS program flyers

Each of these recruitment avenues is discussed in further detail next.

Many protégés learned of SOARS through their home colleges or universities. Professors and academic advisors suggested the program and offered students encouragement to seek out more information and apply. Protégés were further influenced to consider applying after talking with fellow students who were already interested or involved in the SOARS program. Protégés returning from a summer at SOARS provided potential applicants firsthand accounts of enriching and rewarding experiences while spending the summer in Boulder:

Tom's a pretty good recruiter, but if you're talking to another student who's in the program now, and who can basically give you the low down on what it's like—at the apartments, what it's like in the town, what it's going to be like at NCAR—I mean they're not going to lie to you, and I think that brings in a lot of students.

Academic institutions also provided lists or databases for students to find and consider SOARS as a potential summer internship.

Other protégés discovered SOARS through involvement with other internships and research programs, including those local to the Boulder area such as SMART (Summer Multicultural

Access through Research and Training) program. Some protégés discovered SOARS through involvement with research opportunities at their home institutions.

Protégés were also introduced to SOARS and encouraged to apply by Dr. Windham himself. Students would meet Dr. Windham at conferences such as SACNAS, frequently while he sat at a SOARS promotional booth. The director of the SOARS program would answer questions and alleviate doubts, and his descriptions of and enthusiasm for the program made it sound all the more attractive. Many protégés remembered being struck by the friendly and charismatic nature of the director of SOARS:

I rounded a corner, and then I saw Tom. There was no one at his booth, and he was really friendly. He was like: “Hi!” So, I was like, “Wow, he seems really friendly.” And I told him what I was interested in: “Yeah, I’m interested in astronomy—doesn’t seem to really be atmospheric science.” He was like: “Well, you know, there’s solar physics,” so I was like, “Ooh!”

One protégé observed that Dr. Windham used effective persuasive techniques to talk him into it, even going as far as pre-arranging a science mentor in his particular field. Another future protégé enjoyed a personal tour of UCAR and Boulder courtesy of Dr. Windham.

Several protégés discovered SOARS on the internet, often when seeking internship opportunities. One protégé coincidentally recognized that a student in her class was a SOARS protégé, after looking at protégé profiles on the SOARS website, and spoke with her about the program. A few other protégés learned about SOARS from a flyer promoting the mentoring program.

Protégé Motivations to Apply to the SOARS Program

Protégés found SOARS appealing and were motivated to apply for many reasons (from most to least frequently mentioned):

- The financial support of the program, including a good summer stipend, free housing and transportation, and financial help with graduate school
- The continuous, multi-year structure of the program
- The opportunity to gain research experience and increase their skills working with cutting-edge scientists at UCAR
- The opportunity to study a specific scientific field or apply scientific knowledge or interests

Protégés recollected the financial appeal of the SOARS program. SOARS provided protégés with a healthy stipend of full-time work for the summer at a competitive wage, potentially higher than that offered by other internships. Other protégés found SOARS while seeking to make money for the upcoming school year—even in simply in need for a job—in addition to having interest in gaining internship experience. Students told us that they were paid well, surprisingly well for some. Applicants were also aware that SOARS provided financial support for graduate school and were excited for such an opportunity. The free accommodations were an attractive

element for protégés, as well, allowing them to save money while enjoying a nice, secure living environment, as one protégé explains:

The accommodations were over the top. I mean, you don't live in some trailer out in the middle of no-where. You live in a [really great] apartment in downtown Boulder.

Protégés cited the multi-year structure of the plan as an appealing element of SOARS and a motivational factor for submitting an application. Students accepted to the program as protégés are given the opportunity to return for three additional summers, given no reasons for dismissal. The continuous, multi-year opportunity was of initial value for protégés and helped convince many to apply.

Applicants were also excited by the opportunity to do research and work with the scientists at UCAR. Protégés told us that they were motivated to strengthen their math, science, and research skills in a research setting. They anticipated working with scientists, learning the research process, and participating as scientists. That UCAR and their potential mentors are renowned among scientists in the field and among peers and teachers in their home universities heightened some applicant's sense of enthusiasm. However, while protégés' were drawn to certain program elements, their anticipations and expectations of the program pale in comparison with the benefits and rewards gained from their experience, as is discussed later in this report.

The SOARS Program Application Process

Protégés reported that the application process was comfortable and non-problematic. For many, it was a familiar process, similar to applying to college or other internships. A few commented that they enjoyed the opportunity to write a personal essay.

Protégé Selection Process

Once a year, the SOARS Director and Steering Committee review applications from potential protégés and select which ones will be extended offers to participate in the program. The process of selecting protégés is somewhat competitive, with one in four protégés being accepted out of the roughly 30-50 applications received each year. This protégé selection process exists only for bringing in new recruits—protégés who have already participated one summer in the program follow a different process to be readmitted.

The SOARS director and staff perform an initial screening of the applications and sets aside those that are significantly incomplete. Next, the director screens for those students who fail to meet minimum requirements, such as having an inadequate GPA or not being far enough along in his schooling. In addition, the director screens the essays, rejecting applicants who did not address the topic of diversity and forwarding others on to programs that are more applicable for the students' backgrounds or interests. The head of the Steering Committee looks at the rejected applications as well, which the committee members considered to be a good process.

For candidates who are deemed especially desirable, SOARS uses a 48-hour "fast track" process to evaluate whether they should be extended an offer. These potential protégés are evaluated independently by Steering Committee members, who send the director their vote directly.

Beyond that, the filtered set of applications is passed along to the Steering Committee for review and consideration.

Selection criteria

The Steering Committee considers applications that meet the minimum criteria, one of which is grade point average (although some applicants whose grade point averages are close to the minimum and are noteworthy in some other way are also considered). Rick Anthes, the SOARS director, and Steering Committee members believe that, if SOARS is meeting its goals and focusing its efforts on students who need opportunities (rather than on those who already are destined to succeed), the potential protégé's grades will be somewhat lower, and the student will lack some skills and knowledge and need more mentoring. While SOARS officially requires a minimum 3.0 GPA, the director and Steering Committee will accept protégés with GPAs as low as 2.7, depending on the type of coursework taken (such as whether the courses were Advanced Placement or Honors and if the courses were taken for letter grades versus pass/fail). On rare occasions, a slightly lower GPA may also be accepted if other aspects of an application look promising. However, the Steering Committee considered GPAs below 2.7 as "squeaking by" and believed that the student probably would not thrive in the heavy math and science environment of UCAR.

Another key selection consideration is the students' year in school. The committee prefers college juniors because they are more likely to have taken the necessary coursework, had some helpful experiences, and have developed a level of maturity, and still maintained an openness to exploring various career paths. The applicants' essays, which helps the Steering Committee assess the students' achievements and motivations, are heavily emphasized. In the essay, applicants explain why they want to come to UCAR, providing information as to how the students' interests align with what UCAR and SOARS have to offer. Along with the essays, occasionally first-hand information is also considered, such as when the SOARS director has observed a student give a poster presentation at a conference. Students' recommendation letters are also important, with preference being given to applicants with three strong letters. However, Steering Committee members were concerned that some letters did a disservice to the students by not accurately reflecting the students' achievements as indicated by their GPAs and other measures in the application. The committee discussed this problem and decided to provide feedback to the students, even those who were not accepted into the SOARS program.

SOARS considers applicants of all races and genders. However, in keeping with the underlying goal of SOARS, extra interest is given to students who come from groups, such as some racial minorities and women, who are traditionally underrepresented in the atmospheric and related sciences. In addition, it favors students who are the first person in their family on a path to receive a college degree.

The outcome of the protégé selection meeting is that applicants are placed into one of three groups: those who will receive offers from SOARS, those set aside as alternates, and those that are rejected. Some of potential protégés that are rejected for SOARS are forwarded by the committee or the SOARS director, with the applicants' permission, to the University of Colorado's SMART program for additional preparation, and are encouraged to reapply to SOARS the following year. The SOARS director accepted the recommendations of the Steering

Committee regarding which applicants should be extended offers. However, the director reserved the right to change the order of alternate candidates, should one of the first-choice students reject the program offer.

Mentor perspectives on the ideal protégé

While mentors do not make decisions regarding students' admission into the program (unless they happen to be on the Steering Committee), their views of the ideal protégé are useful to consider here. The primary characteristic that mentors agreed the ideal protégé should have is motivation; that is, interest in science and in participating in a summer research program like SOARS. The ideal applicant has an inquiring mind and is curious about problem-solving, in general. In addition, mentors discussed a variety of other qualities that the ideal protégé should possess:

- Be self-motivated and very independent, well-disciplined and organized to succeed in the fast-paced program with its multiple requirements for success
- Be open-minded and willing to try new things, even if the protégé initially knows nothing about the research project or process
- Have already completed the necessary coursework that will facilitate success with their research project. However, some committee members felt that a lack of computer skills, in particular, should not be a barrier to admittance. While the protégé should be smart, passion for science was more important than high grades or prior lab experience
- Be highly motivated to work hard to meet the expectations of the program and be able to manage the inherent stresses
- Be able to initiate discussions with the mentors and to ask questions, which will facilitate learning from the research mentors

Mentors and UCAR managers also voiced some concerns regarding the selection of protégés for the SOARS program. A few were concerned that SOARS may be selecting students who are already destined for success, since the criteria to enter the program are set high. Others were concerned that some students may be more interested in the SOARS stipend than in a career in the atmospheric sciences. In addition, the concern was raised that wealthy students do not need the SOARS program's resources and that the mentors' time is better spent on lower socio-economic status (SES) protégés who do need the resources.

Protégé Re-admittance Process

Protégés returning for their third or fourth summers only have to state their intention to return for another SOARS summer. However, protégés who have completed their first SOARS summer must state their intention to return for a second summer and submit an essay stating why they want to return.

The re-admittance essays are reviewed by the SOARS director to assess the protégés' level of interest in pursuing a science career. In addition, the director obtains grade transcripts each semester to ensure protégés maintain a 3.0 GPA. Protégés are almost always readmitted for a second SOARS summer.

However, exceptions are made for extenuating circumstances and when protégés show improvement. As the director explained, if their grades are “incongruent with what I believe to be their ability,” such as in the case of a protégé who did not ask for help at school when she needed it and instead “drowned,” or a protégé whose research mentor discovered that the protégé had a learning disability, or a protégé who experienced a death in her family. At the time of this study, there were six (out of 50) protégés with GPAs between 2.7 and 2.8 who had been conditionally readmitted. A SOARS staff member explains another facet of Dr. Windham’s flexibility with protégé mistakes:

I just know from being on staff, there have been a few that have not been allowed to come back for various reasons, but very, very few. Tom’s approach is always, “What can we do to keep these students in the program and in science? What do we need to do to support them to do that?” It’s not a hard fast—“There are rules and if you messed up you are out.” ...I know of at least one case where a protégé flunked a class, just the way I would have flunked a physics class and was pretty stressed out about it, because what was this going to mean in SOARS and so forth. And Tom just said, “Hmm. What’s the problem? What was your problem? How do you expect to recover from it? Here’s some possibilities, you could consider taking a class while in the summer.” Just running through possibilities instead of saying, “One problem and you’re gone.” It’s like, “If that’s a pattern then that has to be dealt with but, but if it’s a mistake and you recognize it and you try to recover and move on...” So that philosophy of “What can we do here to keep these people excited about science and in school and in the program” is really different than the school environment where you do something and get axed.

Discontinued Protégés

SOARS has been successful in retaining its protégés, having an 82% retention rate. However, some protégés are discontinued from the program—roughly half of them due to their own choice and the other half by becoming ineligible to participate. Over the years, SOARS has averaged 2.3 discontinued protégés per year. According to one manager, having a few protégés who drop out indicates that SOARS is selecting protégés who can benefit from the program, rather than those who would have succeeded anyway, although she did feel that having as many as two drop-outs per year could be cause for concern.

Of those that chose to leave the program, half did so for personal or family reasons. The other half (a fourth of all discontinued protégés) realized they wanted to pursue either science career paths other than atmospheric science or even non-science disciplines. Only a very small percentage of all the protégés, 9%, are not permitted to return to SOARS for another summer. SOARS strives to support its protégés so that they succeed in the program, and will provide extra help and support to struggling protégés. At the same time, the determination is sometimes made that protégés, despite extra support, are not willing or able to do what is necessary to succeed. Some of these lose their eligibility by not finishing their summer research paper within an acceptable timeframe (although limited extensions are occasionally granted beyond the end-of-summer program deadline for protégés with special circumstances). Protégés may also become ineligible if their course grades or chosen coursework is inadequate. Protégés who violate norms of appropriate conduct may also be discontinued from the program.

Mentors' Perceptions of the Quality of Protégés

Rarely were mentors concerned about protégés' abilities. As we discuss elsewhere in this report, there were some concerns about over-estimating protégés' abilities as well as about protégés' apparent lack of interest in their research projects. Almost all of the mentors viewed their protégés as high-caliber individuals who were "very smart," "very talented," and had "high potential." In fact, one UCAR manager was so impressed with the quality of protégés, that he stated that he doubted that he, himself would have been accepted into the program as a protégé:

I've always been very pleasantly surprised at the caliber of people that we get, but I shouldn't say that by surprise because it's a competitive process, but I always look at these young protégés and just say—I probably wouldn't make the SOARS cut ... I mean pretty high caliber people, very mature for their age.

The SOARS staff members, all of whom were currently teaching university classes, or had taught in the past, were also amazed by the superior quality of the protégés' work, which they felt far surpassed that of typical university students, especially undergraduates. They felt the supportive SOARS environment contributed to the protégés' success. Several mentors judged the protégés' success by attending their final colloquium presentations:

I remember when she gave her final talk...she was just so professional, so polished from her dry run, and made big improvements in poise, clarity, and speaking with assurance, and I'm really, really proud of her. And it's a big deal. I don't think she was a doctoral student yet, I think she was just a masters' student. This is a big deal to go into a room full of world class scientists and talk about your project with poise. I remember being really proud of her.

Another UCAR manager had high hopes for protégé's continued career success, expecting that they would be competing for the top teaching and research positions across the U.S., noting that they would be entering the job market at an opportune time, with many faculty retiring and state pressure on organizations to hire women and racial minorities.

Many mentors were impressed with protégés' high degree of motivation for their SOARS experience: to do well in the program, tackle difficult research projects, and learn new sub-fields. The writing facilitator was very impressed that protégés, when posed with the option of doing a harder research proposal assignment, chose the harder option because it emulated real research proposals that scientists write to solicit funding. Furthermore, the protégés were later upset that their realistic proposals were not evaluated and scored by scientists, as if their proposals were real.¹ Protégés were viewed as very hard workers, who were highly motivated to make something of themselves. During their SOARS summer, however, protégés both worked very hard and played very hard. Dr. Pandya, the new SOARS director, once joked that protégés "work really hard—in spurts!" to which the roomful of protégés erupted in laughter.

¹ In 2004 and 2005, they were evaluated by scientists, though often not scientists in the same area of atmospheric science.

Mentors explained protégés' high level of motivation as originating from various factors: that the program gives protégés visibility in the science community so that protégés recognize it is an important program; that new protégés observe the efforts of experienced protégés and the scholarships and rewards they reap for their work and seek to achieve the same; and that SOARS selects for protégés who are already driven to pursue excellence and then SOARS nurtures that drive. One scientist described himself as being "blown away" at how inspired protégés got from doing their research and presenting it:

It really just blows you away how inspired they get when they're given that opportunity to do research and talk about their research. I think it's a fantastic program and it really fills an important need for giving these under-represented, racial groups opportunities like that.

Mentors also described their protégés as being very mature, highly responsible, and conscientious for their age. Only a few mentors reported that their protégés lacked sufficient motivation and responsibility, either as evidenced by doing mediocre work, slacking by not putting in a full day's work, playing around when waiting for direction instead of initiating learning and investigation, or failing to meet program requirements.

Mentors were concerned that some of their protégés were frustrated, overwhelmed, and under tremendous stress, especially toward the end of the summer when the research projects and final papers and presentations were coming due. In addition, as one mentor explained, some protégés were "burning the candle at both ends" with the intense SOARS work and many fun protégé activities.

VII. MENTOR RECRUITMENT

The Mentor Recruitment Process

Most of the SOARS mentors first became aware of the program's existence through two UCAR-wide information sources: one a broadcast email requesting SOARS mentors, and the other a UCAR employee publication, "*Staff Notes*."

Anybody at NCAR has heard of the SOARS program. ...It's publicized a lot around the institution. You see it in...it used to be weekly *Staff Notes*, now it's daily *Staff Notes*, on the e-mail. And it's featured now in the printed monthly *Staff Notes*, which come out to everybody. SOARS really gets a lot of press in that.

SOARS' initiates its mentor recruitment process each year by sending out a UCAR-wide email in February requesting volunteer mentors for the following summer. This email is also sent to SOARS partner organizations, such as NOAA and CIRES. Potential mentors are asked to answer questions about why they want to mentor, what they expect the protégé will gain from it, whether the mentor will be available all summer, and (for research mentors) what the research project will entail. This broadcast email is the primary avenue by which mentors are recruited.

In addition, mentors report having been recruited by the SOARS director, protégés themselves, other mentors, the Advance Studies Program Director, Steering Committee members, and UCAR managers:

- The SOARS director personally invites mentors who he or the Steering Committee feel would be a good match for the protégés, based upon the mentor's subfield of expertise, skill set, or personality.
- Protégés returning for a subsequent SOARS summer are highly encouraged to seek out their own research mentor, which most do. In addition, returning protégés sometimes ask their current writing mentors to mentor them the following summer.
- Some mentors were encouraged by other SOARS mentors to participate in the program. At least two of the current SOARS mentors are very strong proponents of the program, serving as informal marketing agents.
- Many of the postdoctoral scientists at UCAR became SOARS mentors via their participation in UCAR's Advanced Studies Program, where the director encouraged mentoring as a valuable professional development activity for them.
- Steering Committee members invite potential research mentors at times, especially those who are colleagues or have been SOARS mentors before.
- Directors of UCAR divisions also occasionally recruit mentors when asked by SOARS to help find a suitable research mentor interested in a similar subfield as a protégé.

According to the Steering Committee, rarely have mentors declined a personal invitation, even though they have that option.

With little information about mentor recruitment, some mentors and managers expressed concern whether SOARS experiences difficulties in recruiting the mentors it needs. In contrast to their

concern, Dr. Windham reported that it was relatively easy to find mentors, thanks to the high level of support SOARS receives from UCAR, and that some mentors even have to be turned away. For example, two scientists who had volunteered to be research mentors in summer 2004 were turned down for that role, due to a lack of protégés with similar interests. Instead, the Steering Committee decided to ask them to be writing mentors.

Overall, mentors have come from a broad range of UCAR divisions, although employee participation in the SOARS program varies by UCAR division and with individuals' personalities. Two mentors spoke proudly of their divisions' (ACD and MMM) high rate of SOARS participation. Some individuals are more interested in education and outreach while others are reported to have little interest or are too busy.

Peer mentors come from the pool of returning SOARS protégés. Because there are more returning than new protégés, only some returning protégés can serve as peer mentors in any given summer. During the Leadership and Peer Mentoring Training workshop at the beginning of the summer, protégés volunteer to become peer mentors and then choose among themselves who will actually mentor the new protégés.

Mentor Motivation to Participate in SOARS

What motivates UCAR employees (and those from SOARS partner organizations as well) to volunteer as SOARS mentors? Not financial compensation. All SOARS mentors are volunteers. Structuring mentoring this way is believed to be beneficial, since it encourages employees who are more "people oriented" and care most about education, outreach, and diversity to become mentors without unduly coercing other people to participate, which could result in lower quality mentoring experiences for the protégés. If not financial reasons, what led mentors to volunteer their precious time?

The most frequently mentioned factor in deciding to mentor was having sufficient time, flexibility, and availability during the SOARS summer. Mentors discussed the importance of being on-site rather than off working in the field, traveling for business, or taking vacation:

I felt I actually had time to contribute to the program. Whereas in the past, well it's just really has to do with how much traveling I'm going to be doing during the summertime; that's a big factor.

Some mentors chose to volunteer for specific mentoring roles, also based upon their availability. For example, scientists with limited time who might otherwise choose to be research mentors, chose to be writing mentors, those with even more limited time volunteered to be community mentors. One mentor, who had served first as a research mentor and then later as a writing mentor explained his reasoning:

After [protégé's name], I took the break and was a writing mentor... I guess because of my view that the writing mentor would not take as much of my time to do as the research mentor and certainly as a research mentor I feel a lot more responsibility in that I take it home with me, where I'll be getting ready for the day and I'll think, "Oh, I need to be able to help so-and-so with the..." There's just a lot more responsibility with it that

sucks energy and your time away from you and so I viewed a writing mentor as one where you could leave it behind and it was probably once a week kind of thing whereas a research mentor it's much longer time length.

Other mentors worked around their availability difficulties by choosing to co-mentor, so that absences could be covered or the time burden of mentoring could be shared.

Two other factors also presupposed an interest in being a mentor: some scientists only volunteered as research mentors when they felt their research lent itself to good research projects for protégés and some writing mentors volunteered only if they felt they had sufficient writing skills to mentor a protégé well.

But what led people to feel mentoring protégés was a valuable activity? Mentors often had multiple reasons, with the most frequent motivating factors listed below:

- Valuing education and outreach
- Enjoying helping and teaching students
- Feeling a sense of social responsibility toward underrepresented groups

Over a third of the mentors reported feeling strongly about the importance of education outreach and had a history of volunteerism in other programs as well. Another third of the mentors reported enjoyed interacting with or teaching students—something that there are few opportunities for within UCAR. These mentors took pleasure in helping students, trying to guide them effectively, and imparting knowledge to “young active minds.” Yet another third of the mentors volunteered their time because they felt a sense of social responsibility to help racial minorities and women who have been historically excluded from the sciences to succeed in the field. Some, having faced these barriers themselves, wanted to serve as role models and to provide the support they wished they had received as members of underrepresented groups. In addition, one female scientist also valued being a mentor to male protégés, to demonstrate that women belong in science as well.

Scientists often volunteered out of a desire to encourage students to pursue science careers. Many felt an obligation to pass on their knowledge and wisdom to the next generation:

I've always wanted to work with students and I found this was a good outlet to do that. When I became a tenure track scientist I was actually trying to decide between going to a university or staying here and one of the reasons I would want to go to a university would be to teach and work with students. So I felt that if I decide to stay here there are opportunities to work with students or to work with universities and teaching. So I might as well take advantage of the opportunities that there are here. I think it's part of my personality that I enjoy working with other people and it's fun to teach someone and see them learn something new in their life....

These scientists enjoyed their careers and their work at UCAR and wanted to share their experiences and give protégés similar opportunities. At the same time, scientists hoped to gain

talented and interested colleagues in the future. They also believed that a diversity of perspectives would help produce better science and scientific goals.

Other factors that were mentioned by a quarter or fewer of the mentors were as follows:

- Valuing SOARS as a successful, highly visible program and believing in its goals
- Believing that their mentoring would “make a difference” in the protégé’s career or life (the converse was also true—if a mentor felt their efforts were not valuable, they felt demotivated to mentor again)
- Personally valuing mentoring as a beneficial and important element of a successful career—either because of their own benefits from good mentoring or their struggles resulting from the lack of good mentoring
- Valuing that SOARS is aligned with UCAR’s education and outreach goals and that mentoring is encouraged and supported and can be advantageous to one’s career
- Wanting to improve one’s own mentoring, teaching, professional, or language skills
- Enjoying interaction with young adults
- Having been personally asked to be a SOARS mentor by the SOARS director, the writing facilitator, a protégé, a Steering Committee member, another mentor, or a UCAR division director

A small number of scientists based their decisions to mentor on practical concerns. In these cases, they described their need for help with some aspect of their research agenda. Protégés—especially if they already have summer research experience—are a desirable commodity, because their wages are funded by SOARS. This is not to say that the scientists used the protégés as menial labor, but rather, most of these scientists found a mutually beneficial research project that was both challenging to the protégé and contributed to the success of the lab.

Another factor informing the decision to mentor was raised by a couple of mentors who based their mentoring decisions on their perceptions of the need for mentors—if there seemed to be an abundance of volunteers, they did not feel as motivated to volunteer.

Looking at the entire SOARS mentoring population, not just the interview sample, we learned that some mentors (9%) had served dual or triple mentoring roles and 44% of all mentors had chosen to mentor again. A quarter had mentored three or more years, and 13% had mentored four or more years. In addition, only one-quarter of the “past” research mentors (who had mentored in 1999 or earlier) and writing and community mentors (who had mentored in 2002 or earlier), whom we had initially suspected had “quit” SOARS mentoring, had not mentored a second time. However, research and community mentors were twice as likely as writing mentors to only have mentored once. This topic is discussed in detail in the section on mentor gains, costs, and decisions to mentor again. Slightly more men (54%) than women (46%) were SOARS mentors, although significantly more women were writing and community mentors than were men. In addition, three times as many men were research mentors than women, which indicates a higher volunteer rate among men scientists, given that twice as many NCAR scientists are men (60% men versus 30% women) (UCAR, 2005b).

Qualities of the Ideal UCAR Mentor

UCAR mentors' perspectives on the ideal mentor

A few UCAR mentors offered suggestions about the qualities of the ideal UCAR mentor. They felt the ideal mentor had good people and communication skills and a genuine interest in helping others. The ideal mentor was aware of and cared about the protégés' needs, invested a lot of time in mentoring, and initiated interactions and otherwise checked in with their protégé regularly. The ideal mentor was expected to be patient, and carefully and comprehensively answer the protégé's questions and ensure that the protégé understands what is being communicated. The ideal mentor helps the protégé get the maximum benefit out of the SOARS experience, without imposing the mentors' own agenda. This entails discussing with the protégé available options, opportunities, and resources. Research mentors would ideally mentor the protégé on navigating higher education in science and on becoming professionals.

Protégés' perspectives on the ideal mentor

Protégés discussed the vital roles played by volunteerism, enthusiasm, and care. They valued mentors who were genuinely committed to helping protégés and who volunteered their own time. Protégés also appreciated mentors who were caring and enthusiastic about developing a successful relationship or showed a desire to meet protégés' needs.

Good relationships between mentors and protégés were also characterized as involving considerable dialog and interaction that was non-hierarchical. Protégés valued being brought into research practices as colleagues and understood the learning process as beneficial for both themselves and their mentors:

[Mentor relationships are] not like, "Okay this is the research, this is what it's all about, go figure it out yourself." It's not been like that. We've been working together like, "Okay, I have a problem here," or "What do you suggest?," "Okay I think this will work good," or "Your suggestion is okay." It's been back and forth... We do come with our different ideas and we work together.

These relationships were described as not being top-down or boss-like, but were instead mutually beneficial learning processes. A couple of protégés even (proudly) mentioned teaching their mentors something about computer programming.

Several protégés also mentioned they appreciated having casual or non-pressured mentoring from mentors. These protégés described relationships as supportive and helpful, but also relatively free from stress or undue pressure to meet deadlines. Work with these mentors felt relaxed, occasionally punctuated by breaks and conversations.

Protégés appreciated mentors who could instruct well and explain material on a basic, introductory level. Patient and helpful instruction was characteristic of good mentoring. Good mentors would break complex material down and explain it to protégés in simple terms. Protégés valued having background information supplied, particularly those who were doing research in a new scientific discipline.

Protégés discussed the importance of communication for developing good relationships with mentors. Though not all protégés felt it necessary to develop a personal relationship beyond professional activities, several told us of the benefits of forming a personal connection. They felt that the professional relationship was enhanced by also building a personal relationship. A few participants emphasized that it was the responsibility of both parties to work together to establish norms for working together, expectations, and to develop a productive yet comfortable relationship.

Some other mentor qualities that protégés appreciated included:

- Balancing support of protégés with fostering their independence
- Tailoring explanation and instruction to individual protégés' needs
- Accessibility of mentors to their protégés
- Realistic expectations of protégés
- Promoting active engagement of protégés (i.e., by prompting protégés to ask questions)
- Allowing the protégé to take “ownership” of the project—listening to and supporting protégés

Qualities of the Ideal Peer Mentor

During the 2003 Leadership and Peer Mentor Training workshop, protégés brainstormed the characteristics of an ideal peer mentor. According to them, the ideal mentor would encompass the following:

- Make the mentee feel welcomed but not overburdened
- Learn about the personality of the mentee
- Be concerned with and interested in what the mentee is doing (like a big brother or sister would)
- Work to accommodate and appreciate personality differences
- Know when to have fun and when to be serious
- Separate the roles of friend and mentor (placing mentor obligations first, friendship second)
- Know when the mentee needs help
- Tell the mentee when he is making a mistake
- Provide constructive criticism
- Not be too proud to admit not knowing something

VIII. THE PROTÉGÉ AND MENTOR MATCHING PROCESS

New protégés are assigned four mentors—a research mentor, writing mentor, community mentor and peer mentor—while returning protégés are matched with two—a research and a writing mentor. However, exceptions to this policy exist, such as when two scientists or writing mentors co-mentor a protégé. Also, there have been cases in which a single mentor has served as both the writing and community mentors for a protégé. Just as protégés typically have one mentor serving each mentoring role, mentors have just one protégé per summer, although occasionally a SOARS staff member will mentor two protégés (as either writing or community mentors).

Two distinct matching processes were used for matching protégés with research mentors: one for new protégés and one for returning protégés. Other processes existed for matching protégés with writing, community, and peer mentors.

Matching New Protégés with Research Mentors

New protégés are matched with their research mentors by the Steering Committee, who, because many of them are senior scientists, appeared to have great insight about the scientists who volunteered as well as other scientists who they directly recruited. Similarly, the Steering Committee members who are alumni protégés, provide invaluable insight into protégé needs, both professional and personal.

The process used by the Steering Committee to find science mentors for the new protégés (and for returning protégés who failed to or opted not to find their own research mentors) is lengthy and complex. First, for each protégé under consideration, committee members considered several factors related to the protégé, such as: research interests, academic major, academic preparation, as well as the likelihood of the protégé's success with the research projects offered by scientists who have volunteered to be mentors. They also consider how to best expose the protégé to atmospheric science if her major is not directly related to atmospheric science, such as majors in mathematics, computer science, or engineering. When considering new protégés' research interests, the committee members also take into account both the explicitly stated interests on the applications as well as the implied interests based upon protégés' coursework and application essays.

Next, the Steering Committee determines which scientists at UCAR work in subfields that parallel the protégés' areas of interest. Once a few potential mentors' names are written on a flip chart, a discussion of the scientists' subfields, availability (both professionally and personally), and personalities ensues. The type of research conducted by the scientists is also considered—whether projects are abstract or concrete, broad or narrow in focus, etc. The committee strives to select mentors who are known to be patient, altruistic, who value education, who would not exploit the protégés' labor, and who are considered to be strong scientists. If the Steering Committee is unable to think of a scientist whose expertise matches that of a protégé's interests, the SOARS director asks the director of the most closely aligned UCAR division to help find a scientist with similar interests to that of the protégé.

According to SOARS policy, new protégés are intentionally matched with UCAR scientists to facilitate their integration into the SOARS community, while returning protégés could be matched with mentors from other labs, either locally, elsewhere in the U.S. or even abroad. However, protégés who are matched with non-local mentors are also assigned a UCAR mentor.

Once the matching process is complete, the SOARS director and Steering Committee members decide who will invite the scientists who were not on the list of volunteers to be mentors. The vast majority of those who were recruited responded positively to the request.

Sometimes more scientists from a particular subfield volunteered than were needed, based upon protégé areas of interest. Thus, some mentor volunteers went unmatched, although the SOARS director often asked if they were willing to serve as writing or community mentors instead.

Matching Returning Protégés with Research Mentors

About three-quarters of the returning protégés recruited their own science mentors. Returning protégés generally prefer to choose their science mentors, and some choose their writing mentors as well. Returning protégés reported searching the UCAR website and reading scientists' web pages to find suitable mentors. Protégés also confer with one another about various subfields to gain ideas about what and with whom to study for the next summer.

Mentors discussed the pros and cons of returning protégés choosing different research mentors versus continuing with the same mentor over subsequent summers. With different science mentors, protégés could explore a variety of science sub-disciplines, and gain cross-fertilization of ideas and methods. In contrast, protégés who work with the same scientist over two or more summers could delve more deeply into a sub-discipline and become more knowledgeable and proficient at it. Some scientists themselves valued having a protégé for a second year and felt they could more effectively mentor these returning protégés. They also valued the protégé's increasing ability to make a real contribution to the science. In contrast, other research mentors preferred getting to know and mentor a variety of protégés, helping more people over time.

Matching Protégés with Writing and Community Mentors

The SOARS director is responsible for matching writing and community mentors with protégés. The SOARS director also solicits the advice of SOARS staff members who suggest possible mentors. When considering which writing mentor to match with a protégé, the director also considered if the writing and research mentors' areas of expertise might lead them to have conflicting viewpoints and so be prone to disagreements, and thus not best serve the protégés' mentoring needs. When matching off-site protégés with writing mentors, the SOARS director tries to assign mentors who need to travel during the SOARS summer, but would still like to mentor, since the mentoring relationship will already be a long-distance one and not add an impediment as it would if a traveling mentor was matched with an on-site protégé.

Matching New Protégés with Peer Mentors

Peer mentors made their own matches with incoming first-year protégés based on limited information about the protégés, such as their name, gender, major, and university. The peer mentors found it difficult to rely solely on this information, and wished for more information, specifically about newcomers' personal and research interests, in order to make better matches.

At the same time, they kept “mismatches” in perspective: the peer mentors recognized that they were not the only source of support for new protégés, and while peer mentor/new protégé matches that developed into solid friendships were one metric for successful peer mentoring, when this did not happen, the peer mentoring efforts were not necessarily considered failures.

Quality of the Mentor-Protégé Matches Made

Overall, research, writing, and community mentors were quite satisfied with the quality of mentor-protégé matches. Poor matches were reported to be infrequent and mostly due to random personality conflicts, which SOARS participants generally expected would inevitably happen, or (for research mentors) a mismatch of science interests. As some mentors explained, matches between scientists and protégés were considered effective if the protégé was motivated and interested, even if protégés lacked the necessary background knowledge, so long as the research mentors had the protégés’ best interests in mind, and both parties were open-minded and flexible in making these relationships work.

Although mentors had almost no notion of the matching process, they suspected that Dr. Windham took gender, race, and personalities into consideration when matching mentors with protégés—which one mentor referred to as “Tom working his magic.” For example, an outgoing community mentor who was matched with shy protégés was amazed at how good the matches were. Another mentor expressed surprise and pleasure when matched with a protégé who shared a similar geographic background.

Mentors believed it was important to match protégés with research mentors who shared similar science interests. However, as the SOARS director, Steering Committee members, and some scientists have noted, most protégés are initially interested in pursuing a career in only three main areas: forecasting, hurricanes, or thunderstorms, which makes effective matching difficult:

I think SOARS gets two classes of students. They get students who are interested in meteorology and then they get students interested in other technical science engineering fields. And a large proportion of students who are interested in meteorology—they either want to forecast or they want to study thunderstorms. And there just aren’t enough thunderstorms in the west, Honey.

The SOARS director and Steering Committee members believed this is because protégés have not been exposed to other sub-fields in the atmospheric sciences. Therefore, at times they matched new protégés with scientists in different sub-disciplines than those requested by the protégés. In one case, both the research mentor and protégé reported surprise at the extent of the disconnect between the protégé’s reported interests and the scientist’s research area.

New protégés’ were expected to “stick it out” with their assigned research mentors and research projects whenever possible, even if they were assigned to sub-fields that differed from their preference. The SOARS director believed that conducting any research project provides the protégé with transferable research skills. When a match really was fraught with serious personality conflicts, or when a protégé really did not like the research project, the SOARS director found the protégé a different research mentor and project. However, according to two research mentors, this was sad and upsetting to the abandoned scientists who also felt it a

disservice to the hosting mentor and research team. Challenges aside, SOARS' flexibility in this matter was commended by UCAR managers.

Individual mentors offered a few suggestions for matching, such as trying to give protégés a mentor triad of varying race and gender, although that does not guarantee the mentors will have an awareness of diversity issues or particular experiential backgrounds, relative to the protégés'. Another idea was that writing and community mentors who work in the same subfield as the research mentor could also mentor the protégé on the science underlying the paper and presentation, although this could hinder their ability to help the protégé write to a more general audience.

Protégé Perceptions of the Matching Process

The matching of a protégé with a research mentor was recognized as an important, albeit difficult, process. First year protégés often did not know the circumstances by which they were paired with a mentor, and sometimes they found themselves doing a research project of limited interest to them. Many protégés, however, were very happy with whom they were paired.

How well matched a protégé was with a research mentor was sometimes dependent upon the research mentor's particular field or specialization. Some protégés found it challenging to connect with a mentor whose research interests diverged greatly from their own. Rarely, however, did protégés complain about being stuck with a research mentor and project they detested. Protégés tended to continue with a project—often gaining from it either through other rewards of the research process or by finding an unanticipated interest in the project.

Occasionally a protégé would be paired with a mentor and, recognizing early on that either the relationship would not work out or the research project was of no interest, requested to be paired with another research mentor. Dr. Windham was supportive and proactive in helping these few protégés find different mentors. Returning protégés were better equipped to actively seek out a good fit with a mentor, either choosing to stay with one they already worked with or seeking out a mentor in a specific field or scientific area better fitting their interests.

IX. PREPARATION AND SUPPORT FOR MENTORS

SOARS offers mentor training and support to all of its mentors. However, UCAR mentor training differs from that of Peer Mentor preparation.

The UCAR Mentor Kick-Off Meeting

Most UCAR mentors reported that their only formal mentor training was through the SOARS mentor orientation workshop. Other than that, most mentors learned to mentor “while doing it.” This SOARS 2004 Mentor Kick-Off Meeting was a 1.5 hour training session for new and returning research, writing, and community mentors. The first part included a welcome and introduction, overview of the program calendar, presentation of the program goals, philosophies and outcomes, and summary of mentor responsibilities. The second part of the training entailed break-out sessions for the three mentor groups (research, writing, and community mentors) in which participants discussed practical strategies for effective mentoring.

Of the mentors who attended the training, most reported that they valued it—although a few felt the training was suitable for new, but not necessarily, experienced mentors. Some mentors, especially community mentors, mentioned their appreciation of clearly detailed SOARS’ expectations during the introduction presentation:

There is, I guess you call it a training meeting at the very beginning of each year, where Tom talks about what he expects of mentors and what he expects of the protégés too and when we should intervene, how we should intervene if intervention is necessary.

Many mentors spoke positively about the break-out sessions where experienced mentors shared their insights and wisdom about mentoring with newer mentors:

I thought that the meeting went really well. I came out of it with a much better feeling as to what would be involved and what to expect than I had going into it. So I thought the meeting was really helpful—just relating to experiences of past mentors who went through the program, talking about what the students would be doing, and talking about what past experiences with students had been.

The useful advice research mentors gained from the training included: ideas on what to expect regarding protégé skills and how to estimate what the protégé can accomplish in the short summer timeframe; the importance of designing the research project so progress can be made within two weeks and the project can be completed in six to seven weeks; the need to include milestones and ensure that the protégé is staying on track with the research rather than allowing too much free rein; the importance of not expecting to gain work from the protégé; and the importance of clearing up potential misunderstandings right away. Research mentors highly valued advice that helped them better select research projects and appropriately mentor their protégés:

Questions were asked: How you decide what project, or how do you know if you’re pushing your student too hard—all of these questions came up and past mentors gave a lot of their advice, and some of the new people also had good ideas on how you might

want to approach that because we realize that it's sensitive with the student to not make them feel overwhelmed or to feel like they're not smart enough to do any of the work so we tried to approach it from a point of view to find where their technical comfort level was and trying to work with that. And so I think we had an idea of what would be a good project before [our protégé] arrived.

In addition, a couple of mentors mentioned that the training was a good way to become emotionally and mentally prepared for the SOARS summer, while another said that it validated her mentoring practices while offering additional tips. One experienced mentor reported gaining little overall, although he enjoyed socializing with UCAR colleagues at the training.

The majority of attendees in the Mentor Kick-Off Meetings were reported to be writing mentors, which indicates an underrepresentation of research mentors relative to their population in the SOARS program. About half of the participants were new mentors. Of the mentors who did not attend the training, writing mentors most often reported missing the mentor orientation because of schedule conflicts, while research mentors generally offered no explanation as to why they missed the training. A few mentors expressed regret about missing the training. Only two said that the training, in general, was unnecessary. A Steering Committee member discussed with us the inherent tension faced by the SOARS program, of wanting all mentors to attend training sessions, yet not wanting to overburden them with time commitments when they already volunteer so much of their time. This is a common problem organizations of all types face as they wish to include volunteers in activities, while taking care not to impose too much on the good will of their volunteers.

Some mentors felt the formal training was sufficient because other SOARS mentors and the SOARS director and staff served as a support network that mentors could turn to for advice during the summer. Others remarked that the formal mentor training only partially prepared them for their summer mentoring experiences: one, because the training did not address the needs of experienced mentors as much as first-time mentors, and two, because of the individualized nature of mentoring a unique human being. These instances required those mentors to rely upon their own innate mentoring abilities and to learn by trial and error.

The Writing Mentor Orientation

In addition to the Mentor Kick-Off Meeting, SOARS offered a Writing Mentor Orientation in which the Protégé Communication Coordinator (also referred to as the "writing facilitator") informed mentors of the assignments protégés were required to complete, discussed the Mayfield Handbook reference used in the Writing Workshops, how to review protégé papers, and writing tips. Accompanying handouts were also given. During the training, which lasted a couple of hours, the writing facilitator encouraged writing mentors to focus their critique of protégés' writing assignments on a few key points, rather than pointing out every little error that the protégés make, which she believes can be intimidating to receive. In addition, writing mentors were coached not to correct the errors in protégés' papers, but rather to guide the protégés to a solution, such as referring them to the Mayfield handbook or giving a grammar lesson and letting the protégés find and correct the rest of the mistakes. Her philosophy holds that it is more important for protégés to become better writers than to have perfect papers.

Other Sources for Gaining Mentoring Skills

In addition to the formal SOARS training, mentors drew upon their experiences of being formally mentored by advisors or supervisors as university students and UCAR employees, or being informally mentored by peers and senior colleagues. Others gained mentoring skills from having taught classes as graduate students or as faculty members. Some developed useful strategies from having been a parent, grandparent, or older sibling. People who had worked in a managerial role found their skills in coaching employees to be valuable in mentoring protégés. Mentors who belonged to UCAR's Leadership Academy leveraged skills they had learned there to mentor protégés. A few interviewees mentioned learning about mentoring from a presentation on mentoring by Dr. Windham.

On-going Support for UCAR Mentors

Mentors frequently mentioned that Dr. Windham was a valued source of support. Mentors generally felt comfortable discussing issues with him and valued his advice:

They're very open to if you need any help. Tom's always made it clear to me if there's any questions you have or any problems just come ask... I think they're doing a good job with that.

Mentors sought Dr. Windham for help with a range of issues, from advice about mentoring a slacking protégé to such practical things as acquiring a computer for a protégé. The mentors appreciated that Dr. Windham would meet with them on an individual basis, about a third of the way through the summer, to discuss how the mentoring was going:

The last time I saw Tom was maybe a week or two ago and it was just happenstance. But it was an immediate giving feedback to each other, which is a wonderful thing to get for both of us. I don't feel like I need to have a formal interaction with Tom and I feel that the mentors are quite capable of doing their job. And yet he does check up on the situations and I think he does that more for the protégés and if he senses anything's awry he'll probably contact the mentors and talk with them.

One mentor, who valued the casual conversation during the "Management By Walking Around" visits, noted that she was more likely to mention challenges she was experiencing, things she would not have otherwise contacted Dr. Windham about. One other mentor liked emails from Dr. Windham updating him about formal and informal protégé activities during the summer, such as their camping trips or travels to sites of interest such as the Florescent Fossil Beds.

Writing mentors, in particular, reported supports of the following kinds:

- Many found the weekly writing workshop emails useful, particularly to learn what protégés were learning and what they were expected to accomplish in a given time period (although some felt the emails were too long):

Pat's good about sending what the week's communications assignments are - that's a big help too. So you can kind of say, "How's that...introduction coming?" ... because Pat's putting out volumes of reports of, "Ok, this week we're doing all

this stuff, and we covered all this stuff.” ...And I try to look at the stuff she’s pointing them to, if possible.

- Several valued the writing mentor brown bag lunches where mentoring challenges and advice were discussed:

I think the biggest thing that has helped me is we have a working lunch where all the writing mentors sit down and talk about how your summer is going, and the problems that you’ve encountered and what works for you. What I heard over and over and over from people was that they had the most success when they set up regular meetings and made sure that they interacted. When I started I had let the student take the lead, saying: “I’m here for you if you need help, come to me.” And they wouldn’t come to me very much.

- Some valued the Mayfield Handbook as a good reference on scientific writing (some for use in mentoring their protégé, and others specifically for their own use)
- A few who attended the writing workshops believed that it helped them to be more effective mentors and others said that they wished they had time to attend the workshops for the same reason.

Some mentors, primarily research mentors, also benefited from conversations with other SOARS mentors. They valued discussions on how to mentor, handle specific issues, overcome computer programming issues, and design a good research project. In addition, some reported that the team of two to three mentors (writing mentors, and in some cases community mentors) were a valuable source of support. A few research mentors appreciated that the writing workshop lightened their mentoring work load by teaching writing to their protégés.

In addition, individual mentors found other sources of support, including: the SOARS Welcome Reception which was helpful to them as they began building relationships with their protégés; the structure of the program which held protégés accountable to deadlines and fostered protégés’ responsibility for getting work done; and the understanding and support of the SOARS staff and Steering Committee members when dealing with problematic mentoring relationships.

UCAR Support for Mentors

The degree of support for mentors varied, from managers who actively encouraged their employees to become mentors to bosses who supported the mentors’ involvement as long as it did not interfere with the mentors’ regular work responsibilities. On the whole, SOARS mentors experienced an overwhelming degree of understanding and acceptance from their superiors and peers for their involvement in the program:

Some of my senior mentors have recommended that I do it, or after I thought about doing it, I said, “What do you think about doing this?” and they said, “That’s a good idea,” so they have always encouraged me...I think probably they think it’s a good idea, too, because it’s a worthwhile cause and it’s part of the expectation of scientists at NCAR to put effort into outreach and so I think it’s part of our job description to do these things.

Several of the mentors' bosses and peers themselves had also been SOARS mentors. Some colleagues, who were not themselves interested in mentoring, were thought to appreciate those who did mentor, because these mentors reduced the pressure on others to become mentors.

Mentors also recognized and appreciated the importance of support for SOARS from the highest managerial levels at UCAR. Other structural benefits include a "critical mass" of scientists to provide adequate support for SOARS without posing too much of a burden on individual mentors who volunteer.

Only 12% of mentors experienced negative reactions from their bosses or colleagues. Some mentors reported that their bosses and/or colleagues regarded mentoring as a distraction from the mentors' "real" jobs. One mentor was labeled a "slacker" for spending time mentoring his protégé. Another boss was reported to view SOARS as a minor program on which it is unimportant to spend precious time.

UCAR Mentor Hopes for Protégés

We asked the mentors to describe for us what they hoped that the protégés would gain from SOARS. They primarily discussed specific abilities they wanted to see protégés gain:

- Analytical Skills
 - Problem-solving
 - Analysis of scientific data
 - Scientific method
- Technical Skills
 - Use of tools, such as laboratory instruments
 - Computing skills
- Writing
 - Writing for a specific audience
 - Writing in a compelling way
 - Fundamentals of scientific writing
 - Writing skills generally
- Other communication skills
 - Oral presentation skills
 - Communicating effectively versus communicating to impress
 - Broad skills in communication
- Life Skills
 - Living independently
 - Time management skills

Mentors also hoped that protégés would develop insight into their career ambitions, and particularly that many would aspire to research in atmospheric science. The continuum of career ambitions mentors endorsed ranged from high to low:

- Research in atmospheric science
- Research in science generally
- Work in science generally

- Insight into the real life of a scientist
- Insight into research as a career choice
- Insight into whatever choice makes the protégé happy

Mentors also wanted protégés to gain confidence. They mentioned several specific sorts of confidence:

- Confidence with the tools used in science
- Confidence in scientific writing
- Confidence working in a diverse environment
- Confidence with analytical thinking
- Confidence to do well in graduate school
- Confidence that carries over into other situations (i.e., careers)

Other characteristics of good researchers that mentors hoped their protégés would gain included:

- Tenacity to solve complex scientific issues
- Ability to conduct one's own research
- Insight into one's own limitations and willingness to seek advice on science projects
- Intuitive understanding of atmospheric science
- Ability to seek out one's own mentors
- Ability to effectively learn independently
- Ability to develop a value for doing one's best possible work

Mentors hoped that protégés would gain advantages from their SOARS experiences: succeeding in their research projects, feeling a good sense of accomplishment and developing greater interest in science, going on to graduate school, getting better grades in graduate school than they would have otherwise, and generally furthering their careers. Some, more specific, hopes were that protégés would gain good science vocabularies, produce either publications, something useful on the web, or a good software program. Some of the writing mentors expressed their hopes that the protégés would come to value and to enjoy writing and speaking articulately.

In addition, mentors hoped that, at the end of the summer, protégés left with good feelings about:

- Their accomplishments in SOARS, having met a significant challenge
- Learning something useful for their careers
- Having had a positive experience generally
- Having enjoyed the summer and time with fellow protégés
- Learning a lot, generally
- Positive feelings about themselves, generally

Mentors expressed hope that their mentoring efforts were successful and of value to the protégés, that they had built good rapport with the protégés, established relationships based on trust with the protégés, and that they had been good, positive role models who encouraged protégés to pursue similar careers. In particular, mentors talked about their hopes that the protégés would feel empowered and be encouraged to pursue science careers in what is currently an overly

white, under-diversified, discipline. They hoped that the protégés had come to see science as being receptive to increasing diversity:

I think what they'll recognize, hopefully, is that it's not as intimidating an environment as it might be. There are people who are interested in talking to young people, independent of their background, independent of their race or minority status so I think that's something that they might be impacted. But that racial impact will be a positive experience for them in the sense that they'll recognize that, even though it might be intimidating, it's not a hostile environment necessarily.

While mentors hoped that protégés would feel welcome in the atmospheric sciences and related disciplines, the mentors themselves were uncomfortable with the subject of race, as is discussed later in this report.

Peer Mentor and Leadership training

Dr. Windham brought in a consultant who specializes in facilitating learning communities. Guiding the philosophy of the Peer Mentor and Leadership training is the idea that each new protégé cohort brings unique needs, which are best met by an intentionally flexible training design. Peer mentors are empowered in the SOARS program to help define, design, and refine the Peer Mentor and Leadership Training. Returning protégés arrive in Boulder a week before the first-year protégés and spend two days in a training session learning to be peer mentors.

The protégés were presented with the goal of the peer mentor role and the leadership training as a loosely-structured vehicle in which to develop the peer mentor role and discover what they needed to know in order to be effective peer mentors. Initial discussions about the new peer mentor role included debate among the protégés about the extent of the peer mentor responsibilities: should it be a nine-to-five responsibility or a twenty-four hour a day responsibility? They also determined what sorts of skills they would need to be good leaders and tried to anticipate the needs of the first-year protégés. Each subsequent year this process of reflection has been repeated, as protégés again address the role of peer mentors, the needs of the incoming protégés, and how to prepare peer mentors. Protégés who have been peer mentors in previous summers exchange ideas about what has and has not worked well for them. In this way they not only promote the development of the peer mentoring role over time, they also “own” the process of leadership training, leading themselves. As one peer mentor explained:

It's a really good way for us to practice being leaders...you can take chances out here and not get punished for it, as opposed to when you do it in the real world. And here you can try different things, like you just try it and see which one works and then you take that with you, as opposed to making those same mistakes outside. And this is a very, very sheltered community and everybody out here is here to help you.

Through the Peer Mentoring and Leadership Training, the event facilitator and SOARS director were able to express SOARS cultural norms and philosophical frameworks to the protégés. In addition, they empowered protégés to enhance their leadership and professional skills, by owning the definition of the peer mentoring role as well as some of the training seminar content, as is seen through an observation of the training event:

On the morning of the first day of the 2003 Peer Mentoring and Leadership Training, an air of familiarity and comfortableness was observed among the protégés as they ate breakfast and waited fairly quietly for Tom to arrive. One of the seminar's first activities was for protégés to introduce one another, which became an emotionally laden bonding activity, with protégés sharing personal stories of their friendships during the summer before and expressing how much they appreciated one another. Next, Tom, in a heartfelt, optimistic, and alternately serious and playful tone, shared his philosophies about scientists, mentoring, and learning:

- Capable scientists conduct research, write, teach, invent knowledge, publish, and discover. SOARS' goal is to give protégés as many of these opportunities as possible and for protégés to add your own contribution or discover your own findings, rather than being research assistants following a given path.
- “Mentoring is coaching, teaching, cheerleading in the context of a trusting relationship.” Your voices have more weight as peer mentors than older generation mentors' voices have. The ideal mentoring situation, when it's really working, is where both the mentor and mentee participate in and learn from the relationship—the “*domain* of expertise is all that varies.” [emphasis added]
- In a traditional university environment, you have to demonstrate mastery. SOARS inverts that. It's *because* of your curiosity, desire, and drive that it's ok not to have the answer—it's okay, and encouraged, to seek help to learn.

Protégés led several of the team-building activities and discussion topics that they had chosen for the 2003 Peer Mentoring and Leadership Training seminar. As they took turns, standing in front of their peers and the SOARS director and training facilitator, the protégés spoke with confidence and ease, in a collaborative and collegial style. In breakout sessions and then as a whole, protégés shared stories of their peer mentoring experiences and brainstormed the benefits of being a peer mentor and peer mentee, the conflicts that may arise in the peer mentoring relationship, and the differences in the peer mentoring role at the protégé apartments versus at work. Practical matters that required protégé input were also discussed in the seminar, including ideas for the protégé-designed computer programming workshop, proposed changes to the Writing Workshop assignments and structure and potential topics for the two-hour Protégé Seminars that protégés lead after each week's Writing Workshop. Next, returning protégés discussed and selected which new protégés for whom they would be peer mentors. The first day of the Peer Mentor and Leadership Training concluded with a protégé-led closing inspirational speech, to which another protégé commented, “This is definitely a home away from home.”

Along with conventionally-understood notions of leadership, such as how to handle mentees' needs for orientation to their new environment and the SOARS program, training in group-dynamics was also included. The original SOARS director emphasized skills, such as active listening, decision-making processes, and good communication skills, generally. Dr. Windham

and the leadership training facilitator introduced various ideas, resources and strategies in the training sessions, such as the following:

- A story-telling approach to discuss aspects of leadership, intended to aid protégés as they navigate academe
- Discussion of collaborative versus competitive science environments, to help protégés better understand various situations and how they function
- A “Leadership Practices Inventory Test” to help protégés gauge their leadership skills
- The book, “Everything I Needed to Know I Learned in Kindergarten” to promote citizenship values

Protégé perspectives on peer mentor and leadership training

The content of the Peer Mentor and Leadership training was not always what protégés expected, contributing to mixed reviews. It appears that some protégés did not recognize these lessons as “leadership” training, and so rated their training in “leadership” as weak. Several suggested that, while the leadership retreats were fun and offered a great opportunity for social bonding and status-leveling among protégés, they did not recognize it as effective in training the peer mentors to be leaders. Suggestions peer mentors offered for improving the leadership training included:

- More “hands-on” training, such as role playing
- Information about adjusting peer mentor and mentee matches
- Information about sexual harassment issues

The extent to which mixed opinion of the leadership training was a product of misunderstanding skills that facilitate leadership is not entirely clear. Ensuring that recipients of training sessions are fully aware of the connection between the goals of the training and the methods used to attain these goals will boost the helpfulness of recipients’ feedback.

At the same time, other aspects of the peer mentor leadership training were more clearly appreciated. Peer mentors found it valuable to have time set aside for discussion of and reflection on the peer mentoring role, and reported benefiting from having a clearly-defined peer mentor role. In particular, they appreciated guidance about the limits of the peer mentor’s responsibilities, such as when to refer a mentee to a SOARS staff member or a research, writing, or community mentor. Peer mentors also found recommended supplemental resources such as texts and books useful.

Over time, protégés have begun to ask for increasingly practical instruction in peer mentoring, indicating to the leadership training facilitator that they have progressed from an earlier point of defining, and sometimes even challenging the peer mentor role itself, to embracing the role and refining it.

As discussed elsewhere in this report, there is an unsettled question among SOARS participants about the discussion of race issues. The underlying question is whether or not to raise and discuss the challenges protégés of color are likely to face in their pursuits of science careers. On the one hand, protégés have expressed their appreciation of having a summer in which they are immersed in science research in a supportive, diverse and environment where race and gender

are not immediately relevant to their experiences as scientists. Such an experience is rare for them, and it is both reassuring and inspiring. On the other hand, SOARS offers an opportunity for a dialogue in which strategies to overcome race barriers can be developed and shared. Both viewpoints have supporters. Any discussion about this issue would be important to broach in the same thoughtful, supportive way that other emotionally-charged issues are handled in SOARS—with considerable, intentional sensitivity. The leadership training sessions have offered a forum for exploring these options. Each year the leadership training facilitator asks protégés if they want to discuss cultural and race issues in science. Each year the protégés consider the question and have responded in different ways, with most leaning against discussing race issues, although a few would like to have such a discussion. As one staff person has observed, it may be that the protégés are not yet prepared to critique the culture of science and the careers they are just now learning about in depth. So far, protégés have mostly chosen not to grapple with race issues during the SOARS summer and any issues individuals do want to discuss are handled on an individual basis.

On-going leadership training

Another form of leadership training, which occurs throughout the SOARS summer, is protégé ownership of the weekly, two-hour Protégé Seminars. Protégés are empowered to design and run the seminars, by developing and giving presentations or organizing guest presenters. These seminars include such topics as applying to graduate school, succeeding in graduate school, giving a poster presentation, and exploring careers in policy. In an observation of the 2003 seminar on applying to graduate school, protégé leadership skills are evident:

The three protégé presenters, who were graduate students, passed out a folder of graduate school resources, then shared their personal stories of searching for and selecting a good graduate school. Next, they shared tips on obtaining references from SOARS research mentors, taking the Graduate Record Exam, submitting an application, and applying for funding. The presenters also gave advice on working with professors and shared stories about their first year in graduate school. Dr. Windham, who was always present at the Protégé Seminars, informed the protégés that SOARS has money to help graduate students if they have exhausted all other funding options. The protégés attending the seminar were observed to be attentive and engaged throughout most of the presentation and discussion, clearly eager to absorb the information.

Not only do the presenters benefit from preparing and giving presentations like this, but so do the newer protégés who are seeking to follow in their mentors' footsteps.

Peer mentors met periodically over the course of the summer with the SOARS director, both formally (once) and informally, reporting in on their experiences and their impressions of their mentees' needs. In this way the peer mentoring training was ongoing, and the mentees' needs were routinely assessed:

The peer mentors arrived, I think a week or so earlier than the rest of the students, and it was pretty much during that week or so time we met all day, and we had an outline of things to look for. And we had a whole packet of things that we just went through, and one of the key things that we talked over was the fact that, "If you can't handle it, don't

handle it. You're there to be an ear." But also we had a list of numbers, "Okay, this is the hierarchy—call this person/that person," for example, with various situations. So we had a week or so of training and bonding between groups. So we had our meetings separately during the week with Tom Windham also, to see how the students are doing, if further action needs to be taken in any given instance and that, so...So after the [first-year] protégés arrived we would periodically meet with Tom Windham. We had our training at the beginning where we were kind of, pretty much always together, and then when the protégés arrived, we were working with various students, and we would meet, periodically as a group, to see how things are going.

Practical methods for fulfilling the peer mentor role were left to the discretion of the individual peer mentors, but they largely followed what they perceived to be the good examples of more experienced peer mentors. In addition, peer mentors drew on their own experiences as first-year protégés with their own peer mentors, and their observations of others' experiences.

X. CRITICAL PROGRAM ELEMENTS AND HOW THEY ARE STRUCTURED

The SOARS program is built upon the concept of a learning community where protégés are immersed in a challenging but supportive program and guided by multiple mentors, including the protégés themselves. Protégés conduct authentic research projects facilitated by their research mentors, write and present a scientific paper guided by their writing mentors, transition into the UCAR and Boulder environments supported by their community mentors and peer mentors; and face the challenges of the program with the support of the protégé and SOARS community.

The Research Project

The research component of the SOARS program entails protégés conducting research projects under the direction of research mentors. The primary goal of the research experience is for protégés to learn how to conduct research, including understanding the scientific method, tools (such as computer skills), data analysis, and how to communicate findings. A few mentors commented that striving to produce a publishable paper is not a primary goal of the summer research experience, although it would be great if it happened.

The most common type of research for protégés was a scaled down, but real-world atmospheric science data analysis or modeling project, which required knowledge of computer programming. A few other projects were more applied, such as designing and developing an instrument or software tool, and a few involved field research. Projects involving field research were considered especially valuable experiences by the SOARS directors, Steering Committee members, and protégés. Occasionally, a science mentor offered an exploratory project to the protégé, which could be a very good experience for protégés according to one mentor, or overwhelm the protégé if their scientific abilities are insufficient, according to another mentor. Only one project was a literature review, which was viewed as inappropriate by the protégé and another mentor of the mentoring triad.

Research project designs varied considerably from one research mentor to another. Some research mentors preferred to find relatively simple projects that protégés could do entirely on their own, performing all stages of the project and gaining an understanding of the overall research process along the way. For example, in one case, a research mentor designed a research project to be sufficiently narrow in scope so that it was manageable for the protégé, yet also promoted a broader understanding about the science related to the project. Other research mentors preferred to find projects in which protégés performed more challenging research on a limited part of a broader research project to gain more specific scientific insights and experiences. In one case, the scientist designed a research project so that the protégé would gain specific skills that would be directly applicable to the protégé's anticipated graduate school research.

Several mentors and UCAR managers discussed challenges with designing the ideal, authentic research project that fit the protégé's skills and interests, where the protégé was able to ultimately discover the correct path out of several possibilities, and ultimately arrive at a

meaningful result within the short 10-week timeframe. Mentors identified five key criteria important to designing a good research project:

- Authenticity
- Scope
- Outcome sought
- Level of difficulty
- Flexibility

Each of these criteria is examined next.

Authenticity

Research mentors strongly agreed that research projects should be original, open-ended research that is intrinsically interesting, meaningful, and contributes to the field of study. This, scientists said, would motivate protégés to pursue a career in science and would give protégés a real sense of accomplishment:

None of the stuff they're working on—this is not “make work” science, this is scientific investigation. This is like, “We don't have the answers.” One student was having a hard time a few years ago cause he knew he couldn't get the right answer and why wasn't his research mentor telling him what the answer was and I said, “That's not what the science is!” And so they're doing original research and that's very exciting.

Scope

Research mentors strongly agreed that the research project should be carefully thought out and scaled to fit the protégé's skills and knowledge and the 10 week constraint of the SOARS summer program, including protégé time spent on non-research activities, such as the writing component. Thinking the project through ahead of time and having a good idea of the process and outcome are important since there is no leeway if the project goes down a blind alley or otherwise goes awry:

I really want them to work on something that's a research project. Something that hasn't been done before and yet you have the constraints of only a couple months to see what you can get. You may come out with no result, but at least *that* is a result. And it can be done in the time-scale.

Outcome Sought

Most scientists felt that it was important for the protégé to have a successful research outcome with meaningful results that he could be proud of having accomplished:

It has to be something that the student can quickly master, and get some interesting results from in a very short time...And so a lot of careful thought has to be put into a summer project to set it up so it's small enough that something could be done, *simple* enough that the student can spin up quickly enough to get results, but still is scientifically interesting.

In contrast, other research mentors felt that a successful outcome was great, but not necessary, because, as Dr. Windham reminded the research mentors, real research does not always produce results. Protégés can still learn from projects that result in dead-ends or unexpected results. However, learning is considered more limited when projects are compromised by problems in data collection or analysis. Even if protégés do not have an ideal research experience in a given year, they can return in future summers for new experiences. In addition, protégés have other valuable experiences with their other mentors, via the program communication component, and as part of the community of protégés, that can offset frustrating research project outcomes.

Level of Difficulty

Research mentors strongly agreed that a balance must be reached between projects being so difficult that the protégé becomes overwhelmed and struggles excessively and it being so simple that the protégé becomes bored and learns too little. The ideal research project fits the protégé's skill level, yet challenges the protégé to go beyond her comfort zone, albeit not so far as to demotivate the protégé or lead to feelings of inadequacy. To achieve this balance, mentors had to learn more about the protégé's abilities:

I try and find out what they're capable of doing, what level they are working at, and then just tried to find something that looked like it was of appropriate scale, and appropriate ability for the protégé, partially based on their resume, and then partially based on interviews that I conducted via email before they arrived, and then also after the student arrived.

Research mentors reported their most common challenge to be overestimating what protégés could handle. As a result, one research mentor advised choosing a project based upon the notion that one day of the mentor's effort is equivalent to two weeks of a very experienced and knowledgeable protégé's work.

Flexibility

Many mentors discussed the importance of projects that are iterative in nature, because they offer a range of goals and can be scaled to fit the protégé's abilities and the program's time constraints, ensuring the protégé can accomplish at least one of the goals, if not more. One mentor recommended designing the project to have four or five goals, but informing the protégé of one goal at a time. As the summer progresses, the protégé and mentor could assess the level of project difficulty and choose what the ultimate goal should be. Another advantage of project flexibility was that the mentor could offer goals that aligned with the protégé's skills and interests:

You have got to think about something that's expandable, that you could add onto if you see that they're going to get it down. You want to keep challenging them. If you have somebody who needs to learn lots of background material, it's going to take them a lot longer, and you want them to feel like they've accomplished something. So you want to start out with a project and define it so that you're almost guaranteed that any protégé, even if they're green and brand new coming in, can accomplish it. Something that you can expand, and it may be starting with a small data set and if they accomplish that then you can give them a larger data set to work with or complimentary data sets or another

analysis on the same data set. You know, think about a project that maybe would have four or five steps, but only talk about the first step, when you initially assign it. Don't overwhelm them, and say we're going to do all five steps... I think the point is that you have to adapt. You have to constantly evaluate where they are in the project. And try to keep re-scoping.

Many mentors felt that it is important that research projects be well thought out, because protégés, as novice scientists, need the structure. These mentors believed that the research mentor needs to have carefully planned out the goals, process, and timetable required to obtain results. However, the procedures should still include flexibility in which the protégé would make decisions and have sufficient time to manage difficulties that arise. By having a good idea of the expected results, the mentors could coach their protégés away from blind alleys and also validate the findings. For data modeling projects, mentors performed most of the mundane work ahead of time so protégés could focus their limited time on the essence of the project—all the protégés have to do is tweak variables, rather than produce the computer program, and then analyze their outcomes based on the models used.

In addition to designing and preparing the research projects, several mentors believed that protégés benefited from reading articles related to the research, either prior to the start of their summer SOARS or when they first arrived for the summer. Similarly, with projects involving instruments, a few mentors began the research project with an introduction to the instrument, complete with background reading material.

Defining and preparing the research project

Scientists' initial ideas for potential research projects are generated long before protégés are matched with research mentors. At the time when scientists formally state their desire to volunteer as research mentors, they include a broadly conceptualized idea or two for possible research projects. Once the research mentors are matched with protégés, the scientists refine their research project ideas into workable projects.

The vast majority of research mentors sought the input of their protégés (in some cases before the SOARS summer began) when designing the research projects so that the projects would fit with the protégés' experience, skills, interests, and career goals:

Well [protégé name], he's a pretty advanced SOARS protégé in the sense that this was his third year in the SOARS program. He had finished his undergraduate in January of this past year and was going on to graduate school so he had some specific interests, areas that he was specifically interested in doing research in. So whilst I couldn't completely tailor the research activity to exactly fit what kinds of things he was interested in, I could suggest a few topics that would help him in the future in terms of advancing his graduate career and doing the kinds of things that he was interested in doing. So that's how we negotiated areas for him to settle on. In fact, even up 'til his arrival in the first week, we still had two topics that we were going back and forth as to which one might be the most appropriate for him.

In some cases mentors offered their protégés a choice of research projects, letting the protégés choose the ones that most interested them:

I narrowed it down to three or four potential topic areas, and then discussed those with the student and went over the various pros and cons of the various projects. And more or less let the student pick from those three or four projects, with a little bit of guidance from myself as to what might be most appropriate, given what I knew about them and their abilities.

Mentors felt that getting to know their protégés by discussing their interests, skills and career goals was useful when trying to tailor a good research project—as one mentor noted, such discussion was more valuable than reading a resume or vitae would have been. Another mentor cautioned, however, that protégés lack the ability and knowledge to actually design a research project, so that responsibility must lie with the research mentor. Only a couple of mentors simply assigned research projects to protégés, and those projects involved essential work that the research mentors needed to get done.

Some science mentors agree with the SOARS program philosophy that research mentors exist to support the protégés, and not vice versa:

[The protégés] really are quite bright and they're quite good. SOARS can be picky. You can say, "We want the best." So I think for the mentors it's a no-lose situation. If you go into it, I hate to say, "with the right attitude," but we, as mentors, can be very using of people, and, if you approach it more of, "I really want to be a mentor, and I really want to make a difference in someone's life," then you get the best students, you get support, you get everything else, it's the best of all possible worlds here.

Protégés, in these mentors' eyes, should not be free labor for scientists. However, if useful results are unintentionally gained out of the research project, then that is an added benefit. In contrast, some other research mentors felt that it is important to select research projects that will enhance their own research productivity, either by directly contributing to their research agendas or through finally getting the opportunity to do valuable "back burner" projects. That is not to say, however, that these mentors were inappropriately "using" protégés (although occasionally instances of such behavior were reported):

The projects were based on current research that I'm doing so it wasn't something that was thought up just for them. It was something that I needed to get done but the idea was to isolate a small chunk of my current research that was manageable for them.

It was more I had a project and I was looking for somebody to work on it than the other way around. ...There's more interesting stuff to do in this project than you would ever have time or money to do and so I was always looking for somebody who could help out and the level of scientific rigor is not as high as a lot of the projects I'm doing. So it's a project that's really in line for that kind of undergraduate level.

These scientists indicate through these statements, as well as throughout their interviews, that they found a happy medium, with projects that met both their own and protégé's needs for professional growth in the mentoring relationship. The risk, however, of relying upon protégés to perform essential work, as one scientist found out, was that inadequate performance by protégés must be compensated for by the research mentor or colleagues.

About a third of the research mentors reported being very pleased or highly impressed with their protégé's accomplishments on the research project, including, for one scientist, learning computer programming in such a short timeframe. A few scientists expressed feeling very disappointed with the outcome of their protégé's work. They perceived their protégés to have a lack of research comprehension, a lack of growth in scientific or writing abilities, or a lack of motivation.

Research Mentoring

Research mentors had varied professional roles. About half were tenure-track scientists, 18% were post-doctoral scientists, 15% were non-tenure track scientists, and 12% were engineers or computer scientists. According to the SOARS mentor training, the formal responsibilities of research mentors are as follows:

- To help protégés focus on the research topic and process
- To oversee the research project
- To provide direct science instruction when necessary
- To teach scientific processes and methods
- To guide protégés' research practices
- To assist protégés in entering the scientific community

Research mentor time commitments

Prior to the protégés' arrival each summer, research mentors invest a week or two of time upfront, designing and preparing the research project. During the summer, most scientists spent between five and eight hours per week mentoring their protégés, although those who split their everyday mentoring responsibilities with another mentor or who delegated significant parts of it to informal mentors spent closer to two hours per week. At the high end of the spectrum, four mentors spent 10-20 hours a week mentoring their protégés. The amount of time mentoring per week varied, with more time in the first few weeks helping their protégés get started on the research project and again at the end of the summer helping the protégé finish the project by the deadline.

Mentoring strategies: Encouraging collegiality and a culture of inquiry

While scientists used a variety of mentoring strategies, common themes arose from their accounts about how they mentored their protégés:

- Frequent interaction
- Collegiality
- Encouragement of asking questions
- Building confidence
- Development of a deep understanding of research

- Achieving a balance between support and independence
- Provision of career advice and professional development.

Frequent interaction

Many of the research mentors initiated near-daily interaction with their protégés, especially early in the summer. They contacted their protégés either in person or via e-mail to assess how they were doing and whether progress was being made:

Frequent, frequent interactions. Give them something to do that was fairly well scoped and focused, and then point them at the resources and references, and then try and meet with them at least on a daily basis, to see how they were doing, whether they were making progress, whether they were completely blown away. I think that was probably key.

Research mentors felt that frequent interaction was useful in keeping their protégés focused on the right path, gauging their protégé's level of understanding, and assessing the appropriate level of support for their protégés. Research mentors also discussed the importance of making themselves available to their protégés on an as-needed basis. A few mentors made an extra effort to be approachable as part of their strategy to encourage protégés to ask questions. One scientist set up daily, early morning meetings with her protégés to give him guidance for the day, which reduced the disruptions to the scientist's own work later in the day. Once the protégés became confident in their ability to work more independently, mentors reduced the frequency with which they checked in with their protégés.

Collegiality

About half of the research mentors reported trying to build personal connections with their protégés, such as by leveraging their shared experience of being, or having been, students to connect with protégés, welcoming protégés into the mentors' personal and professional lives, minimizing the hierarchical difference between them, going to lunch together, wandering by to chat, and showing that they care. One scientists' advice on how to achieve rapport was as follows:

[In] the very initial weeks, establish a rapport. Go to lunch. Go to coffee. Do a few things so that they get to know a little about you and you know a little bit about them, in a non-work, non-pressure kind of setting. I'm able to share the student background and say, "I've got a different background than you have, but I came up as a student too and so, if you have questions about just being a student, feel free. To try and create a, 'I'm not section head' or, in some cases, 'Doctor so and so'" (Laughs).

Some mentors reported intentionally treating their protégés as regular members of the work team and having them attend group meetings. These mentors were pleased to report that their colleagues also welcomed the protégés into the workgroup and sought to make the protégés feel comfortable. According to one mentor, building a personal relationship is a good way to foster protégés' interests in and understanding of science as a profession. And, as discussed earlier, some protégés agreed.

Encouragement of asking questions

Half of the mentors discussed the importance of creating a relationship in which protégés felt comfortable asking questions about the research project. Unfortunately, many protégés have been socialized to worry about asking questions, or feel intimidated by science professors, and so are reluctant to ask many questions. Yet, asking questions and being inquisitive is an essential part of doing science, as one scientist explains:

[T]he mentors in the SOARS program, it's their job to bring out the natural inquisitiveness of people who are drawn to those areas and expand their horizons, show them what can and what needs to be done. I think that's one of the challenges and one of the things to try to instill in SOARS protégés, that not only is it not a sign of weakness to ask questions, it's actually what you're supposed to be doing. Questions at every level, no matter how silly they might seem, are really the part and parcel of doing scientific research... We become inhibited in asking questions as we age and so particularly, from the perspective of an undergraduate student of an underrepresented group, it's very easy not to ask those questions. So it has to be hammered home that asking questions is what the program is all about.

Learning to ask questions is also critical for the protégés' success on their SOARS research projects. Mentors strive to encourage question-asking by initiating interactions with the protégé, asking the protégé many questions about the research project, and engaging the protégé in scientific discussion.

Research mentors appreciated and looked for inquisitiveness in their protégés, such as protégés' addition of their own research question to the project or exploring beyond the minimum requirements of their research project. Mentors were pleased when protégés initiated asking questions and sought their mentors' help with the research projects or writing assignments. However, mentors noted that some protégés were not uniformly comfortable seeking advice from their formal and informal mentors. Returning protégés demonstrated more of these behaviors, which mentors believed was a result of experienced protégés' increased confidence and experience.

From the initial meetings of first-year protégés with returning protégés, new protégés are strongly and repeatedly encouraged to ask questions of their mentors and of everyone around them at SOARS and at UCAR. It is well-recognized in the SOARS program that hesitance to ask questions is a predictable problem among incoming protégés, and that their peers' encouragement to overcome this reluctance is an important strategy in the socialization of first-year protégés. One mentor recommended increased structure in the SOARS program and mentoring relationships to facilitate these protégés getting help.

A few research mentors expressed disappointment when their protégés showed a lack of scientific curiosity and initiative relative to the research project and career investigation. As one

research mentor explained, how “A-student” protégés were hard workers, but often had little scientific curiosity:

They’re *really* hard working people, but they were *very* disappointing to me because they didn’t ask questions. They just worked like crazy all the time and did a really good job at what they were doing, but they had no feeling for inquiry, no curiosity. That was discouraging to me. And it’s a quality that I associate with lots of straight A students... they just worked like crazy and they did all the things a student should be, but none of the things that a scientist should be.

Building confidence

Roughly two-thirds of the research mentors emphasized the importance of bolstering protégés’ self-confidence. They believed that a positive research experience—where the protégés were challenged and had to work hard, but were not pushed so far as to feel overwhelmed and intimidated—was central to building protégés’ confidence. To facilitate a challenging, yet successful research experience, mentors tried to determine the ability gap between themselves and the protégés so as not to place excessive pressure on the protégés. Some mentors promoted their protégés’ confidence by praising the protégés’ ideas and deliberately avoiding criticism.

Other strategies to encourage self-confidence included assessing protégés’ needs for support and then mentoring accordingly with either baby-steps or larger steps; giving coding examples which protégés could leverage and so feel a sense of accomplishment, as contrasted with giving protégés answers or leaving them feeling overwhelmed and stuck; actively helping the protégés weigh alternative paths to accomplish the goals instead of leaving them to figure things out entirely on their own; and leveraging the protégés’ existing skills. Another strategy used was to normalize challenges that protégés experience explaining that everyone goes through learning stages, in order to bolster confidence. For example, one research mentor described her approach:

I really tried to be conscious of their ego to some degree. I know everyone’s got a different ego level and basically to find out where that was and to not make him feel stupid at all. I wanted to avoid that at all costs because I knew that, being in this situation it’s easy to be intimidated with your surroundings. I’ve been intimidated before. The science field is somewhat intimidating. I mean basically, any field is. You want to be looked at as someone that knows what they’re doing, that’s smart and is a hard worker and is respected. I think we all have an inherent [need] to be respected. It’s a hard time for the students when they come here because they’re still feeling that out.... So I would try to avoid making him feel inadequate technically or anything like that... It’s hard for me to think of specific examples but, like one thing we were talking about software stuff and I said, “Well, you just have to practice. And you should definitely take a course when you go back this semester.” I would try to just give him some answers on how he could improve in an area and just make him feel like it’s normal that everyone goes through these things and you just have to learn it.

Other mentors also believed that being gentle and non-competitive with the protégé would nurture the protégé's interest in science. Yet, occasionally UCAR scientists hold a different philosophy, as one mentor disapprovingly observed:

She gave her final presentation and a scientist [not her mentor] asked her a question. He asked her a question that he knew the answer to. He simply asked her because he thought it was her final Ph.D. defense or something. It was that kind of mode of discourse. It was: "You need to show me that you really have earned the right to stand up there and speak." And she answered it wrong. He, at least, was gracious enough not to say that. But it was an awkward moment. Everybody in the room was embarrassed. She was embarrassed. And, it didn't need to be that way. At the same time it would've been nice if she knew the answer. It was related enough to her research that she probably should've. But, God, I just don't—why he thought—and yet, that's not uncommon. And of course he was an older white male, right? ... And he's already this accepted authority figure, because he's a UCAR scientist, but then he's also a part of the dominant culture of our society and why he felt like he had to do that I don't know, except that I think that he felt like that was his role as a senior scientist was to check and make sure that they were up to snuff. And I really think that if you asked him, he would describe himself as doing a kind of service.

Development of a deep understanding of research

Most research mentors sought to help the protégés foster a deeper understanding of the science behind their research projects. They frequently asked questions and engaged protégés in discussions about the research projects to ascertain gaps in the protégés' understanding, and then gave them more information accordingly. For example, one mentor, whose protégé did not understand some of the basic science underlying the project, realized during the protégé's practice talk that the protégé would have benefited from more discussion early on about the science:

[O]ne or two times per week, sit down like you and me. We'll talk about what we're doing and kind of stress them. Say "What do you understand? What don't you understand?" Poke around until you know what they don't understand, "Here draw me a picture of this on the board." "I can't because I really don't understand." "Okay that's good, now we know where you are. Go read this paper and we'll talk about it tomorrow." So you kind of figure out where they are and if they're at the bottom they just have to do baby-steps and if they're in the middle they take bigger steps.

To help the protégés gain a better understanding of science, a few mentors sought to foster critical thinking skills, such as teaching protégés how to step back and analyze results to see if the actual results make sense or not. Other strategies included outlining the research project plan, using visual aids to explain process-related concepts, having protégés write notes during their discussions with the mentors, explaining the atmospheric science underlying the research project, and putting into context the greater value of the research project and how it would be useful to the broader scientific community.

Achieving a balance between support and independence

Several mentors discussed the challenge of appropriately balancing the level of support versus independence they gave to their protégés. Scientists sought to encourage independence in their protégés, yet not to frustrate them with too little support. They believed that it was important for protégés to have the experience of conducting independent research so that protégés could “try on” the career and assess whether it was something that they liked. On the other hand, insufficient support, mentors believed, could lead to protégés becoming stuck on their research projects, or getting off track and wasting precious time in this fast-paced program. As one research mentor described telling his protégé:

I’m always your resource, just come and ask me. If I can’t tell you the answer, we’ll find the person that can tell you the answer. But it doesn’t do any good to be sitting at your desk by yourself just wallowing in something, you know, that kind of thing. A little wallowing is good, but if you’ve spent an hour on this and you’re still—let’s just brainstorm about it and see where we can go.

However, as one mentor feared, too much interaction and support might negatively affect the protégés’ sense of accomplishment. Some mentors made ongoing assessments of their protégés’ progress, abilities, and need for support throughout the summer, typically through discussion of the protégés’ work and observations of how well the protégés appeared to be doing. One mentor discussed the utility of gauging his protégé’s emotional state to determine when and how much support was needed. Rarely, however, did research mentors discuss the topic of support directly with their protégés.

Mentors used a variety of strategies to foster independence in their protégés, including discussing the scientific questions related to the research projects and letting the protégés discover what to do, rather than telling them specifically what to do; weighing alternatives together and letting the protégés choose the best path; encouraging protégés to problem-solve first and then ask for help if still stuck; giving experienced protégés free reins and then reviewing and critiquing their work; and giving protégés a push and seeing what is accomplished, following up as necessary.

As we discuss later in this report, achieving the ideal balance between support and challenge is among the core challenges that mentors face.

Provision of career advice and professional development

Most research mentors provided mentoring beyond help specific to the research projects. Some mentors advised protégés about the nature of research work, including the understanding that setbacks are a normal part of research, that research often includes obstacles, and that unexpected results are typically due to research process errors. A few mentors reported that their protégés were shocked that the scientists were less than all-knowing, such as when the mentor did not have answers about the research, or had “no clue” when a research project assumption was in error and had to collaborate with others to find out, or when one scientist revised her own writing draft numerous times before it was top quality.

Some mentors gave their protégés academic advice, such as how to select a good graduate school and succeed at the university, along with career advice and encouragement and sharing accounts

of the mentor's personal career experiences and obstacles. One highly respected and renowned UCAR scientist met with the protégés each summer, even when he was not a formal mentor, inviting each of them to come speak with him individually about their career and education plans.

In addition, a few mentors provided a variety of other career advice and professional development strategies to their protégés, including: encouraging their protégés to attend presentations by renowned and local scientists to further stimulate the protégés' interest in science; teaching the protégés about the UCAR division of which the protégé was a member; taking their protégés on science field trips and conducting field work; introducing their protégés to field experiment and data collection instruments related to the research projects; discussing their daily work with their protégés to broaden their protégés' understanding of what the life of a scientist is like; coaching their protégés on professional norms regarding interpersonal interaction and communication within a competitive science culture; speaking with their protégés about how to succeed professionally and personally within the white, male-dominated science world and encouraging female protégés to find female scientist role models and allies.

Informal Research Mentors

In addition to their formal research mentor, protégés often also had informal science mentors. Typically, these were colleagues whom about half of the research mentors had asked to help the protégé when the mentor was unable to, such as when traveling or otherwise out of the office or overly busy. In addition, some senior scientists delegated the majority of day-to-day mentoring of the protégé to more junior colleagues. Some informal mentors became involved because they possessed a unique skill, such as expertise in a particular programming language. Informal mentors of all three types were reported to willingly mentor the protégés, and their contributions greatly appreciated by protégés. As we note elsewhere in this report, the program would benefit from inclusion of the informal mentors, where possible, in the orientations, training, and meetings that are organized for official mentors.

Protégé and Mentor Challenges with Research Projects and Research Mentoring

Protégés discussed the challenges and frustrations inherent in conducting authentic research and cited the following as especially challenging aspects of their research projects:

- Frustrations with computer programs and related technical glitches
- Conceptual challenges of learning a new discipline in 10 weeks
- Learning to reframe thinking to encompass the “big picture”
- Frustration with lost security of “black and white” answers
- Time management and developing a professional work ethic

Research mentors reported a set of challenges they encountered when working with their protégés on the research projects that overlap and echo the challenges protégés reported with

research projects:

- Issues with computer programming
- Miscalculations of protégés' abilities
- Protégé disengagement
- Research project time constraints

We discuss protégés' and mentors' challenges together below.

Protégés: Frustrations with Computer Programs and Related Technical Glitches

Many protégés cited computer programming as their largest challenge and source of frustration while at SOARS. Learning to use new programming languages and work within a new operating environment was difficult for many, and few reported having an extensive computer science background when they first came to SOARS. Becoming acquainted with writing code or a new programming language was both frustrating and time-consuming for many, and for others, painfully tedious.

Mentors: Issues with Computer Programming

Almost all mentors found protégés' computer skills to be lacking, which had negative effects on the research project goals, particularly for new mentors who were forced to scale back research project goals to allow time for protégés to come up to speed on programming. (There were a few exceptions, as when protégés were computer science students or had learned the necessary programming language in a prior SOARS summer.) When protégés had to spend valuable time learning programming languages, research mentors bemoaned the lost opportunities to learn the science, itself.

We use IDL, which is a fairly common, high level data manipulation language. So, rather than having to write, in a low-level programming language, it's a user interface and it's the way to plot data and to analyze data, and that's mostly what the people in our community use. And we did say, first thing, "Do you know IDL?" And, they didn't have any knowledge of IDL. So just getting them started on that was a couple of weeks of figuring out how to read in data and how to plot out data, and how to do some, real rudimentary things. When you only have 10 weeks, and you're spending the first, I don't know, quarter of it learning, just how to plot, it's going to take some time—you're not going to be able to accomplish as much.

According to one Steering Committee member, one of research mentors' top two complaints has been that protégés lack computer skills and that research mentors must spend too much time tutoring their protégés to bring them up to speed. Our interviews confirmed this. In one extreme case, we found that one mentor spent fully half of her mentoring time tutoring her protégé on computer programming.

Adding to this problem, UCAR scientists use a variety of computer languages, so that protégés may face the need to learn a new program each summer they return. An additional problem we found is that UCAR scientists use the FORTRAN programming language, which is much less

frequently taught at universities. At the same time, one mentor pointed out that learning *any* computer language makes picking up a subsequent one much faster and easier.

Individual mentors suggested various strategies to manage the programming challenges:

- Design research projects to require minimal computer programming
- Use a computer language that the protégé already knows
- Enroll in a programming course with the protégé so both mentor and protégé would know the same language
- Design research projects to use tools the mentor knows and that are well documented
- Rely on a computer programming expert to help the protégé with programming difficulties
- Write the computer program for the protégé, enabling the protégé to focus on analysis and scientific content
- Minimize the role of computer programming in research projects

Protégés: Conceptual Challenges Trying to Learn a New Discipline in 10 weeks' time

Several protégés spoke about the difficulties and challenges of learning a new discipline in science. Given the tight schedule of the 10-week SOARS summer, some participants were faced with a steep learning curve in a short time, as they worked to learn the necessary background knowledge.

Mentors: Miscalculations of Protégés' Abilities

The vast majority of scientists reported miscalculating their protégés' abilities. Mentors found it challenging to accurately predict what their protégés would need help with. In fact, this was the biggest challenge mentors reported regarding their mentoring experience. They reported having had excessively high expectations of their protégé's abilities—whether it was with regard to computer skills, background coursework, or a physical or inquisitive (versus rote) grasp of scientific principles. These miscalculations had negative repercussions for the goals and pace of the research project, as one mentor suspected happened with a colleague:

I've had really good protégés; I've seen other people that have had less positive experiences in the SOARS program. So I'm trying to think of what their protégés were and, maybe the protégés weren't as, weren't excited about the project that they had or didn't understand it. I also think that the research mentor in that case might have had unrealistic expectations of what the SOARS student was going to be able to do during the summer. They had a big project lined up for this student and this student was starting at ground zero as far as their understanding of that research. So they, they gave him a really challenging tough project and not a whole lot was accomplished.

Experienced mentors offered advice to future research mentors that they should downsize their expectations about protégés' current abilities and not assume that protégés are similar to advanced graduate students or post-docs coming from leading institutions, which comprise the majority of student interns UCAR scientists see. Instead, experienced mentors advise new mentors to assume that protégés, especially new ones, will need a lot of support from the mentor. Other suggestions experienced mentors offered was that new mentors develop accurate

expectations of their protégés' abilities by speaking with them before the start of the SOARS summer; and that mentors ask the protégés about their interests, confidence levels, personality traits and so forth.

Protégés: Learning to Reframe Thinking to Encompass the Big Picture

Occasionally protégés had difficulty understanding their research projects in terms of a bigger framework, particularly when first beginning the research process. They were frustrated by not fully understanding the point of a research problem or how different research processes related to one another. As mentioned above, gains in scientific thinking were most noticeable for returning protégés, so it was not surprising that first-year protégés were especially challenged to learn to frame research projects in a bigger picture. One protégé took some comfort in the notion that the SOARS director regarded such frustration as a productive part of the learning process. A few protégés reported more general difficulties visualizing and thinking abstractly.

Protégés: Frustration with Lost Security of “Black and White” Answers

Another, less seldom-reported outcome from undergraduate research is students' growth in understanding that science is an open-ended endeavor and that knowledge is constantly emended or refuted (Hunter, et al., 2005). Some SOARS protégés reported disappointment that science does not ensure clear cut black and white answers. They were challenged to accept the grey area of doing research not evident to them within classroom work. Whether or not this disappointment is transformed into an appreciation of the puzzle-solving of science is an important indicator of one's potential happiness as a scientist.

Mentors: Protégé Disengagement

Another challenge mentioned by six research mentors is when protégés appeared to be disengaged from the research project. Protégés who were uninterested in their research projects or showed a lack of initiative and scientific curiosity were frustrating for scientists to mentor. One mentor was disappointed by the lack of scientific questions asked by protégés during the final colloquium presentations, perceiving it as a lack of interest in scientific topics.

We suggest that protégés who are struggling with their conceptual grasp on the science underlying their projects or in appreciating how their projects relate in broader perspective may experience frustration and lose heart and interest. Exploring with the protégés the underlying conceptual framework, as well as the value of the scientific issues to the “bigger picture” may serve to encourage protégés by stimulating their interest and engagement. To the extent that new mentors overestimate the scientific sophistication of their protégés, it may not be apparent to these scientists when their protégés are disengaged because they are conceptually lost. Connecting the research projects to the protégés' lives or specific interests in some meaningful way may re-engage struggling protégés.

Similarly, protégés may seem disengaged if they are disheartened by the revelation that science is not a collection of black and white facts to be discovered. The “grayness” of science exploration may be daunting and discouraging to protégés whose confidence and self concepts have been based on their proven abilities to learn facts given to them in a classroom setting. Adjusting their world view to encompass the messy difficulties of real science, while at the same

time wrestling with new confidence issues, may make protégés appear disengaged. When the conceptual “rug” is pulled out from under any of us, we experience a period of adjustment.

Protégés: Challenge of Time Management and Developing a Professional Work Ethic

Protégés’ time was limited during the 10 week SOARS summer and work plans had to be carefully made. However, there were several additional sources of time challenges that exacerbated the stresses of already limited time, including systemic factors:

- While many of the research mentors carefully designed their protégés’ research projects to fit in the 10-week program, inherently unpredictable timing of research, and problems with implementation of models, made setbacks common. Protégés occasionally felt stressed to make up for lost time when having to redo some part of the research process.
- Computer and other technical glitches imposed setbacks
- Some protégés felt frustrated when trying to focus on research, but were periodically interrupted by program obligations involving the writing component, conferences, and other scheduled SOARS events.
- Challenges of a personal nature also complicated time management:
- Some protégés felt personally challenged to stay focused and on task while on the job. Operating within an environment of flexible supervision and little micro-management, many protégés consciously struggled with self-discipline.
- Several protégés also noted the challenge of trying to balance their work and research obligations with their social life and activities with other protégés.

The support and encouragement protégés gave one another were important to protégés meeting their final deadline at the end of the summer. They also credited the periodic due dates imposed for bits and pieces of the research report over the course of the summer with helping them to complete the project (even though some disliked the “interruptions” this entailed). Note, however, that protégés also voiced concerns about the relative helpfulness of some of the assignments, as discussed elsewhere in this report.

Mentors: Research Project Time Constraints

Many research mentors expressed frustration with the brief 10-week duration of the SOARS summer. Exacerbating this time constraint was the amount of protégés’ time spent on non-research activities related to the SOARS program (roughly 8 hours per week), including the writing and communication component and the protégé seminars.

The time-consuming nature of the writing component was particularly criticized by new mentors. As we discuss in considerable detail later in this report, the value of time devoted to teaching scientific writing was not intuitively apparent to newcomers to SOARS. (As discussed below, over time the greater majority of all SOARS participants came to appreciate the time spent on writing.)

The Writing and Presentation Component

Another key SOARS objective is to improve students’ writing and presentation skills. These skills are viewed as important to protégés’ success in graduate school and in learning how scientists work professionally. As such, teaching students writing and presentation skills is a

structured element of the SOARS program. The writing and presentation component was led by a facilitator and consisted of two main parts: student attendance of a weekly two-hour writing workshop, and a set of writing and presentation assignments (including a research proposal, paper, an abstract, practice presentations, and a final colloquia presentation). In addition, each protégé had his own writing mentor. The facilitator's objectives for protégés were that they would come to appreciate the importance of good writing and presentations skills for scientists and become persuasive and confident public speakers. The facilitator designed the assignments to model scientific reality and illustrate professional aspects of the life of a scientist, rather than simply be exercises in writing. She also hoped that protégés would gain an appreciation of peer critique and iterative writing.

Assignments

The assignments protégés were required to complete consisted of a research proposal, a formal research paper that included introduction, methods, results, discussion and conclusion sections, and an abstract. Interspersed throughout the summer were two practice talks and the final colloquia rehearsal and presentation. Some research mentors and protégés complained about “putting the cart before the horse” when protégés had to turn in their results section before they had actually achieved any results with their research project. However, the facilitator argued successfully with some scientists that this does indeed mirror the real world, since scientists submit conference presentation abstracts before they have achieved results.

Over the years, the current facilitator had modified the set of assignments, building upon the work of her predecessor and based upon the yearly and ongoing formative feedback from the protégés themselves. One recent change, added in for the summer of 2003, entailed making the research proposal more realistic, which the facilitator did after soliciting ideas from past research mentors. Mentors generally believed that the proposal writing taught protégés more about the life of a scientist.

Writing Workshop

The weekly two-hour writing workshop encompassed two distinct parts: the first hour involved presentation and discussion of concepts, and the second hour was small-group work where protégés reviewed and critiqued one another's writing assignments or presentations. As the summer progressed, each workshop emphasized sequential steps that paralleled stages of the research projects.

Workshop presentation and discussion: The first hour

The first hour of the writing workshop is led by the facilitator who raises topics related to the writing assignment for that week and prepares the protégés for the peer-review portion of the writing workshop:

The basic idea is they are writing their research paper in pieces. They write their proposal first—so that's the problem definition part and a little on the methods. I try to present points about writing that are related to the piece that they're writing—next, the introduction, methods, results, discussion and conclusion. With the introduction, we talk about plagiarism and effective use of resources—I try to have some discussion, I show some examples and sometimes, more the first year than the second, we make a list of

things we're going to look for in the piece of writing that they have in front of them. ... But the basic idea is to present the material, show some examples, have some discussion, and then they read each others' writing and comment on it using this checklist to guide them on what they're looking for and was it done effectively? And how to help the writer.

During the first hour of the writing workshop, protégés learned about a variety of scientific writing concepts, such as the contents of each section of a report, and issues of proper citation and avoiding plagiarism. The SOARS directors and staff members believed that the writing and presentation component was highly beneficial for protégés, but that the writing workshop itself still needed improvement.

During the SOARS director and staff's review of the 2003 SOARS summer program, they had an intense and in-depth discussion of protégé observations on and resistance to the writing workshop. Protégés' strongest complaint to their mentors and the SOARS staff was that the workshop was boring. SOARS staff reported that protégés complained regardless of whether the workshop was held at 8 AM or later in the day, the format was lecture or collaborative in nature, and one facilitator or another was teaching the workshop. Protégé resistance to the workshop had existed for years. One year, a protégé even led a rebellion to get rid of the writing workshop. This was not an option as far as the SOARS director was concerned. Some time later, this particular protégé said that he had come to appreciate the writing skills he had learned while in SOARS.

The writing and presentation component facilitator expressed frustration with trying to make the writing workshop interesting and engage protégés who had skills ranging from no scientific writing experience to those with up to three years worth, and from little English fluency to native speakers. When the facilitator attempted to engage protégés in a new active-learning pedagogical method that was hoped would overcome complaints of the workshop being boring, the facilitator struggled with limited protégé participation in discussions. It was argued by the leadership training facilitator that young adults in their early 20s are at a developmental stage where their mental processes emphasize "the concrete," rather than more abstract "systems thinking," and thus they tended to be resentful if they perceived information was known but was being withheld from them when they ask for it, as happened in the collaborative active-learning environment where the facilitator strove to have other protégés answer the questions rather than act as the all-knowing expert herself. In addition, protégés were frustrated that collaborative dialog was expected of them on topics, such as writing standards, that, it seemed to them, offered little room for discussion.

Another challenge was whether to require all protégés to follow the American Meteorological Society writing standards or to have protégés follow the standard required by the particular journals in which they might publish their work. Research scientists preferred that protégés follow the unique standards of their sub-discipline journals. However, trying this approach increased protégé frustration during the writing workshop because answering protégé questions about specific formatting requirements became virtually impossible. Nevertheless, the decision was made to continue with specific journals' standards because it better enabled mentoring by the scientists on the research paper and the possibility of publication without additional editing.

SOARS has made progress over time in attending to protégé complaints about the writing workshop and in improving protégés' attitudes toward the writing workshop. At the "All Hands Feedback meeting" held at the end of the 2004 summer, just over half of the protégés commended the director and staff for achieving a big improvement with the newest incarnation of the workshop. The changes included altering the physical setup of the workshop so that protégés sat in a circle, and changing the presentation section so that returning protégés presented some concepts (though SOARS staff was concerned that this reduced the quality of the material presented). However, the protégés still complained that experienced protégés returning for additional SOARS summers gained little benefit of participating in the workshop again. The strategy informing the requirement of experienced protégés to attend the workshops was that, as returning protégés with superior writing and presentation skills, they would help teach first-year protégés, and that the returning protégés would refine their understanding in the process. As of the summer of 2005, the SOARS Director and staff divided the workshop into two sections—one for new protégés, that covered more introductory material, and one for returning protégés that centered around the peer review of manuscripts and included more advanced topics.

Workshop peer review: The second hour

The second half of the writing workshop, which entailed peer review, was much better received by the protégés than was the first half. Having already discussed goals and methods of doing peer critique during the Leadership Training workshop at the beginning of the summer, the facilitator gave the protégés in the writing workshop a checklist against which to review each other's assignments. Protégés provided feedback to one another in groups of three or four. Group membership remained the same over the course of the summer.

The challenge for the facilitator was to find the ideal peer review group composition. She avoided organizing groups in which protégés were matched with their peer mentors, as peer mentors were already reviewing the papers outside of the workshop setting. Groups of four to five were too big, as they left less time for feedback on any given paper. Changing group members weekly compounded the logistical problems. In addition, protégé skill levels affected the quality of the reviews. The facilitator strove to match a weak writer with a strong writer so the former learned what good writing is and the latter gained teaching experience. Another reported problem was that sometimes groups finished early and spent their time chatting, rather than continuing to focus on writing.

Mentor and UCAR manager perspectives on the writing and presentation component

UCAR managers support the emphasis on helping students improve their written and oral communication skills. In general, students are lacking in these skills; more importantly, these are professional skills that scientists require in their everyday work. However, there was some degree of resistance by research mentors (especially newer ones, as discussed elsewhere in this report) to the writing and presentation component of the SOARS program. Some scientists believed that the main goal of SOARS was the research experience, and that the writing and presentation component was too time consuming and significantly reduced the time available for protégés to conduct research.² In comments to their mentors, protégés described the emphasis on

² In a recent study examining what students gain from undergraduate research (Seymour, et al., 2004), faculty members directing undergraduate research voiced similar frustration that student professional development

writing as “overkill” and aired their frustrations with the writing workshop, especially the mandatory attendance for all protégés. Some of the points made by each side of the debate were:

Pro-writing and presentation component:

- The weekly writing assignments in which protégés progressively write up their research papers helped the research mentors assess whether their protégés really understood the science.
- Writing could help improve the logical reasoning of the research.
- Because publishing is a top priority for scientists it is essential for young scientists to build their writing and communication skills since these abilities are typically lacking

Against writing and presentation component:

- Writing assignments take too much time in an already time-intensive program
- Protégés should only be required to document what they’ve learned
- Concern that protégés spent too much time and focus on making PowerPoint presentations for the final colloquium presentation instead of gaining a better understanding of the science
- The research proposal assignments do not fit well enough with the research projects
- The writing assignments do not fit well enough with the research projects
- The timing of the writing assignments does not fit with the research projects

Protégé perspectives on the writing and presentation component

Protégés talked to a great extent about the gains and benefits involving writing, editing, and critique. Most protégés told us that their writing skills and abilities improved dramatically through their involvement with SOARS. While many told us they typically or previously did not like to write, they greatly appreciated the increased confidence and capacity to write clearly with well-supported information. The writing process was recognized to be difficult and laborious, but ultimately worth the effort in the end. Though painful and frustrating at times, they recognized the value of having a paper thoroughly edited by another and came to expect rigorous, constructive feedback. Solid writing skills proved to be useful back in school, when applying for graduate programs, and in further research and career environments.

Protégés found writing to be an often challenging and sometimes frustrating part of their experiences while at SOARS. Protégés were personally challenged to write well and write to the high expectations they often assumed were placed upon them. Some noted having to work hard to make their writing more scientific, and not overly wordy, flowery, or poetic:

My writing style has changed from being very poetic, because that’s the way they want you to write in “creative writing” or “composition” [classes]. To be in this like, beautiful language with beautiful sentences and just being so descriptive and drawing a picture for you with words, kind of thing. Which is, I was really good at and then got to SOARS and I think I started to do that and then my writing mentor was like, “You don’t need to

workshops detracted meaningful time from research. The compact timeframe of the 10-week research experience inevitably raises issues of how best to balance program objectives.

describe this with an analogy. You don't need to do that, you just, be more straightforward and, and scientific and you need to use bigger words to describe things. Like, better words than just these short, simple sentence kind of structures." So my writing style changed. And now I think when we wrote I had to write two research papers this past semester. And, a few of the other students I've worked with, because these were group papers again, were writing a certain way and I would kind of set the tone I like, I wrote the introductions, said, "I think we should write this way because this probably a better scientific way. And more straight forward." And then our whole paper carried on that way. And we did really well on our paper.

At the same time they were challenged to make their papers clear to a general scientific audience and not overly technical. Protégés recognized that writing and editing process was a difficult and time consuming process. Working with writing mentors and revising their papers required re-editing many drafts. Though they acknowledged the value of having a paper heavily critiqued in an editing process, it was difficult at times not to take it personally.

Protégés also discussed the additional stress of finishing their research and writing during the last week of the summer. Some protégés waiting anxiously for research results to be finalized before final writing and edits could be applied. Others regretted missing out on final goodbyes with other protégés while frantically writing up their final drafts. Further instances of frustrations or challenges with writing cited by the participants in our evaluation include knowing how to write up ambiguous or unclear research results, difficulty establishing who the intended audience of a paper was, and negotiating differences in editorial opinion among more than one mentor.

Protégés told us about the extensive benefits and gains from the writing workshop component of the SOARS experience. One of the most highly valued elements of the writing workshop by protégés was the opportunity to collaboratively discuss and work on their writing together, offering critique and edits. Protégés taught each other and appreciated having feedback from multiple perspectives. Protégés provided each other with insightful and sharp critique, but most often did so tactfully and respectfully. The writing workshop was valued because it offered clarification of the writing process and guidelines for effective writing and correctly citing sources. The workshop's discussion of plagiarism was also helpful. In addition, protégés benefited from learning to write research proposals. Protégés also told us they liked having writing assignments that were practical and applicable to either their research or graduate interests.

Protégés told us that the writing workshop helped them organize their writing, as well as providing them with a timeline for writing during the summer. Deadlines for writing various sections of their paper kept protégés on track during the busy summer, insuring that all their writing was not rushed at the end. The production of drafts along the way additionally provided protégés more of an opportunity to work on and improve their writing. The writing workshop also provided help with regard to the practice presentations, giving protégés an opportunity to prepare and gain feedback from one another. Protégés credited the writing workshop with improving their writing and, in some cases, helping them produce strong, publishable papers. There were several protégés who told us they complained about the workshop at the time, but later came to recognize and appreciate the value:

The writing workshops—I used to think they were ... I felt like I didn't get that much done in the past, like in the past few years. But after being in [offsite SOARS location] I realized they were incredibly useful. I mean when I was in [offsite SOARS location] all I got were [the facilitator's] e-mails. And I swear I'd be reading every word just to find out what's been happening. Whereas in the past being here with everyone else ... I don't know if it's because when you're sitting in a room for like five hours you, want to commiserate later on.

On reflection, several protégés noted the value of the workshop and wished they had put more effort into making it a positive experience.

Despite the high frequency benefits cited with regard to the writing workshop, protégés often levied complaints against the writing workshop and its instruction. Protégés likened the writing workshop to a classroom environment, a clear departure from the rest of their experiences at SOARS. They often complained that it was difficult to attentively sit in the workshop, which began early at 8:00am.

Many protégés described the workshop as boring or repetitive. Some felt that material presented in the workshop did not warrant thorough discussion, and instead could simply be provided as a handout. At times they were uncertain as to the relevance of workshop instruction, particularly with regard to their research projects. Returning protégés felt it unnecessary to attend the workshop lectures again. One graduate student felt it patronizing to be reviewing fundamentals of writing. A few protégés told us that the true benefits of the workshop—reading and editing each others' papers—could be done without the workshop.

Further problems involving the writing workshop identified by participants included:

- A common concern with the writing workshop involved its encroachment on valuable time that could otherwise be spent doing research or writing.
- Several comments pointed to a frustration with an apparent disjuncture between the timeline provided by the writing workshop for writing sections of the paper and the actual progress made through the research process.
- A few protégés complained that they were forced to re-write sections of the paper as necessitated by unforeseen changes in the research project.

Protégés attributed much of the frustration and many of the problems with the writing workshop to the writing instructor. Though they most often described her as a nice, friendly, likable person, many protégés found the writing workshop instructor's pedagogy and instructional style to be frustrating. Protégés often described a situation where they felt straightforward, decisive answers to specific questions were appropriate. Instead, the instructor employed an inquiry-based approach, answering their questions with questions in an apparent attempt to engage them in a process of discovery. Several protégés expressed the desire to simply have a concrete answer. Furthermore, protégés complained that they did not receive individualized feedback, but rather instruction was generalized. Others complained that her teaching style was not engaging

or lively enough. Protégés liked the writing instructor and were sensitive that negative feedback could potentially hurt her feelings, yet many noted that her instruction merited such critique.

The writing workshops were seen by both protégés and some mentors as repetitive for returning protégés and met with resistance for this reason. However, no one suggested that returning protégés have no need for writing mentors. In addition, most protégés acknowledged benefits they derived from the writing workshops, and several admitted that it was not until later, sometimes years later, that they fully recognized its value. It was not uncommon to hear alumni of the program describe how, as protégés, they disliked and objected to the writing seminar while attending them, but upon returning to school, and then progressing on to careers, they came to realize how much value they had gained from the experience. With this in mind, it is important to distinguish between resistance to the writing workshop based on reactions to pedagogy and resistance based on evolving needs of the protégés. While it is unlikely that a person would be able to fully master scientific writing techniques in one summer writing workshop series, given the learning gains protégés make from one year to the next, as noted by the writing mentors, a considerable amount appears to be learned in a given year. How much is learned in the first year, as compared with subsequent years, is a question perhaps best answered with a form of pen and paper test that could be administered prior to or at the beginning of each summer. It is possible that, since the protégés are exceptionally capable students (given the competitive nature of admittance to SOARS), that they do indeed learn a sufficient amount of information in their first summer, preparing them to proceed to a higher level of writing instruction in subsequent years. Current changes in the writing workshop that address these questions will likely shed more light on these questions. (It is too early to determine the value of successively more advanced writing seminars for each year in the program.)

Suggested improvements for the writing workshop

Protégés offered some suggestions for how to improve the writing workshop:

- Instruction needed to be made more lively, engaging, and interesting
- The writing workshop more interactive and reducing the amount of down time
- Use PowerPoint or some visual stimulation
- Distribute hard copies of resources with cited examples instead of making them a discussion
- Make writing assignments helpful and useful, such a graduate applicant statement
- The instructor needed to be more proactive in guiding the time spent
- Bring in scientists to give presentations
- Review other scientists' writing
- Specific topics should be addressed at sessions more concisely
- Do collaborative evaluation of proposals and mock proposal review
- Provide incentives to do proposals, such as compiling them into a book.
- Involve the whole group during discussion--not so individually focused (note, though, that this in contrast to the criticism offered that instruction needed to be more individually-relevant)

Protégés noted some changes in the writing workshop and overall improvements in the instruction. Some attributed these changes to the incorporation of protégé feedback into the workshop design. Increased revision of each others' work was also cited as beneficial.

Presentations

Protégés were required to give four presentations: two practice talks, a final colloquia rehearsal, and the final colloquia presentation. The format of the presentations was modeled on those given at professional scientific conferences, with the protégé being introduced by another scientist (in this case one of their mentors), giving a formal presentation using PowerPoint (or occasionally overheads), and responding to scientific questions from the audience. Protégés took the experience very seriously, especially the final colloquium presentations, where their mentors, other UCAR scientists, and NSF program officers were in the audience.

At the first practice session, new protégés were observed to be very anxious. Throughout the talks, members of the audience were very attentive and respectful. Occasionally, a science mentor helped the protégé out during the middle of the practice talk if she got stuck or significantly misspoke. Typically two to four questions were asked after the talks. The writing facilitator handed out forms to the audience during practice talks to solicit formative feedback. The pedagogy behind the method was to ease the protégés' pain when receiving critical feedback verbally and increase the amount and honesty of feedback from reviewers. The larger volume of feedback also made a greater impression upon protégés, especially when multiple reviewers wrote similar comments. Mentors gave their protégés hearty congratulations and encouragement, especially after the practice talks. The facilitator also gave protégés feedback, including help with PowerPoint slides and encouraging those with distinctive dialects or accents to speak more loudly and slowly. The facilitator's greatest frustration during the practice talks was when a protégé's science mentor and other mentors failed to attend, which occasionally happened.

Protégés invested many hours in the last two weeks leading up to the final colloquium presentations; one observation, made at 11:00 PM one evening, found a half-dozen protégés crowded into one apartment, everyone still intensely focused on writing their reports with expectations of staying up much later for many nights in a row. Not only did protégés work hard on their own papers and presentations, they also supported one another, offering critical reviews and recommendations beyond that which they did in the peer-review portion of the writing workshop. This investment in one another's work led protégés to care even more deeply about their final colloquium presentations.

The final colloquium presentations were held in a large, formal presentation auditorium at UCAR, at the request of the protégés. The SOARS director requested that research mentors attend all of the final colloquium presentations, but they rarely attended every one. Most commonly, mentors attended their own protégé's talk plus a few others either before or after it, leaving at the next break. On the other hand, many protégés attended each presentation, providing emotional support as the presenter protégés' emotions ranged from anxious to focused to elated to exhausted over the course of the five minutes before to the five minutes after the presentation. The protégés' colloquium presentations were observed to be highly polished summaries of their research and findings, presented in professional conference format. In addition, the protégés and their real-world research receive genuine interest from scientists in the

audience and hearty support from the audience. An observation of the supportive, collegial and professional environment in which the protégés gave their final presentations is described below:

Many protégés, some scientists, and the SOARS director and staff were present, as was the NSF liaison. The research mentor introduced his protégé and acknowledged the protégé's previous research mentor. During the protégé's talk, the audience laughed appreciatively at the excellent fit of her data after she had shown two prior graphs which did not fit. The protégé laughed proudly and recounted her earlier fear when the data from one instrument did not agree with the data from another. She said, in conclusion, "I would like to thank [my research mentor], who was so awesome this summer and I would love to thank SOARS and the protégés for helping me this summer." Two scientists asked the protégé questions, the second scientist prefacing his with "This probably isn't a fair question for you either..." The protégé's research mentor fielded the question, and referred him to another scientist in the room. The one who asked the question then said to the protégé, "When you're going for your PhD, getting your committee arguing is always a good strategy!" The protégé was then given excited and hearty congratulations by her mentors and fellow protégés and SOARS staff members, and a gift by her mentors. Two protégés took photos of her on stage as she beamed with pride. She then sat down in the audience, receiving yet more congratulations from people around her, and gave a big sigh of relief.

Protégé perspectives on presentations

Several protégés talked about the challenges involving practice talks and making presentations. For many protégés, getting up in front of others and speaking was a nerve-racking task in itself. Protégés were naturally nervous and sometimes uncomfortable with giving talks and presentations. They told us about feeling weak in the knees and sometimes forgetting part of a well-rehearsed presentation. A few protégés told us they still struggled to understand their research projects or the meaning of their analysis when giving a presentation.

Protégés frequently cited the benefits and rewards of giving practice talks and presentations. Many protégés told us they gained confidence in their ability to explain material and answer questions. Furthermore, practicing in a relatively safe environment of protégés and mentors allowed some protégés to develop confidence and overcome their nervousness. Protégés often practiced their presentations with each other, offering critique and asking questions in anticipation of their presentations. Protégé also talked about the gains made in terms of increased skills or abilities to present material well. Protégés valued knowing how to explain complex or technical material to a general audience, or how to tailor their presentations to a specific audience. SOARS prepared protégés to give presentations in the future. Several told us that the confidence gained in SOARS was beneficial for talks given back at school, at conferences, and at work.

Writing Mentoring

Writing mentors came from a variety of UCAR positions: 23 were scientists of one sort or another (such as tenure-track, non-tenure track, postdoctoral, or working in a non-scientist role despite being trained as a scientist); 8 were writers or editors; 2 were engineers; and 11 came

from a variety of other UCAR roles including administrators, library services, educators, and governmental liaisons.

According to the SOARS mentor training, the formal responsibilities of writing and communication mentors, hereafter referred to as “writing mentors,” were as follows:

- Help the protégé improve the colloquium presentation, scientific paper and other products
- Provide direct instruction as needed
- Guide tone and style
- Offer suggestions for improvement

The mentors themselves described their role as writing mentors as generally helping protégés with their written assignments as well as with both informal and formal presentations. The writing mentors helped with the writing, in general, while the research mentor focused on the content. In addition, writing mentors with science backgrounds also helped the protégé to understand the science. Writing mentors, however, came to a consensus at one of their brown bag lunches that protégés were already teaching each other how to create PowerPoint presentations, so therefore writing mentors did not have to assume that particular responsibility. Likewise, some mentors did not coach the protégés on their presentations since they felt the protégés did not need their help. As noted above, in addition to receiving writing mentoring, protégés attended a weekly writing workshop. Writing mentors generally attended protégé presentations and gave feedback and support.

Writing Mentors’ Time commitment

Writing mentors spent two-thirds less time mentoring their protégés than research mentors did. Two-thirds of the writing mentors spent one to three hours per week, a quarter of them spent four to six hours per week, and a couple of mentors spent more than that. Writing mentors typically interacted with their protégés weekly, although some stretched it to every other week. A greater time investment was generally made toward the end of the summer when the final papers and presentations were due. A quarter of writing mentors spent their personal time on weekends or evenings in order to provide quick feedback to their protégés, which these mentors sometimes perceived as a burden.

While some mentors initiated interaction with their protégés, either formally through weekly meetings or informally by stopping by the protégés work site to see how they were doing with the research and assignments, most waited for the protégés to contact them when help was needed. Mentor-protégé interaction was therefore primarily driven by protégés striving to meet assignment deadlines and partially by questions they had for their writing mentors. Some mentors found a strategy that bridged both approaches: to let the protégé be responsible for initiating interaction, but to check up on the protégé if he failed to turn in the assignment to the mentor on time or was falling behind schedule:

I think it works best because some people don’t need to really meet on a regular basis and again, for me, it’s like I wanted not to have to be too rigid and too structured, because they’re coming out of such a structured environment with school. This is supposed to be a

little bit more of an independent, “You have to take some responsibility here, and figure out how to make it work.” So I prefer to let them figure it out what works best for them and if they get towards the middle and I find out they’re way behind on this stuff then I’ll start pushing them and start trying to meet with them more regularly but I haven’t really had to do that very much. They’re usually pretty on top of stuff.

This gave the protégés control over and flexibility with planning their workloads yet provided a safety net to ensure that the protégés were not falling behind and putting their success in the program at risk. However, as one mentor cautioned, protégés will oftentimes say they do not need any help when, in actuality, they do.

Strategies employed by writing mentors

Unlike the research mentors, several writing mentors had explicit discussions with their protégés about the mentoring relationship:

In the beginning this year, I said to [my protégé], “What is it that you would like to achieve this summer?” She wanted to think about it, and she responded to me in an e-mail message, this was early on, our first week together, and she had a series of goals, some of which I may not have anticipated had I not asked. So I really liked that, and I think that’s a good thing to do.

Some mentors set deadline expectations at the beginning of, or part way through, the summer to ensure that they had adequate time to critique their protégés’ assignments. Others discussed their mentoring style and protégé needs for the mentoring relationship, including interaction frequency and desired feedback methods:

The first thing I did was sit down and talk to [my protégé], and see how he wanted to get feedback. How he wanted to receive it. “Did you want me to mark it, did you not like red, do you like pencil, do you like little notes?” I think that’s really important, otherwise he’d ignore it.

In a couple of cases, the discussion entailed conflict management approaches for the mentoring relationship. One mentor had to confront her protégé about slacking excessively and violating program requirements. Another mentor reported that her protégé asked if they could use a different editing and feedback process, to which the answer was, “No.”

Writing mentors observed that protégé writing and presentation skills varied considerably, with some being great writers and public speakers, while others were lacking in skills. As one would expect, protégés for whom English was a second language were in greater need of writing support. In contrast, some new protégés had better skills than some returning protégés.

Interaction format

More than half of the writing mentors felt it was important to discuss their recommendations about the writing assignments in person with the protégé.

I gave him feedback through email using the track changes with Microsoft Word. So sometimes it goes that way but my preference is to work with him in person because amazing stuff comes up, you know.

You can write a draft and give it your advisor and they cross it all out and try again, but they're not explaining why they're crossing it out and moving things around which is the unfortunate part and so as a writing mentor and even as a research mentor you try to explain why you think this part that was in page two should be on page one or why things should be moved around and the like.

Meeting in-person enabled mentors to “listen—with ears and eyes” to assess how their protégés were doing and how best to support them. In addition, mentors could more readily engage in discussion about the reasoning behind editorial recommendations and seek clarification about what the protégés were trying to say and help them find a clearer way to express it. The mentors edited the papers prior to meeting with their protégés, then discussed the edits face-to-face. One mentor did the entire process in the presence of his protégé. A couple of mentors encountered significant scheduling conflicts when trying to meet with their protégés to discuss edits.

Another method of mentoring involved e-mail, which was used by a third of the writing mentors. Some believed that face-to-face mentoring is best, but that e-mail mentoring could be effective, as well:

The times when we met it was just times when she had specific questions. She's like, “Can I come down to talk about this?” That was probably, I don't now, maybe three times over the whole summer that she came down and we just sat down and talked over stuff. So the other was just e-mail, she'd send me a document and I would make comments on the document in Word and then send it back to her in the morning.

Mentors utilizing email especially liked the “Track Changes” feature of Microsoft Word, which made it easier to display the recommended edits to the protégés. It also was the only viable option for mentoring protégés who worked in the field, away from their writing mentors. A couple of mentors offered suggestions about how to maximize the effectiveness of e-mail mentoring. One recommended following up e-mail with a phone call to discuss the edits, rather than have their suggestions “go into a vacuum.” E-mail mentoring was considered by some as effective only for independent and conscientious protégés who could understand and would incorporate the less-detailed suggestions on their own.

Approaches to teaching through editing

Clarity of content was the foremost goal of writing mentors:

For initial drafts I concentrated on the most important problems, maybe overall organization, maybe overall tone. I didn't find that it was worth criticizing on a sentence by sentence level because in subsequent revisions those sentences might not even revise. So it'd be a waste of my time to comment on things that might not make it to later drafts and I think it also might tend to dishearten [my protégé] if he just got nothing but comment after comment on it. It might really hit his motivation pretty hard. So the first

drafts I try to tackle the big problems and then as he was finalizing things, when I knew that if I didn't comment on that paragraph that's exactly how it would appear in the final document, that's when I went in and said, "Ok, now we need to work on some of this stuff too."

SOARS and its writing mentors sought to facilitate the protégés' comprehension of their research projects. This was accomplished, in part, by having protégés express their thoughts clearly to a general, rather than a specialized, scientific audience. A few writing mentors had their protégés orally explain to them the intentions behind their sentences to facilitate clear thinking about the subject:

It's not just, "There's a problem with this word here," type of thing, it's more conceptual, it's more like, "Well, I've read all this but I still don't quite understand what is the significance of this research?" As Tom always calls it the "So what?" factor. "So what does this do for the world if you find this out?" ... You let the little stuff go because you're working on the big questions like what's the significance of this research and I don't understand what this instrument does and where was the data collected and those kinds of things.

Believing protégés might not know what good writing looked like, a few mentors showed their protégés examples, in one case including an example from the protégé's own writing, one from a reconstructed paragraph of the protégé's writing, and one from a journal article. After the science content was well organized and clearly written, the mentors focused on helping their protégés work on problems with sentence construction and grammar.

Mentors believed it was important to teach the protégés the principles behind editing and not do the editing for them. However, mentors noted that identifying and explaining the reasoning behind suggestions was significantly more time-consuming than simply editing the paper and correcting mistakes, which was tempting for overly-busy writing mentors. In addition, focusing on principles of good writing required that the mentors forego expectations that the papers would be journal quality or perfect:

I've tried to be a little bit more big picture in editing. I think at first I was a little more trying to just make it perfect and, rather than teaching the bigger principle things.

To teach writing principles, one mentor would point out two or three examples of a particular problem, and then have the protégé look for other instances of it. Other mentors followed the writing facilitator's advice to point out problems, refer the protégé to the appropriate Mayfield guide section, and let the protégé figure out how to correct the problem. A few mentors found it challenging not to impose their own writing style upon their protégés' work.

Offering criticism gently

Believing that people in general are sensitive to criticism, writing mentors felt it was important to foster writing suggestions gently, building protégés' confidence rather than criticizing harshly or excessively. Writing mentors had different strategies, though, in providing sensitive criticism.

Most felt it was important not to “bleed” all over the protégés’ papers with their red pens, but rather to first praise the well-done aspects before suggesting a few key changes:

I do try, even with an advanced student like [my protégé], not to totally, as one of my students put it, I try not to “bleed” on their papers. Even with someone as advanced as she is, since I do have this realization that people are so fragile around this writing thing. I don’t know why everybody thinks they write well.

Some writing mentors, however, felt that thoroughly editing the papers was beneficial to the protégés, especially when the mentor and protégé agreed upon that approach. Trying to foster the protégé’s sense of ownership over their own papers, some mentors encouraged their protégés to decide which editing recommendations to follow. Generally, mentors felt it was more important that the protégés learn the principles of good writing than for them to produce perfect papers.

Various strategies were used to give feedback gently: many mentors explained the reasoning behind the edits they suggested; others asked the protégé to clarify confusing sections; one mentor discussed the effect of the writing on the reader rather than declaring the sections as “wrong;” a few compared problematic parts of the papers with those that were well done as a basis for discussion; and another pointed out the protégé’s progress over the summer. One mentor explained that writing is difficult for her as well, which bolstered her protégé’s confidence; the mentor also shared advice about the importance of revising papers multiple times to improve writing quality, and having colleagues review one’s writing.

Mentors did report that most of the protégés were receptive to feedback on their papers:

They’re at that level where they’re welcoming input. They’re like, “Oh okay, “and you’re almost like, “I’m just giving these as suggestions, you can do with it as you want,” which I always say that, and pretty much they always just do exactly what I said. So, no they’re very—I’ve never had any problems with anybody saying, “Oh, I don’t want you to,” or any problem with any suggestions. I mean if they have questions, we’ll certainly talk about it, but there’s never been, you know, any resistance.

The mentors attributed this to protégés truly wanting to learn how to write good papers. A couple of protégés, however, were more challenging to give feedback to as they took criticism negatively, or otherwise did not appear to be receptive to learning about writing.

Attention to timeliness

Several writing mentors spoke of the importance they placed on helping their protégés improve their time management skills. The writing mentors wanted to ensure that the protégés completed the program assignments successfully:

The first couple of years that I was a writing mentor I think I had a lot less of a clue of, well, the component of pushing the student to make sure that, if they don’t ask for help that you make you make sure that you still interact with them, that you’re checking in with them that they need help. I think that a lot of times these students get really overwhelmed. Because it’s such an intensive program for a short period of time. And

you don't hear much from them. If you don't kind of apply some pressure to say, "Hey talk to me what's going on, is everything okay?" Half the time you hear that everything is fine, but you still want to do that. In the beginning I didn't have any of that kind of skill at all. So I've gotten better as I go along.

As one writing mentor recounted, her protégé learned a painful and embarrassing lesson about the importance of deadlines and commitments his first year in SOARS, and became "fired up" the second year to stay on top of his responsibilities.

Providing a more structured relationship, such as scheduling weekly meetings or regularly checking in and following up to ensure progress was being made, was viewed in retrospect as important in teaching the protégé time-management skills. One mentor encouraged her protégé to get a first draft written, because that is the largest hurdle. From there, the other mentors and protégés' peers could provide helpful feedback and ideas.

Other types of support

Some writing mentors also provided other kinds of help to their protégés, such as by offering tutoring in science, computer programming, PowerPoint, and conflict management. They also offered practical support such as providing transportation, and being a general resource person. A few writing mentors offered career advice, including experiences in becoming a UCAR employee, discussing alternative science career paths, and offering advice on how to overcome cultural alienation, stay in graduate school, and achieve one's desired goals.

Beyond mentoring protégés on scientific writing and presenting, several writing mentors also provided emotional support: empathizing with the challenges of writing scientific papers well, helping protégés overcome their predictable feelings of intimidation of their research mentors, letting the protégés vent feelings, and lending a caring ear when protégés felt overwhelmed at the end of the summer and did not feel comfortable speaking with their research mentor about it.

Challenges faced by writing mentors

The two biggest challenges writing mentors experienced were struggling with "last minute papers" and trying to work with disengaged protégés. Mentors found it difficult to quickly edit papers that protégés submitted the last minute before the deadline. One mentor, who struggled with a protégé who was behind in completing his work, was comforted by Tom's advice:

The last week things get really crazy, it's finals weeks times two or something, it's that kind of feeling. So there was something going on that was not going at all well with a protégé and I was sending him an email, this is at 2:00 at night, I'm feeling really bad. And from Tom I get back this little message, he's like, "Well, we can only love them as much as they'll let us." That was his entire comment to my sort of (whining noises).

Various responses included setting boundaries to protect writing mentors' personal time, accommodating protégés' creative "jam session" styles, and accepting last minute papers as inevitable, given the short SOARS summer. However, writing mentors generally regarded last minute papers as an under-use of their mentoring, and were disappointed when this happened.

The mentors felt badly when late paper submissions resulted in poor quality papers, as mentors did not have time to review them. A related disappointment occurred when protégés fail to give their mentors a copy of the final paper, especially if the mentor had not seen it before it was submitted to SOARS:

It's a lot of work to get done for the summer and there have been more than one time that I've never seen the results in the discussion section of the paper and they're gone, they're out of town, they're down. Because, and it's true, they're running models, things don't work, they're doing data runs and stuff right up to the end and then they have this paper that they have to finish off and so there have been times when I don't see that and that's a bad feeling for me in terms of completion and it's like, "Well, what have we been leading up to all summer?" Then the feeling of, "Is it somehow my fault?" Well, of course it's not really. So that's kind of hard.

The second challenge described by writing mentors was trying to work with protégés who were disengaged at some level, such as those who resisted the writing component of the program, "disappeared" for extended periods of time, failed to turn in assignments, and those who did not accept the mentor's authority (which in two cases was believed to be a gender issue, as the male protégés did not feel it appropriate to take guidance from a female writing mentor):

You do run into cases where you have to kind of track your student, and hog tie them, and grab them, and have a meeting now and then. If you ever want to see them. That is probably more so in the earlier years than the later years. The later years, they kind of wise up and go, "Oooh, you can help me." ... Those are just things that you learn over the years [laughs]. Little strategies for making sure you keep in touch.

Another, less frequently experienced challenge, was the difficulty that a few non-scientist mentors had with understanding the science content in their protégés' papers, which made them feel insecure in their role and intimidated about asking the research mentors to clarify or explain the scientific concepts, which one mentor overcame with time:

The challenge part for me is the science because sometimes understanding the science of the projects is difficult, which I'm sure if you talk to other community and writing mentors, you'll hear that. Well the positive thing for me is I'm not as intimidated by the science as I used to be...and always the positive thing for the protégés in that situation is they have to explain their project to us in a way that we can understand. ... So over the years I've gotten less timid about asking questions, gotten away from feeling like I should know this or figure this out; I'll just say, "Could you explain to me again what [long word] is—is that how to say it?"

Not understanding the science well also made it more challenging for writing mentors to coach protégés correctly with regard to wording explanations correctly. (Note that we also discuss in this paper the benefits mentors cited of editing work from a non-scientific point of view so that other non-expert readers would understand it.)

A few mentors expressed frustration with the timing of the writing assignments and project results. The deadline for the results section of the paper generally preceded the natural timing of research results. Without having results, it was difficult for protégés to explain their findings. This may not be a problem that is easily solved because projects will naturally produce results at different times and writing deadlines appear to be necessary to ensure that the final reports will be done in time.

A few writing mentors mentioned their discomfort with the devaluation of the role of writing mentors relative to that of research mentors. Given the cultural values of research over writing in science, scientists clearly held higher status than writers at UCAR and in SOARS. On occasion, even protégés gave less credence to the writing mentors' perspectives than to the research mentors' perspectives on their written work.

Protégé perspectives on writing mentoring

The level of contact and interaction between writing mentors and protégés varied between frequent or weekly in-person meetings to occasional or infrequent contact via email. Good relationships and practices involved communication and finding a good balance between support and independence. The availability of writing mentors toward the end of the summer when final sections of the paper were written was important. As with the research mentor, writing mentors were sometimes unavailable or traveling. The success of these various relationships depended in part upon the protégés' expectations and comfort levels. A few protégés considered little interaction and occasional edits and feedback via email appropriate. Likewise, a few other protégés felt there was too much interaction and critique.

Writing mentor relationships varied in the form the interaction they would take. For example, some writing mentors would simply return a paper to protégés with edits, comments, and suggestions. Others would sit down with protégés and go through the papers line by line, critiquing the writing together. Developing practices that worked best in individual cases involved communication between the writing mentor and protégé about critiquing styles and preferences. Relationships with writing mentors also varied according to the editing and critiquing style of the writing mentor. Some mentors preferred to focus on grammar and writing technique while others engaged the protégé on the level of the meaning and flow of their argument, encouraging protégés to make difficult scientific jargon accessible.

Overall, protégés felt they had good relationships with writing mentors and appreciated the support and help with writing. Relationships with writing mentors varied in several ways, as did protégé ideas about developing effective relationships with their mentors. Like research mentors, some protégés developed personal relationships with writing mentors, while others were more restricted to the editing and critique of protégé papers. Again, some protégés felt that having a personal relationship helped the professional work with their writing mentors.

A few protégés mentioned obstacles or challenges with regard to the writing mentor-protégé relationships, including difficulty getting prompt feedback, maintaining a balance of autonomy and support, and managing the potentially sensitive issue of critique.

Community Mentoring

The community mentor role was filled by people from a broad variety of positions at UCAR. In this respect it was the most varied of the three types of mentors. People volunteering as community mentors worked at UCAR as administrative assistants, research scientists, and as managers.

According to the SOARS mentor training, the formal responsibilities of community mentors were as follows:

- Serves as a sounding board, provides moral support, relieves stress
- Helps protégé connect his or her science to society
- Helps protégé understand and navigate UCAR communities
- Helps protégé acclimate to Boulder

The ambiguous nature of the community mentor role

The community mentor role was the least well-defined of the mentor roles, and caused some degree of confusion and discomfort among community mentors. Seven of the 15 community mentors reported uncertainty about what they should have done as community mentors:

My role here is a community mentor, which is (laughs), well, I've always been a little confused about what community mentors do. It seems more like they make sure that the protégés have the opportunity to do things outside of work that they wanted to do. So it wasn't a mentorship that I was very used to, because I was more used to the "helping me with science," not "helping me with things that I was doing outside of work." It took me a long time to get used to that and figure out what exactly I was supposed to be doing... (laughs) What they do. Everyone asks me too, "Oh you're a community mentor. So what do you do?" I'm like, "Uhhh... I don't really know." (Laughs). Yeah, other than offering a car to drive people around....

Community mentors took the anomie³ of their roles in stride for the most part. Some expressed concerns that they could have been more effective mentors if they understood their role better, while others thought the role itself defied definition:

I think it's a great idea to have somebody there that's just kind of a friendly face, not the person that's telling them they, "Ok, you have to get this done," and stuff like that, but it's very unclear what my role really is. That's how I see it—is just being here, a resource, talking to him and trying to be helpful, giving information, whatever, but I'm not sure it could be a more well spelled out role because it's very much whatever it develops into—whether we talk a lot or don't talk all that much or I listen to [his] talks and make suggestions, or I don't know... And then just meeting other community mentors because it was very unclear to me at that point what exactly a community mentor does, and I had a rough idea... and actually my rough idea didn't change that much. It's just having talked to the other community mentors was good, just having some background in what other people had done and how it had all worked in the past.

³ Anomie is the lack of clear norms, conflicting norms, or weak norms that undermines social interactions (Durkheim, 1915).

Another problem caused by the anomic community mentor role was concern expressed by some community mentors that they did not adequately fulfill their roles. The multiple mentor model provides alternative sources of help for protégés, so that at times community mentors wondered if the things they were expected to do were in fact taken care of by other mentors, or even by other protégés. This concerned some community mentors, who felt they had let the protégé and team of mentors down, while other community mentors took it in stride, seeing it as a functional artifact of the multiple mentor design. A couple of the community mentors indicated that they found the open nature of their role to be useful, as they felt free to improvise as they saw fit. In any case, it would be helpful to community mentors to better understand how the fluidity of the mentor role is functional and what the core expectations are that SOARS, protégés, and other mentors have of them. In short, it would be helpful to normalize the fluid nature of the community mentor role, if the flexibility is valued in the program. This would provide support to the community mentors as they improvise.

Protégés' reactions to unclear community mentor roles

Protégés frequently noticed that the community mentor role lacks a clear definition. This made it difficult for some protégés to understand how to interact with their community mentors, and how to appreciate the efforts of the community mentor. In these cases protégés asked that SOARS offer more information and guidance on what the community role entails and how to engineer fruitful connections with their community mentors.

Some of the protégés observed the discomfort felt by their community mentors and tried to smooth the difficulty by initiating contact with the community mentors and offering ideas about activities the two of them could do together. Notions of what community mentors and protégés typically did together came largely from conversations first-year protégés had with returning protégés and/or other first-year protégés who had more active or defined relationships with their community mentors. Some first-year protégés described initiating contact with their community mentors and taking responsibility for creating and maintaining social relationships. A couple of community mentors appreciated when their protégés informed them of what they would like to do while in Colorado, which simplified the mentors' task of finding out how to support the protégé within the broader community. These sorts of overtures made by protégés were unique to the community mentor role. This unanticipated turn of events may have facilitated the development of leadership in these protégés, although it is a discomfort for the first-year protégés, and would seem to run counter to the idea that community mentors look after, in albeit loosely defined terms, the protégés' needs.

Perhaps because of the under-defined role of the community mentor, a few protégés complained that they had little interaction with their community mentors and did not get to know them. As in other mentoring relationships, protégés developed a variety of different connections with community mentors based upon personalities, respective efforts exerted, types of communication used, and expectations brought to the role. A handful of protégés said they did not feel they needed a community mentor. Overall though, protégés considered the community mentor role helpful and valued the support, friendship and practical help community mentors offered. Generally they agreed that the community mentor role is especially good for first-year protégés, and that it is not necessary after the first year (the community mentor role started as an ongoing role from one year to the next, but was changed to a first-year-only role by the time the

evaluators became involved with the program). In a couple of cases returning protégés reported seeking out their community mentors they had in their first year or otherwise making connections with another first-year protégé's community mentor, as they found community mentors to be of particular value.

Community mentors' time commitments

Not surprisingly, just as the role of the community mentor is unclear, the time they spent with their protégés varied as well. The range of time mentors spent was from a brief, introductory overture to let their protégés know they were available if needed, to a high of once a day, every day. The community mentors who interacted with their protégés on a regular basis reported spending 1-2 hours a week with their protégés. Several mentors noted that frequency of interaction varied over the course of the program, with more contact in the beginning of the program.

The character and depth of the community mentor-protégé relationships ranged broadly, from close personal friendships in which protégés were incorporated into their mentors' homes, akin to honorary family members, to a single meeting which may have included a general invitation extended to the protégé to call upon the mentor for help.

Community mentoring strategies

Approaches community mentors used to establish relationships with their protégés reflected mentors' ideas about the nature of the community mentor role, as well as the mentors' personal styles of interaction:

- Asking questions of the protégé in order to get acquainted
- Sharing personal information, feelings, confidences
- Looking for common interests
- Communicating the safe nature of the relationship, with an emphasis on trust and unconditional acceptance of the protégé
- Conversations over lunch—normal interaction with an activity informed by familiar norms in a public informal space
- Invitations to one's home (personal, informal space, as opposed to public, informal spaces)
- Joking as an ice breaker
- Asking open-ended questions such as how things are going—inviting monologue—listening, allowing venting

A few community mentors confided that, just as many of the protégés were very shy, they, too often struggled with their own shyness.

Community mentors described four main strategies they tried in order to be of help to their protégés:

- Befriending protégés, acting as a friend/parent/grandparent
- Orienting protégés to the local area
- Helping protégés with their professional development
- Providing a personal “safety net”

We consider each of these in turn below.

Befriending protégés, acting as a friend/parent/grandparent

The most common understanding of the community mentor’s role was to befriend protégés and provide them with interpersonal, social support. Variations of this included being a confidant, someone with whom to have fun outings, a surrogate parent or grandparent, acting as a resource (lending camping gear was most often mentioned) and providing personal support as needed:

I take it very personally. It’s something that I choose to get involved with and to follow through. I’m sure that from a mentoring, the “professional mentoring” thing, I don’t think that I quite qualify as a quote “mentor.” I’m more like a friend, a support person. I don’t really think of it, because mentoring to me is teaching and I don’t think I have anything to teach them except for what I can help them through with the program. What they’re going to learn is part of life. And my teaching them is wasting time. They’re not going to listen about that. My job is to get them through the program and to help them be able to learn and adapt.

Another community mentor had a similar view of being a general support person, but with a more practical bent:

We had a lot of talks, not so much about the science part—I wasn’t a science mentor, as much as I was like a living-the-life kind of mentor. We had tons of conversations regarding how the world works and what is important to dream, and sometimes, especially there were some people in the minorities had a hard time just figuring out how to solve the daily issues. Like, you know, putting gas in your car or... So how to work around all those issues keeping in mind the bigger goal.

Community mentors talked about how they saw making protégés feel welcome and building their confidence as central to their mentoring goals:

I am a proponent of positive reinforcement. I don’t ever criticize them. I just reward them. Not “reward” them, but I compliment them a lot, even for small tasks or accomplishments.

Another commonly reported demonstration of support was attending the protégés presentations. Some community mentors offered constructive criticism, and others attended in order to provide moral support. Likewise, some community mentors made a point of reading the protégés papers, whether to offer suggestions or to communicate their interest and support. For some community

mentors, the strict separation of their roles as a general support and all-around resource person, distinct from the research work or the writing and research mentors, was viewed as important. They viewed the separation of roles as distinguishing them as unconditional promoters for the protégés, without any agenda for the protégés. In short, however else community mentors saw their roles, they embraced the notion of being the protégés' allies.

Orienting new protégés to the local area

Another common idea about the community mentor role involved orienting protégés to the local area, whether at UCAR specifically, Boulder more broadly, or even the Denver metro area as a whole. "Orientation" was interpreted differently by various community mentors: as a practical familiarity with the physical locale, and as a psychological comfort with the local culture. For the former, this translated into introducing their charges to the physical layout of the area and helping them with any logistical problems. To the latter it meant introducing first-year protégés to people (and maybe places), so that the protégés came to feel comfortable and well-acquainted.

Helping protégés with their professional development

Community mentors helped protégés with their professional development in a variety of ways. Some offered their scientific expertise and advice on their protégés' research projects. Others edited protégés' written work. Some helped the protégés "translate" their science into "ordinary speech" for their presentations. Still others helped protégés with computing problems. Those few community mentors who felt uncomfortable with or unable to establish a more personal relationship with the protégés, sometimes opted instead to provide support with protégés' professional development in these ways.

My general impression was that you just do whatever it is. There's no real description or no real constraints as to what I had to do as a community mentor. And I think, in the end, I fell more into, because of what my scientific interests were, they enabled me to kind of relate to the project that she was working on. I was able to kind of act as a second kind of scientific mentor and just give her advice about what she's doing, how she's presenting it. And in some ways I kind of bridge both the science and the writing aspects of it. I told her what my philosophies were... I really can't spend a lot of time with her outside of the work hours, but during the work hours I can try to get her feeling comfortable in the NCAR community, and that was sort of my feeling for what it was I was supposed to do.

One mentor described how he encouraged his protégé to explain her research project to him. It was this mentor's hope that the protégé learned from and enjoyed the role of teaching.

Aside from research-specific help, a few community mentors also tried to help protégés network, introducing them to other scientists, particularly at UCAR, although community mentors often reported feeling particularly unfamiliar with many of the scientists, themselves. To at least one community mentor it also meant including them in social gatherings of local professionals, such as at professional seminars of interest. Other examples of non-project specific professional support are: community mentors who as, persons of color themselves, sometimes discussed with their protégés, their own experiences as minorities at UCAR; and one community mentor who said that she, in response to her protégé's request, advised the protégé on how to dress appropriately for the presentations.

Providing a personal “safety net”

Community mentors also frequently saw their role as a resource for the protégés when they needed help of any sort that either did not seem to fall in the “job description” of anyone else, or when protégés needed help negotiating the SOARS structure, itself. In particular, help with negotiating the SOARS structure might be needed in the event of a conflict between the protégé and any of the other mentors (peer, writing, or research), or if they were in conflict with another protégé.

A potential problem with a general, but anomic, safety net role is that it may be invisible to protégés. As a couple of community mentors noted, they felt they ought to be on the sidelines, prepared to help their protégés, if the protégés seek them out. It is not clear, however, if the protégés are fully aware of the capacity for community mentors to provide specific help in particular situations. Blanket offers of, “Let me know if I can do anything,” while warm and genuine, are often sufficiently vague and passive that they are essentially empty, and unlikely to be utilized when needed. This is not an artifact of SOARS, but rather of miscellaneous “safety nets,” themselves.

Protégés’ observations about community mentors

Most of the protégés found the community mentors to be beneficial. In broadest terms, the community mentors helped new protégés acclimate to Boulder. Community mentors provided information about the area, how to get around, and what activities were available. Outdoor recreation is among the many regional recreational activities common to the Boulder area, and several community mentors loaned protégés their camping equipment for weekend camping trips that protégés took together.

Many protégés described their relationships with their community mentors in terms of valued friendships. Some protégés appreciated having an adult perspective in addition to the perspectives of their peers. One example of a protégé who valued having a friendship that spanned an age difference is a protégé who told us how she appreciated learning to bridge gaps in perspectives informed by differences in age. Others glossed any age differences that may otherwise have separated protégés and mentors.

Some community mentors invited protégés to their homes and included them in family activities over the course of the summer. Others would occasionally meet for lunch with protégés, offering opportunities for conversations about research, careers, or simply personal issues that protégés may have wished to discuss.

In sum, protégés cited the following specific ways in which they benefited from community mentors:

- Help acclimating to the Boulder area
- Companionship and friendship
- Opportunities to discuss stressful issues with a relatively “neutral,” yet supportive, individual
- Information about, and insight into, specific scientific disciplines
- Sounding boards for or active sources of help for work on the summer research projects

- Help with technical aspects of science projects, including writing, science methods, and computer programming.
- Support and feedback regarding practice talks and presentations.

Mentoring Relationships with Protégés

Some UCAR mentors had a professional and social relationship with their protégés, where they went to lunch or dinner with the protégé. They tried to build rapport by breaking down formal barriers and making their protégés more comfortable with them, such as by going to get coffee or juice together. Some had their protégés to their homes for dinner with their families. While some limited discussions to work-related topics, such as how things were going with regard to SOARS, others had personal talks about their protégés' hobbies or social lives. Other mentors preferred to limit their relationships with protégés to purely business. As one mentor explained, with so much work to do, he did not want to sacrifice mentoring for chatting. In these cases mentors expected the protégés to seek out other protégés or the SOARS staff for support on non-research or non-assignment-related issues. Both strictly professional and a combination of professional and social approaches were broadly regarded as appropriate.

The UCAR Mentoring Team

SOARS encouraged protégé mentors to interact as a team to facilitate the best mentoring experience possible for students. Interaction of the mentoring team included discussion of the research project schedule, writing and presentation assignments, how the protégé was doing, and other details supporting protégé progress. Many mentors reported having meetings with other members of their protégé's mentoring team. In half of the cases, all three UCAR mentors and the protégé met together, in the other half only the research and writing mentors met with the protégé. Occasionally mentors, especially those who worked near one another, met informally to discuss how their protégé was doing. Most of the mentoring teams met early on in the summer to discuss the goal of the research project and the science underlying it. This was particularly valued by the community and writing mentors, many of whom were not in the same science subfield as the research mentor, or were not scientists. Understanding the science helped the other mentors better coach and support the protégé on the writing and presentation assignments. Community mentors also valued learning how the protégés were doing from the other mentors' perspectives and how to better support the protégés and the other mentors. A few teams met regularly throughout the summer to discuss how the protégés were doing, to debrief on the protégés' practice talks, and support the protégés as the final paper and colloquia presentation deadlines approached. Mentoring teams met less frequently for experienced protégés versus those who were new or otherwise needed more support. One barrier to mentor collaboration was that some non-scientist community and writing mentors felt intimidated by scientists generally and, in a few cases, their protégés' research mentors, specifically. We also heard of one case in which a writing mentor tried repeatedly to set up a meeting with the research mentor who never agreed to meet. Occasionally, mentoring teams experienced conflict, such as when the writing mentor disagreed with the appropriateness of the research project, or the mentors clashed over how the research project was conceptualized or conducted.

Peer Mentoring

After the first few years of SOARS, Dr. Windham came to believe that returning protégés could be of significant help in setting a good tone for the new protégés and in ensuring their integration

into and success in the program. In keeping with the underlying philosophy of SOARS that protégés learn to become leaders, he introduced peer mentoring as a structural element of the SOARS program. Peer mentors are returning protégés who are trained for and take on the role of supportive friends to first-year protégés. They have a core of responsibilities over the course of the summer program that revolve around facilitating the inclusion of their mentees⁴ into the protégé community and the success of their mentees in their research work. Because adjustment to and success in the program are multi-faceted, the peer mentor role is flexible and accommodates whatever creative ideas the peer mentors may invent to help their mentees.

According to the SOARS mentor training, the formal responsibilities of peer mentors were as follows:

- To support the protégé's social learning
- Model “best” practices for navigating UCAR, delivering presentations, developing professional relationship

Returning protégés typically looked forward to assuming the role of peer mentor. In part, they see becoming a peer mentor as an opportunity to “give back” the kindnesses shown to them by their own peer mentors:

It's something that lets you give back a little bit of what you've gotten and make friends.

In addition, there is a social distinction that peer mentors hold among the protégés. It is a position of leadership and of trust. At the same time, there is a norm in SOARS generally, and among the protégés themselves, that such elevations in position are to be minimized. This is part of a conscious effort to reassure the first-year protégés that all protégés have equal status, are equally welcomed, and equally valued, as a first-year protégé describes:

There was some effort being made to just be friendly and welcome them, but also at the same time, they were considered “peer” mentors. So, it was basically they were there to show you the ropes and not there to be condescending in any way or have some sort of higher status.

While the peer mentor role was not authoritative in nature, peer mentors did develop attitudes of responsibility toward their mentees. The minimization of status difference did not expunge the status differential altogether, just as the same value of equality that is emphasized in the protégé-scientist relationships does not extinguish the status differential there. The democratization that occurs is genuinely embraced. However, the fact that it is appreciated as a social “gift” of sorts, indicates that a status differential exists, albeit graciously minimized. In a truly level social relationship, any indication of leveling a higher and lower status would be seen as “putting on airs” because of the assumption made that there is a higher status that could be adjusted.

⁴ For the sake of clarity, the term “mentees” is used in this section in which we discuss protégés in both roles—as peer mentors and as first-year protégés.

Peer mentor-mentee relationships and interaction levels

Frequency of interaction between peer mentors and their mentees ranged from daily connections to conversation only when groups of protégés were gathered for another purpose. Interaction varied because of the nature of:

- The personal relationship
- The level of need perceived by either party for peer mentoring
- The proximity of the protégés' work sites

Some peer mentors made an effort to stay in contact with their mentees, while mentees were out doing fieldwork, checking in with them, trying to keep them in the protégé social circle. Upon mentees' return from the field, these peer mentors ensured that the mentees were included in the social activities of the protégé community. Since maintaining social ties with the other protégés while one is working in the field, poses a considerable challenge to protégés, such efforts on the part of peer mentors were especially appreciated by mentees.

Others, by contrast, described a limited connection and difficulty establishing comfortable bonds. Such relationships were not necessarily characterized by tension or difficulty, but rather a simple lack of “click” or particular friendship connection. In some cases, mentees would establish friendships with other protégés who then filled the role of informal peer mentors. In addition, a few mentees preferred to be more independent and opted not to call on their peer mentors.

While peer mentors expressed some disappointment when their mentees did not demonstrate a need for them, they generally took it in stride. The steady focus of the SOARS program broadly and the peer mentoring aspect specifically, on the welfare of the mentees made it easier for peer mentors not to take infrequent contact personally. The frequency with which new protégés found friends who subsequently served the function of a peer mentor served to de-personalize any disappointment felt by such “under-used” peer mentors. In some cases, though, peer mentors and mentees maintained contact throughout the academic year after the SOARS summer.

Peer mentoring strategies

Even though the peer mentor role is open to creative interpretation, it has become routinized in most respects, as discussed in this section. We found five main strategies that peer mentors employed:

- Befriending new protégés, making them feel welcome and included in the program
- Offering ongoing psychological support and friendship
- Helping the new protégés adapt to the new location and anticipating protégé needs
- Providing practical advice about managing the research project and other program features, including tips about professional development
- Socializing the new protégés into the peer culture and the SOARS culture

Each of these are addressed below.

Befriending new protégés

Peer mentors were often a new protégé's first contact at SOARS. Peer mentors typically reassured the new protégé that he was entering a nurturing, supportive environment. Many new protégés arrived at UCAR with apprehensions about a competitive environment at UCAR, and equally competitive, "smarter than me" SOARS protégés. Peer mentors were key in dispelling these misconceptions and in reassuring first-year protégés that they were welcome, included, and would be successful in the program.

The peer mentor was integral to developing and maintaining the cohesiveness of the peer community and peer culture. Peer mentors play a supportive role for the first-year protégés, acting as experienced protégés who have a holistic kind of interest in seeing their mentees adjust to the SOARS program (both in practical and in social terms), and succeed in their research projects. Because returning protégés come back to an established peer group, it would be easy for them to focus on their ongoing friendships and lose track of newcomers. The peer mentor role helps to prevent the first-year protégés from slipping through either practical or social "cracks."

One big job of the peer mentor is to bring you into the group. Because we're already established... You come into the group as a solo person. You come in by yourself, whereas the returning protégés, we all know each other. We can hang out, just pick up where we left off the day we left. Whereas the new protégés, you come in as this whole new experience by yourself. And if you have that loner type of person, it could very well happen that they will be in their room all the time, or this that and the other, and be very left out of the whole SOARS experience.

Peer mentors also offered social interaction for new protégés, as someone to talk to and engage with before other friendships and bonds developed. Some of these relationships became close friendships while others did not. The presence of the peer mentor was appreciated, however, despite the nature of the mature relationship.

Ongoing psychological support and friendship

Mentees also gained intangible benefits from the interaction with their peer mentors, beyond help and support with specific research, writing, and presentations. Mentees received encouragement and validation from peer mentors, who were often older role models and looked up to by mentees. Mentees enjoyed the social interaction and gained communication skills from engaging with these older, more confident peer mentors. Peer mentors took a global kind of responsibility for their mentees, and sometimes offered candid advice with regard to social interaction and presentation of self. Overall, peer mentors offered support by: providing encouragement, offering advice, critiquing mentees' oral and written work, attending mentees' practice and final oral presentations, and ensuring the mentees' inclusion in protégés' organized and impromptu activities.

Helping the first-year protégés adapt

Peer mentors also had the practical function of helping new protégés spend less time figuring things out on their own so that they could quickly focus on their objectives and work in the program. Peer mentors often helped orient new protégés and acquaint them with the Boulder

area, answering questions or addressing concerns. Peer mentors were particularly valuable in this role because they often appeared to new protégés to be more approachable and more available than were the scientists who acted as mentors, and the SOARS staff. Furthermore, the scope of the support from peer mentors was not limited to a particular area, but would cover practical issues such as transportation, personal problems or concerns, as well as specific scientific or research questions. For example, one peer mentor saw his role as helping the mentee develop problem-solving skills. Oftentimes new protégé needs and apprehensions were anticipated by peer mentors. New protégés were relieved to have someone who proactively offered advice and support.

Providing practical tips to facilitate success with research projects

Mentees also benefited from peer mentors' experience. Protégés were actively involved with each other's research experiences and, in particular, their writing and presentations. Peer mentors offered mentees valuable critique in writing and presentation. The fact that protégés lived in close proximity provided a resource for mentees when other mentors or scientists were not available. Peer mentors edited their mentees' papers and encouraged their mentees to practice their presentations, providing feedback and critique, sometimes late into the night. Mentees gained pointers and practical advice about giving professional talks, as well as help with technical problems or making a smooth PowerPoint presentation. Because of their prior experience, mentors helped mentees make their presentations more concise and effective. Peer mentors also provided moral support by attending protégés' presentations, listening carefully and asking questions. In some cases mentees benefited from their peer mentors who had some knowledge about their specific disciplinary or scientific areas. Sometimes a peer mentor helped a new protégé stay on task, inquiring into the progress made in research or writing or reminding them of their responsibilities as a protégé.

When particular mentor relationships were limited in some way, such as when a community or writing mentor was out of town, peer mentors often stepped in to help fill that role. Some peer mentors supplemented the other mentors' roles even when these other mentors were available:

It was like she encompassed, I mean she took everybody's position. She checked over my paper like my writing mentor. She helped me even if she didn't know what I was doing with my research, on my research. And she was my community mentor too, because she took me places. I mean I went all over Boulder...

Socialization into the protégé culture and into SOARS culture

Peer mentors helped to socialize new protégés by giving protégés practical pointers and in transmitting the SOARS protégé culture via stories retold from one summer to the next and in sharing their own personal experiences from previous summers. This helped to set the tone of the program and transmit normative values and expectations in behavior. In this sense, the practices and knowledge gained by one cohort of protégés was passed down to subsequent cohorts of protégés, preserving the core culture. This was consciously built into the peer mentor role from the beginning, as an alumnus protégé described:

There was a fourth level of mentoring: we had the community mentors, the research mentors, the writing mentors, and the peer mentor. That was very important in that we

had a lot of new students coming into the program. Again, when I started the program it was fairly new, so we were trying to find ways in which we could acclimate the new students to the program, and not always have someone hovering. And since we had to live in the same environments, we had apartments, and we'd always be there. Tom [SOARS director] thought it was important to have peer mentors. Someone they could come to who's right on site, they don't have to call anyone else. And that was quite important because we were there at those awkward hours of the evening when someone needed to talk, or vent, and just needed someone to say, "Okay, no you're not crazy."

First-year protégés' appreciation of the peer mentors

The peer mentor role was often central to the first-year protégés' successful experience in SOARS. First-year protégés expressed great appreciation for the ongoing welcome and support that peer mentors extended to them. The camaraderie and encouragement they received were seen as key to their SOARS success by some protégés:

She [peer mentor] was like my [sister], my [mom], my friend, the person I could talk to...I mean the first day I got there she had cooked for me, so I had some food to eat. And I mean, anytime she was going somewhere, if I was going to sit in the room, it was, "[name] is not sitting in the room, she will not be sitting in that room today." I had to go!...Because [name] was going to make sure that I was interactive in everything. I was doing, something. And I loved it! I appreciate...out of everyone this summer, there was, they were all wonderful to me, they were all like family. I mean, coming here was like, it was no color, it was no race, it was no size, it was no nothing, you were just another person...She came in and she just took over all these roles, and these positions, and just made the transition so easy. If I become a peer mentor, I want to be a peer mentor just like her. Because she made the transition so easy for me, it was like I didn't even try, I didn't get a chance to miss home, I didn't get a chance to be sad. I didn't get a chance to not feel the part, I didn't get a chance to, to feel down, because even if she had tighter bonds with other people, she made sure that every minute I knew that she, if I needed her, I could call on her...But, so she did a lot for me. I think she also helped me in a large part to feel at home, and also to feel like I can do something. Because I'd see that [she's] done something, and [she's] accomplished something, and she keeps pushing forward. And we've had, we had a lot of like incidences in our life, and stuff that goes wrong in our life, and she told me that she could get over it, and all you have to do is just take that step and try to step over it, and you can make it. Because if you keep on standing behind it, you'll stand behind it all your life, and never get anywhere.

Informal peer mentors

In some cases, though, the peer mentor plays a more auxiliary role. First-year protégés commonly found the support through other people, such as roommates, other first-year protégés, or other returning protégés. In these cases, knowing that a peer mentor is available and stands ready to help as needed, provides a measure of psychological security, which is appreciated as well. First-year protégés established informal mentoring relationships often enough that these became recognized, accepted, and regarded as assets in the overall SOARS experience. As a peer mentor explained:

The idea of coming up with a peer mentor-mentee is that no one gets left behind in the program. But in reality what happened is that we all help each other. That's what really happens... Everyone helps everyone in different ways... So, you have someone that you have to take care of [as a peer mentor]—see that they're getting everything they need, but in reality, I may not click that well with my peer mentee, and well, I'll still help them but maybe [name] here is the one that's taking more care of him and at the same time somebody else is helping at that place...actually we're helping everybody.

The minimization of the status distinction that comes with the peer mentor role also appeared to contribute to the acceptance of informal peer mentors. Just as peer mentors felt a sense of responsibility to their mentees, they oftentimes maintained an awareness of their mentees' needs, and remained ready to offer support if they perceived a need, but stayed in the background.

A lot of times what would happen is, I may be a mentor to a particular student, but they may talk to another peer mentor. It's just who they feel comfortable speaking with. So that peer mentor may say, "Okay, your mentee may need some assistance in XYZ area, you know, can you forward this information to whomever it needs to be forwarded to." So the idea was kind of we were tag teaming a lot of times in those situations. And after that when the mentor, like I said, when the whole group of students were there, we met periodically with Tom Windham, kind of to debrief him as to how the living situation was going ...and just how the students were getting acclimated to their work environments, and their living environments.

Benefits of the peer mentor role for peer mentors, themselves

Peer mentors identified three types of benefits they gained from being peer mentors:

- Gains in professional development
- Personal growth
- Intrinsic rewards

Peer mentors found their role mutually beneficial with regard to learning. While the mentees profited from the tutoring that peer mentors provided, the peer mentors reinforced their own conceptual grasp of the material in the process. Peer mentors also benefited from learning about their mentees' science projects, reinforcing their scientific knowledge generally, and their exposure to more disciplines related to atmospheric science. Helping their mentees also provided them with the opportunity to practice verbally explaining science concepts, thus enhancing their verbal skills. Peer mentors cited improved writing and editing skills as they practiced critiquing their mentees' written work:

Every problem that you help the person solve, you learn from. In some cases, simply seeing another's writing style contributed to learning about writing, and providing critique sharpened their writing skills and overall communication.

The practice of being a leader and a mentor for new protégés was an empowering experience and emblematic of the latent potential within all protégés. Peer mentors cited personal benefits from assuming this level of responsibility. As role models, peer mentors were challenged to assume a

higher level of maturity and self-discipline. Peer mentoring was intrinsically rewarding in that peer mentors found helping others to be very gratifying. Sometimes this was described as the satisfaction of “giving back” to the SOARS program, from which they had gained so much. They also enjoyed sharing their knowledge with others and valued the opportunity to help mentees accomplish their own goals. Peer mentors valued seeing their mentees progress and succeed through a SOARS summer, and felt pride in helping them develop skills and confidence. For example, one participant we spoke with talked about the benefits of considering another’s needs, desires, and career ambitions when formulating advice and guidance:

Seeing someone progress though the summer—I mean, especially in your first summer in this program—someone may or may not have had experience with scientific writing, someone may or may not have had experience with presenting in front of their peers, as well as professional scientists. So, when you’re checking up on your mentee’s paper, and watching his or her practice talks throughout the summer, leading up to the final colloquium, you do see people get more comfortable talking in front of people and they get that paper together. So, it’s rewarding in that respect. [Another peer mentor in this focus group voiced agreement]

Additionally, in the course of spending time helping their mentees with their research projects and writing, peer mentors also learned about other protégés’ backgrounds and cultures.

One interesting outcome of protégé ownership of peer mentoring is that peer mentors have reported raising their expectations of their own behaviors, to be better role models for the incoming protégés. For example, one peer mentor reported trying to act in more mature ways, toning down her partying in particular, in order to set a more mature example:

Interviewer: Does that change things a lot, having to be a role model?
Peer Mentor: At least for me. (laughs)
Interviewer: Does it? How does that change?
Peer Mentor: Well, I might be behaving better this year. (laughs) I mean you know, from last year to this year, I think I’m trying to pace myself.
Interviewer: Were you going too fast last year, or too slow?
Peer Mentor: Too fast.

Challenges for peer mentors

Peer mentors were eager to examine and improve their mentoring practices. In their periodic meetings with one another, they reflected on their mentees’ needs and on their own experiences as peer mentors. The emphasis in these meetings, as elsewhere in the program, was on continual self-examination and improvement, and putting into practice protégé feedback. They generally recognized that there is no single formula for a good peer mentor-mentee relationship, but appreciated learning from one another’s experiences, which contributed to the dynamic nature of these meetings.

One of the challenges peer mentors identified was striking a balance between initiating action with a mentee and waiting for the mentee to seek out the peer mentors, after inviting the mentees to bring to them any problems or needs. Protégés preferred that peer mentors act as resources,

rather than constantly, hovering over mentees, imposing the mentoring relationship, and acting as a ready resource was one way in which to incorporate this “light handed” support system. The challenge of finding this balance lay in facilitating the mentees’ comfort level with seeking out the peer mentor for help. Note that this is not unlike the challenge that other mentors reported in striking a balance between support and independence in their relationships with protégés.

Another challenge was that of adapting one’s mentoring style to accommodate individual mentees’ needs. Peer mentors recognized that dynamic and unpredictable factors, such as personality, influence the shape of a mentoring relationship, and are key to successful peer mentoring. Developing versatile communication skills was a challenge for peer mentors and mentees alike. As these (four separate) peer mentors (in a focus group) answered when asked what they found the hardest about being peer mentors:

- 1st Peer Mentor: Knowing when to back off.
- 2nd Peer Mentor: And knowing when to step in.
- 3rd Peer Mentor: Yeah. Level of involvement.
- 4th Peer Mentor: And it is really kind of strange because what [name] was saying before: It depends on the mentee and we as a peer mentor have to cater to their needs. Because my relationship with my first year mentee is totally different from my relationship with this year’s mentee.

Some peer mentors struggled with their own leadership skills and mentoring techniques. Despite the recognition that personality or differences in personal preferences or learning styles were occasional barriers to developing ideal peer mentor-mentee relationships, peer mentors held themselves to high standards and felt disappointed when relationships did not live up to their expectations. Peer mentors were not overly hard on themselves in such cases, but did feel let down.

Despite strong advice and leadership from Dr. Windham, and appreciation of the non-hierarchical nature of SOARS relationships in general, there were a few instances in which first-year protégés reported feeling that peer mentors assumed an attitude of superiority. In a couple of instances, first-year protégés complained that their peer mentors had talked down to them or made them feel dumb, especially when critiquing their writing. Several peer mentors acknowledged the challenge of trying to critique without appearing patronizing. Learning to provide critique without offending the writer was a problem for writing mentors, as well as for peer mentors. It is possible that consultation between writing mentors and peer mentors would be helpful, as they both grappled with this particular challenge in their own roles.

It was suggested to us that new protégés may feel threatened at first with a peer placed in a position to mentor them. This was especially clear in the case of a new protégé whose cultural background contributed to his discomfort with a woman as a peer mentor, as it implied to him that she was in a position of authority over him. Similarly, in a few other cases, mentees expressed discomfort with peer mentors who were younger than them. Happily, in the instances where there was an initial problem, it appeared not to persist, as the participants told us things later improved or worked out and the peer mentor role was clarified as one of support and

guidance, rather than authority. It is also helpful to recall here that incoming protégés generally expressed reservations about coming in as “freshmen” into a peer group with other protégés who would “surely be smarter than them.” This “imposter syndrome” was common, and in all cases we noted, was dispelled in short order upon the warmth of the welcome extended to them by the returning protégés and as they came to understand their peer mentors as supportive *peers*, distinguished only by their additional experience with the SOARS program.

The costs to peer mentors

Protégés also discussed with us the costs of being peer mentors. They were in general agreement that the benefits of the role for themselves, as well as for the mentees, and the SOARS program overall, were well worth the costs. However, they did experience some frustrations and challenges. In particular, the role required a good amount of their time and energy—commodities in limited supply for all protégés.

The amount of time invested into a peer mentoring relationship was dependent upon the nature of the relationship, the needs of the mentee, the dedication of the peer mentors, and the point of time in the summer session. The end of the summer marked a particularly demanding time for all protégés, and some peer mentors found commitments they had made to read or edit a mentees’ work to be taxing. Some peer mentors devoted more time and energy to their role than others, and a few of the more committed admitted compromising some of their own personal time or research and writing obligations. On the other hand, some peer mentors devoted less of their time to their mentees. A few spent proportionally more of their time with their other friends, particularly “going clubbing” or otherwise partying.

Peer mentors also told us that some mentees were overly needy, approaching the peer mentor with trivial questions of a practical or personal nature without first trying to find the answer themselves. This, of course, contributed to the costs peer mentors experienced.

Practical challenges contributed to some peer mentors’ difficulties, as they did not work at the same site as their mentees. For them, this diminished the number, and perhaps types, of opportunities they would have used to provide peer mentoring. However, as pointed out above, some protégés considered the peer mentor role as support between friends outside of the project work environment. For them, location was not an issue.

Mentors’ observations on peer mentoring

Other mentors (other than peer mentors) had little to say about the peer mentor role. Their lack of commentary would seem to indicate that they were either largely unaware of the role, or did not recognize the substance of the contributions that peer mentors made. It is doubtful that mentors considered the peer mentor role to extend much beyond an initial friendship and peer resource, akin to a resident assistant role in a college dormitory—helpful, but not necessarily key to one’s core educational experience.

In summary, returning protégés were trained as peer mentors, and provided friendship as well as practical support to first-year protégés. Peer mentors made the transition for incoming protégés easier by making them feel welcome and assured of their inclusion in the protégé group. They also provided ongoing support over the course of the summer, including practical help with research projects. Peer mentors also ensured the continuity of the SOARS culture and the

protégé culture of community. Peer mentors appear to be well-prepared for their roles, although they did not consistently recognize the leadership training exercises that promote group processes as relevant to leadership, per se. The institutionalization of the friendly inclusion of incoming protégés via the peer mentoring role ensures protégés' readiness to assume the significant research work required of them in the program. In part, this is done through the reassurance of full inclusion in SOARS and the protégé community, and both moral and practical support needed to be successful. The morale of the protégés, the related productivity and quality of their work, and their allegiance to science careers are all affected by the peer mentors.

The Protégé Community

One of the strongest indicators of protégé bonds to one another and the SOARS community was the end-of-summer SOARS Recognition Celebration, where protégés offered thanks to those that made their SOARS experience valuable, including the protégé community, their mentors, and the SOARS director and staff. With photos displayed on a large screen, protégés emotionally recounted images and stories of their SOARS experience. Joy and laughter filled the room in 2003 as protégés celebrated their summer experiences, while in 2004, joy and sorrow were prevalent as protégés said thank you and goodbye to Dr. Windham. One protégé summed up the feelings of many with a poem presented at the 2003 SOARS Recognition Celebration to two protégés who had just finished their last summer at SOARS:

Goodbyes are not forever

We all came here to undertake this endeavor
To be come the best protégés SOARS has ever encountered
Coming from as far North as New York and as far South as Puerto Rico
From California to North Carolina to discover what SOARS can do for us
but moreover what we can gain from SOARS
Dreaming of winning contest with our research
And upon our walls having plaques to perch
Yet we gained something more here
A sense of connection
A bond built on some unique perfection
That says it matters not where you came from but that you will always be a part of SOARS
So as we say goodbye
We know that with this bond that bye is only see you later
Because Goodbyes are not forever

Friendship and Strong Connections

Protégés often talked about the value and benefit of developing friendships and strong connections with other protégés. Meaningful bonds and close connections among protégés were created by virtue of living together, sharing the protégé identity, and experiencing the challenges of the SOARS program.

Several protégés with whom we spoke continued to maintain contact with one another beyond the SOARS summer, in some case years later. Participants sometimes met with one another at professional conferences, and others talked of making travel plans specifically to reunite with

each other. Meaningful friendships and connections made through SOARS continued to be valued by protégés years after their SOARS summer.

While a sense of cohesion and group community was important, protégés tended to develop especially strong relationships with a limited number of protégés. Some of these friendships became “best” friendships and continued long after the SOARS summer experience. “Best friend” relationships did not necessarily develop into cliques, although in later years there were more clique-like groups among peers, as discussed below. These relationships were not necessarily exclusive, but rather predicated upon shared interests, backgrounds, or personalities. In addition, a few protégés developed romantic relationships with one another.

Most protégés described the protégé group relations as a close-knit community characterized by a comfortable atmosphere, mutual support, and strong bonds of respect and friendship. This community of protégés was commonly depicted as a cohesive family. The word “family” was consistently used by protégés to describe the protégé group. For some, the interconnectedness of the protégés seemed to form naturally and without great effort. Close relationships developed quickly among protégés, surprisingly so, compared with their experiences of friendships in university and other settings. Protégés commonly described the community as holistic and nurturing, conducive to sharing personal and intimate experiences. One interviewee had this to say:

It’s just that sense of, I think, *family*. You know, when I first went, I was kind of worried: you know, we’re just going to be, individuals going there and doing our own thing, but we soon became our own group, our own family—a family of friends and that makes a big difference as well.... When you know there’s people that you can fall back on to ask questions about or talk about issues or problems that you’re having.

The gains to protégés from their sense of belonging to the social community can not be overemphasized. For many participants, the comfortable social setting increased their confidence in social interaction and enhanced their interpersonal and communication skills generally. The social community had a lasting effect upon participants and was a key component in the protégés successful experience within SOARS.

Factors contributing to cohesion

Protégés spoke a great deal about the factors that contributed to the positive cohesion that characterized the protégé group. Several of them mentioned that the small size of the protégé group was important in maintaining close interpersonal relationships. Others noted that the shared experience of involvement in SOARS brought the diverse group together. Protégés also described many instances in which protégés deliberately worked to maintain friendly and constructive relations. Protégés reported, and we observed, strong norms in place encouraging protégés to communicate and work through interpersonal tensions and obstacles between each other, rather than letting problems persist. In all, protégés discussed five main factors that contributed to the sense of community they enjoyed:

- Living arrangements
- Norms of providing support

- Values placed on collaboration versus competition
- Leadership roles' contributions to social cohesion
- Shared activities

Each of these factors is discussed in turn below.

Living arrangements

The living community was a crucial factor in promoting and maintaining protégé interaction and group cohesion. SOARS provided protégés with a central location where they all lived, with roommates, in a single apartment complex. Protégés had their own bedrooms for personal time and space, but they shared kitchens and living room areas with a roommate—two protégés in each two bedroom apartment. Protégés reported three main benefits of living together as roommates and as close neighbors:

- Provided opportunities for protégés to get acquainted outside of their daily work
- Provided opportunities for protégés to practice interpersonal and communication skills
- Protégés facilitated each other's success in the program by helping each other with research-related work and by practicing their presentations together

Protégés described the living situation as a positive social environment where protégés got to know one another quickly in a new environment. Since the protégés worked at different locations during the day, as they worked on site with their own research mentors, the common living location provided the main opportunity for protégés to interact with one another. Living so closely together strengthened protégé friendship bonds, trust in and reliance on one another, and an overall sense of community.

The living community also served as a place where protégés could practice and strengthen interpersonal and communication skills. The, overall friendly and positive, social interaction encouraged especially shy or introverted participants to gain confidence talking with others and for some, a newfound comfort level around their peers.

Another benefit from living so close together was the opportunity it afforded protégés to support each other, promoting one another's success in the program. For example, they helped one another with difficult research and computer problems and practiced their project presentations together, providing encouragement and constructive criticism to one another. As with the interactions throughout the SOARS program, protégés valued and practiced constructive, rather than negative critique. Protégés' support of one another often extended late into the evenings, as they were literally "there for" one another when needed:

That's where our support is. I don't think, if we [weren't] together I don't think we would be as successful in the program...[It's a] big thing. I mean everybody is there, and so if we're confused about something we can just go to them at two 'o clock in the morning and just be like, "I don't know!" (Laughs) But just knowing someone is there, you're not by yourself, oh God, it is so important! So that's where our support is, it's there in the apartments where everybody is—it's right there.

Protégés described an “open-door policy” where protégés often freely entered each others’ apartments when the front doors were left open in the evenings as a signal to invite companionship or provision of practical help with their science projects. At the same time, protégés could maintain a balance between private and social space. By arrangement, they would signal the need for some quiet time alone by closing their outer apartment doors. In this way personal time and space were also honored.

Norms of providing support

The strong communal bonds among protégés provided a foundation for an extensive support network. Protégés offered each other support and encouragement in many areas. For example, one protégé told us that protégés would set aside personal differences in a commitment to helping others develop professionally. In this sense, protégés acted as informal peer mentors for each other, offering constructive feedback on writing and presentation material, help and advice with research, as well as general and overall encouragement. Returning protégés played a vital role in creating this secure environment for sharing answers and advice. Confidence in the ability to succeed, and the ambition to try, were strengthened among protégés through this environment:

We’re a very close-knit community, and I think that that sense of support makes people want to go out and succeed.

The strong personal connections developed among participants facilitated a constructive support network characterized by encouragement and non-competitive collaborative learning:

I was just in awe of the other students and learned a lot from being in that type of group where we’re living together, and we’re working together, and we’re going on excursions together on the weekends, and [sharing] different perspectives on education and family. And finding that I wasn’t alone in this struggle to continue through graduate school—it helped me, it motivated me to continue on.

The value of collaboration versus competition

Though protégés recognized competition within the work environment at UCAR, they personally experienced little to none of this during their time at SOARS. Protégés offered several explanations for this. They also noted that the supportive, collaborative environment at SOARS reassured protégés that competition is not necessary, despite initial expectations of some that such a prestigious program would surely be competitive. Protégés spoke frequently about the culture of cooperation and collaboration among protégés, and contrasted it with a competitive environment they were aware of in other internship programs and university settings. This environment was greatly appreciated by protégés. They believed that cooperation was a better, more effective route to successful science careers than was competition.

Protégés suggested that their own diverse scientific backgrounds also helped them to avoid potential competition among themselves, whereas the likelihood of competition would be increased if all students studied the same sub-disciplines within atmospheric science. For instance, one of the protégés noted a subtle level of competition between protégés at SOARS who were studying similar aspects of atmospheric science.

Leadership roles' contributions to social cohesion

An important factor promoting group cohesion was the continuous, multi-year structure of the program. In particular, the leadership roles played by returning protégés, especially as peer mentors, which were made possible by the multi-year design, were deliberately focused on creating and maintaining an atmosphere of support and inclusion among protégés. Peer mentors helped set the tone for types of behaviors that promoted mutual respect, and clarified expectations of social interaction, particularly as they organized protégé group activities. Returning protégés drew on their experiences from prior summers as sources of information and encouragement for new protégés. Returning protégés were mindful of including all new protégés in group interaction, and not allowing any particularly shy or introverted participants to “slip through the cracks,” as discussed in the peer mentoring section above.

The protégés were aware of the role played by strong leadership in maintaining group cohesion, and returning protégés noticed some variations from one year to the next. Some protégés described the strong leadership role provided by protégés as having “parent-like” characteristics, as they organized group activities and worked to influence everyone to come together. This was especially poignant to protégés one year when a male and female protégé appeared to act as “mother” and “father” to the protégé group. In a group photo taken of them, the “parental figures” even appeared together, somewhat separate from their charges, much as families are often depicted in photographs where parents and children are distinctly posed.

Some protégés were seemingly unaware of leadership efforts returning protégés made to organize the group. For them, e-mails were the most obvious efforts made. Group cohesion appeared to be unconscious and “natural” to them.

Shared activities

Another important factor contributing to protégé group cohesion was shared activities. Social engagement through activities such as going out dancing, watching movies, taking short trips, and other organized events (some organized by SOARS' staff, others by the returning protégés), facilitated community building and personal bonding. Early protégé cohorts established a tradition of organizing group trips and camping expeditions, and this became a tradition that was carried over in subsequent years. Alumni protégés had fond memories of trips to Mesa Verde or Six Flags and camping trips in the nearby mountains. These activities strengthened their sense of community and helped define the culture of the protégé group.

Sharing food through organized group dinners, such as the highly celebrated “Soul Food Sundays,” also contributed to group cohesion. “Soul Food Sundays” were weekly occasions when protégés each prepared their favorite dishes, often those they felt represented their cultural backgrounds, and came together in one of the protégé apartments for a potluck. These occasions highlighted the cultural diversity of the group, serving as opportunities to acknowledge and discuss their rich, diverse backgrounds. Sharing food also promoted bonding on special occasions, such as a farewell luncheon for a protégé who had to, reluctantly, leave the program.

Increased Appreciation of Diversity

Protégés reported rewards they experienced with their own increased appreciation for diversity. They expressed delight in learning more about other protégés' racial and cultural backgrounds.

Though racism and race issues were rarely an explicit topic for discussion among protégés, many told us that they enjoyed interacting with people from diverse backgrounds and cultures and learned much from these encounters. Some described the diversity of the protégé group as a positive dynamic contributing to the community and enhancing the protégés' experiences. Protégés cited various benefits of the exposure to diverse people and different ways of thinking:

- Increased understanding of other cultures (particularly Native Americans)
- Greater tolerance and respect for differences
- Increased confidence that inspired more interaction with diverse people in the future
- Greater interpersonal and intercultural communication skills for interacting with diverse people in the future
- Enhanced sense of self and personal potential

A protégé explained why he valued being part of such a diverse group of protégés:

They were really [diverse]... racial, ethnic, personality, people's backgrounds as far as the type of homes they grew up in, financial background. There were tons of levels of diversity in that regard. And just learning a lot from different people from that aspect. Hanging out with that type of group and learning so much about people. It was definitely amazing.

A few protégés found that being among a racially diverse group was personally beneficial because it allowed them to connect with their own racial or ethnic groups or cultures. For example, one participant told us she gained increased confidence in and acceptance of her own ethnic culture.

The whole cultural interaction for me has been...it's...opened my eyes some and gotten me more comfortable with—I mean, honestly, the only ethnic group I've ever had problems of dealing with is blacks [her own ethnicity]. Hispanics, Native Americans, any other is just no problems. So getting myself more comfortable with that has helped me *a lot*...I started listening to hip-hop again and things like that. Random things, you know? Even if I had tried at [school] I probably would have been accepted. It's just, I had been avoiding it for so long that I just kept doing it and now that I'm more comfortable here then I feel like I could go back to where I *am* from and being like more comfortable there too. [Verbal emphases]

Diversity and a comfortable environment at soars

Positive implications of diversity at SOARS ranged from the liberating experience of normalizing an interest in science among one's peers to the comforts of fitting in with others because of the shared experiences or cultures. Protégés greatly appreciated the varying personalities, backgrounds, and ethnic cultures of their peers. Similarity as well as overall diversity among protégés allowed for an environment where culture and ethnic backgrounds could be appreciated, as could individual identities. At one end of the continuum, the sense of belonging promoted the pursuit of science:

In SOARS, just because you are the population and you're not a tiny little minority piece of the population—I think there was something to that too, as far as developing your own identity, or racial identity, and having that be a positive experience, and being able to talk about things in an environment that's...safe and inclusive and whatever, as opposed to—when these come up in a classroom setting and you're the only person that looks like you, or you're one of a few female students or whatever.

At the other end of the continuum, the diversity of the group freed protégés to feel comfortable with their own individualities. For example, this participant said he would advise new protégés to prepare themselves for this unique feature of SOARS:

And I'm going to tell them, "Be ready for a culture shock! (Laughs) Be ready for it, but be ready to appreciate it. Because it's going to be an experience that most of us growing up in this area have never seen. It's going to be an experience of a lifetime, when you're going to actually be free to be a person. Not to be a race, not to be a sex, but to be a person. You're not going to be based on your race, or your gender, you're just going to be a person. So you're going to need to enjoy that 10 weeks of being a person.

Even though in their interviews with us individual protégés expressed considerable excitement about the benefits of a racially comfortable environment, they also reported that racial and ethnic issues were not often explicitly or critically discussed among protégés. This is not to say, however, that the diversity of the protégé group went unacknowledged or unappreciated:

Interviewer: How often would the protégés talk about race issues?

Protégé: Not very often.

Interviewer: Why do you think that is?

Protégé: I think because it wasn't an issue in SOARS because we created an environment where race—finally race isn't an issue; where sex isn't an issue. So we didn't need to [talk about it]. It wasn't something that stopped us forgetting where we need to go, I think it just wasn't an issue.

Protégés relished being understood and respected on an individual basis. They also enjoyed living and engaging in science with other students from underrepresented groups who shared some of their perspectives, life experiences, and personal struggles. They valued seeing members of underrepresented groups excelling in science and research.

Breakdown of Protégé Cohesion

Despite the impressive level of bonding we observed among protégés, cohesion of the overall protégé group appeared (based on our interview data) to have lessened in recent summers.

The development of cliques

Notably, several protégés reported that cliques had started to form among the protégés. The increasing size of the protégé cohorts over the years may be an important contributing factor. Early protégé cohort groups were smaller, making whole group activities easier to facilitate. Some protégés also suggested race and ethnicity were factors playing into the fragmentation of

the protégé group and the development of cliques. As the cohorts grew, there were groups of protégés of particular races for the first time. Some protégés observed that members of a specific racial group would spend more time together, implicitly excluding themselves from the others, as one protégé explained:

When it started getting bigger, there started being enough students to where there could be five or six or seven or eight, of one particular race. You started seeing the separation, just in where people sat when they ate and, you know, who hung out together on the weekends.

In contrast, the diversity of the protégé group, itself, was a prominent group feature in past years.

Protégés also cited the addition of television sets in individual apartment as contributing to a breakdown of protégé community. In the early summers, protégés would often gather in a single apartment to watch television as a group. Later, with the arrival of individual televisions and free cable in the apartment complex, it was easier for individuals stay to themselves in their own apartments, watching shows of their preference by themselves or in smaller groups.

Conflicts between protégés

Protégés cited relatively few challenges, tensions, and obstacles encountered within the protégé group. They described challenges that did come up as occasional, minor, and normal problems to be expected in any ongoing social interaction, and these tensions rarely grew or persisted. Occasionally, an individual protégé would have difficulty fitting into the group because of simple shyness. In addition, those who spent much of their summer “in the field” working on their research projects experienced difficulties trying to reconnect with the other protégés upon their return. A few protégés also told us that divisions existed among protégés surrounding partying and drinking. While partying was popular among some, not everyone enjoyed it, and some felt pressured to conform.

In general, protégés proactively and consciously addressed tensions or negative issues among themselves. Protégés prided themselves in their abilities to, and their receptivity to developing skills in, productively confronting disputes and solving problems through open communication. These strong norms of promoting group cohesion often acted to encourage protégés to reexamine their own patterns of social interaction and to learn to compromise.

Interpersonal conflicts that were not resolved by the individuals were typically mediated by peer mentors or, if that failed, a community mentor, or even the SOARS director. Even though tensions and challenges among protégés were the exception, there were a couple of especially difficult disagreements between protégés that were not entirely resolved by the end of the summer that we observed.

Despite the overall consensus that the living situation was positive and emblematic of the protégé community, tensions and obstacles typical of roommate relationships and dorm-room environments pushed participants to work through personal issues. Some protégés reported that they learned empathy and respect by working through typical roommate-type tensions.

Roommates

Protégés were aware of the sensitive issue of pairing roommates. They expressed interest in minimizing roommate assignments as a source of potential conflict between protégés. A few suggested that SOARS staff survey participants and assign roommates based upon personal living habits, such as preferences with regard to tidiness, cleanliness, and/or if the protégé enjoyed drinking alcohol and partying. Other protégés questioned if roommates should be assigned by SOARS staff, and suggested that protégés ought to choose their own roommates. Some protégés recognized that, allowing protégés to choose their roommates may further encourage the development of cliques, especially drawn along the lines of new- versus returning-protégés. Because of strong friendship bonds formed in previous years, participants feared that new protégés would all choose to room with one another, creating a separation between them and first-year protégés. Concerns about this prompted some participants to endorse matching new protégés with returning ones.

Mentor Observations on Peer Collegiality

Mentors noticed the camaraderie among the protégés, and generally saw it as helpful to protégés as they faced a challenging 10 weeks each summer. Mentors expressed concerns about the challenges of building collegiality among scientists in general, and particularly for scientists from underrepresented groups who can expect a more difficult career path. Mentors expressed the hope that the close knit protégé community would produce colleagues of long-standing who will help one another in their future careers.

In summary, the gains and rewards to protégés from the social community can not be overemphasized. For many protégés, the comfortable social setting increased their confidence in social interaction, enhanced their interpersonal and communication skills, and contributed to work on their research projects and presentations. However, the housing arrangements did not, in themselves, guarantee a sense of community among protégés. Other social dynamics must also be considered, such as the sheer numbers of protégés, perceptions and appreciation of diversity, and activities (including the assignments of roommates) that serve to bring protégés together versus dividing them into groups. The long-term benefits of developing a network of collegial peers may be of crucial import for the protégés as they enter in their future careers.

It should be noted that establishing collegial relationships with research advisors and other peers are common gains from undergraduate research opportunities (Hunter, et al., 2005).

Undergraduate research programs with the objective of increasing underrepresented groups' participation in the sciences are often premised upon building strong collegial relationships between faculty and students and strong peer communities since integration into and feelings of belonging to a learning community have been found to positively effect students' persistence and retention, especially for underrepresented groups (Astin, 1975, 1982, 1993; Pascarella and Terenzini, 1989, 1991; Tinto, 1993; Terenzini and Pascarella, 1977; Levin and Levin, 1991; Braddock, 1981; Fleming 1984).

XI. ISSUES OF RACE AND GENDER

Race and Gender and the Mentoring Relationship

Most mentors reported having no notion of how race affects protégés' experiences during their SOARS summer, because it was not a topic that they broached with their protégés. Some mentors avoided the topic because it was uncomfortable for them to talk about and they suspected that it was uncomfortable for the protégés as well. Other mentors felt that such discussions were beyond the purview of their mentoring role. Bringing up the issue of race seemed risky to mentors because they were afraid of appearing racist in some way—it was an “iffy topic to broach in the workplace.” As one mentor explained, he did not know if it was necessary or even acceptable to discuss race and ethnicity, so instead he tried to model the value he placed on diversity:

I've never discussed ethnicity with any of the protégé's, I wouldn't know where to begin. I wouldn't know if it were acceptable, if it were necessary. Is there something particular, I don't know... I don't have any different idea where the cultural or the ethnicity angle comes in at all, if it should come in or if just being who I am and living that and modeling that for them is enough. Nobody's told me otherwise, so I guess it is enough, but every now and then I wonder, is there something I should be addressing or should I just be myself and show them this and somebody else has taken care of the rest. So that's a bit of a puzzle.

In addition, EuroAmerican mentors wondered how protégés felt being in Boulder and UCAR and amongst the other protégés:

I've taken students before, for example, to [a place in Boulder]. And on, at least one occasion I thought, “This is the only black face [here] this morning, how does that feel?” And, in that case, this young woman was so confident, and so centered, and I think she had a really amazingly, supportive family, and did go to an all black school in [city]. So there has to have been some awareness on her part, that in some cases that she was different, and we had talked about that through the summer.

Only a few mentors reported having discussed race and gender issues with their own or other protégés. Mentors who were members of underrepresented groups could identify with the protégés and the challenges and joys related to race or gender. A couple of female mentors discussed with their protégés experiences they had in overcoming gender barriers in their science careers, such as addressing hierarchical cultural values, norms for communication and emotional expression, and issues of maintaining one's diversity in an otherwise homogenous workplace. A mentor who was a racial minority chose not to discuss racial biases, because it was too painful, but instead talked about overcoming difficulties.

Even though most mentoring relationships were cross-race and cross-gender, mentors believed that, at least at a conscious level, it did not affect how they mentored their protégés. In addition, when asked how issues of diversity might affect their mentoring, most mentors believed diversity had no little effect and no negative effect on mentoring experiences and outcomes:

[P]rotégé is a [racial minority] woman but that really hasn't affected how I'd treated her, or seen her at all. I mean, to me she's an undergraduate who's learning how to do research and her race and gender's immaterial to that.

Both mentors and SOARS staff felt that race and gender “just were not big issues” in the SOARS mentoring relationships. They felt that protégé-mentor relationships were not hindered by issues of race or gender.

UCAR, in general, was seen by the primarily white male mentoring population as a progressive organization whose people value diversity. As one mentor explained, UCAR has a sufficiently international population that the work environment would be comfortable for protégés. Mentors generally believed that protégés were welcomed into UCAR as researchers who were expected to succeed in their career paths. Some mentors held a colorblind perspective and tried “not to see it” and instead sought to treat everyone as individuals, a strategy which ignores cultural and experiential differences. A few mentors believed that the protégés were not concerned about race issues because they had already overcome them.

Occasionally mentors wondered whether specific protégé behaviors that they observed were rooted in cultural norms of the protégé's race or gender, or if they were due to personality or age differences. A couple of mentors confessed to occasional discomfort with cross-race relations. In particular, as mentioned earlier, a couple of female mentors experienced challenges in their mentoring relationships with their protégés, both of which were viewed by the mentors as gender-related problems in which male protégés rejected female authority figures. In addition, one mentor reported that another research mentor asked what appeared to be an inappropriately “testing” question of a protégé, which replayed societal gender and racial power dynamics.

Many interviewees raised the concern that UCAR was located in Boulder, Colorado, a predominately white city in which protégés might feel uncomfortable. These interviewees worried that protégés might feel out of place as some of the few professional people of color in the city, would experience culture shock and isolation, or feel like unwelcome outsiders—especially those protégés who grew up within their own ethnic communities and attended universities populated by their own racial groups or that were racially diverse:

I think for the people of color, living in Boulder and so forth. I mean there are pressures that extend well beyond that of the workplace environment. And that's one of the strengths of the SOARS, program from the get go. Tom and others understood that there were going to be lots of issues that these young people would be confronted with coming to a predominately upper middle class, white community and, trying to sort of find a comfort level there.

Only a few mentors expressed concern that UCAR itself was dominated by white males and suggested that this posed a challenge for them. Two mentors also mentioned the large age and class gap between protégés and their research mentors. The SOARS director and staff raised additional concerns regarding how protégés would do with bridging their own cultural worlds with that of the science organizations and what effect it would have on the protégés' identities and acceptance within their own cultures of origin. Their goal, and the overall goal of SOARS, is

to promote diversity in science instead of eliminating diversity through assimilation into the white male culture of science. Similarly, some of the mentors also expressed concerns that protégés not experience pressure to assimilate into the role of scientist and lose their cultural identities in the process.

As addressed elsewhere in this report, mentors expressed related concerns that the SOARS program not inadvertently send the message that science careers in general are as supportive and accommodating as SOARS, itself, is. These mentors were worried that SOARS would engender a false sense of security and comfort that would leave protégés ill-prepared for, and thus vulnerable to being discouraged out of, the more common competitive science environments.

In general, mentors expressed appreciation for the opportunity to promote diversity in the sciences. Mentors who were themselves from underrepresented groups were eager to help protégés to benefit from their own experiences and to encourage protégés to persevere in their pursuit of a science career. Several mentors expressed delight at the increasing diversity that protégés brought to UCAR during the summer. A few mentors came to realize, as a result of their SOARS experience, how few people of color are employed at UCAR or in the field of atmospheric science and that providing opportunities to students of color who want to pursue the career path is important.

Protégés' Challenges and Problems with Race

In addition to frequent protégé observations about the absence of racial tensions in SOARS, some protégés did report a few race-related incidents. *There were no instances of overt racism reported within UCAR, nor between mentors and protégés.* However, protégés also told us of a few incidents where attitudes toward racial, cultural, or national differences caused tension among the protégés themselves:

- Two protégés felt their places of origin were disrespected
- A protégé of African heritage reported being excluded by other blacks on the basis of “racial authenticity”

As discussed above, mentors and scientists generally avoided any reference to race. However, as this participant described, she felt subtly patronized at times:

I feel like people on the whole are smart enough and savvy enough, to not be, even if they do feel like, “Whoa, there’s a minority here!” They’re not like “Wow, what’s this minority doing here? They’re not smart enough to be in this building.” I don’t think it’d be that kind... Yeah, so it’s a little bit patronizing, but it’s never cruel. It’s more like “Oh, cute little minority, we’re so happy to have you here.”

Protégés reported encountering racism and racist attitudes on occasion within the Boulder/Denver area. Protégés reported the following incidents perceived as racist:

- A group of intoxicated, white men yelled racist slurs and harassed protégés one night outside of the apartments

- One protégé was followed by a store employee inside a Boulder store (inferred to be racial stereotyping)
- A group of protégés felt uncomfortable being inappropriately stared at while shopping at Target.
- Receiving what appeared to be deliberately slow service in a restaurant in Denver
- Comments directed to a protégé indicated he was assumed to be a working-class laborer
- A protégé was not allowed to play ethnic music in a work environment at a work site outside of UCAR, while rock music was permitted

These are all of the accounts of racism reported to us by protégés.

Protégés' Challenges with Cultural Adjustments

Cultural adaptation was challenging for protégés, especially for first-year protégés. They faced adjustments to new people, a new program, work environment, and town and for some, being away from home for the first time. Any one of these adjustments was potentially stressful and, in combination, proved nearly overwhelming to some protégés. One mentor observed that some protégés appeared displaced, and “not at home in this place.” Protégés who came from rural or big city environments had to adjust to small city life. Some protégés, however, said that they were already comfortable with and well-adjusted to the white world.

One of the happier adjustments protégés were challenged to make was the collaborative work environment evident throughout SOARS. Students who had adapted to competitive educational environments at their universities had to readjust to the collaborative SOARS program where people strove for individual excellence within the supportive embrace of their peers, mentors, and SOARS director and staff. Protégés who rebuffed the collaborative culture were believed to have a lower chance of succeeding in the demanding program.

At the end of the SOARS summer, protégés had to adapt yet once again, leaving the supportive environment and their close friends behind. As one protégé explained, half of the protégés cried during a group discussion at the end of the summer because they did not want the summer to end—they wanted to remain in the diverse, supportive, and fun SOARS environment with their new, close friends:

By the end of the summer we would have these nights where we'd drink champagne and we'd go around and say a word or two about what we're going to miss, and half would be in tears and it was just, people didn't want to go back. Everybody wanted to stay here. They got used to this diverse environment with all these new people that were so much fun...

XII. PROTÉGÉS' GAINS FROM SOARS

In this section we discuss what protégés recognized as gains from their participation in SOARS. This differs from what protégés and mentors believe are the successes of SOARS and from what they identify as contributing to its success. Rather, protégé gains are outcomes of the articulated structural elements upon which SOARS is built. Thus these elements provide the context shaping protégés' experiences with the overall aims of protégés recruitment, retention and persistence in science majors, and particularly, atmospheric science. As already discussed, student participation in authentic, hands-on science research contributes strongly to students' recruitment into science careers. Several research and evaluation studies have examined the gains students make from participation in summer undergraduate research experiences (Alexander, et al., 1996; Foertsch, Alexander, and Penberthy, 1997; Alexander, Foertsch, and Daffinrud, 1998; Seymour, et al., 2004; Hunter, et al., 2005; Ward, Bennett and Bauer, 2002; Bennett and Bauer, 2003; Nagda, et al., 1998; Hathaway, et al., 2002; Zydney, et al., 2002a, 2002b; Lopatto, 2004). We report here what SOARS students identified as gains from their summer research experience.

Protégés reported gaining many different benefits from SOARS. Their list of benefits and the depth of their discussion of these gains are considerably richer than one would expect if we only considered the primary SOARS goal of increasing the population of underrepresented groups in the atmospheric and related sciences. Students described both over-arching gains from the SOARS experience, as well as specific types of gains.

Over-arching Protégé Gains from Hands-on Research Experience

All of the protégés appreciated the opportunity to learn how research is done by conducting authentic hands-on research and recognized its importance in their own development as scientists. As one protégé said:

To actually do *real* research—I think that's the best thing about SOARS. It's not just, "Oh, I already know the answer to this," but you finding it out, it's like, "We don't know the answer, we're waiting on you to figure this out." ...SOARS gives you that chance to realize you're going to go into situations not knowing anything, and it's your job to go and just do it...until something comes out of it.

Protégés discussed both the rewards and the challenges and frustrations they encountered as they conducted genuine research. They talked at length about the gains and rewards of doing real research:

- Learning how science research is done
- Increased confidence as a result of engaging in hands-on work
- Insight into science careers, particularly in atmospheric science
- Thinking like a scientist; developing critical thinking skills
- Increased understanding of how scientists practice their profession
- Understanding science in political and global perspective

We discuss each of these rewards in turn below.

Learning how science research is done

Protégés were pleased that they had learned an entire research process, for example beginning from literature review and formulation of the research questions, through research project design, data collection and analysis, to writing up final results and the presentation of findings.⁵ This experience enhanced confidence, informed career aspirations, and prepared them to excel in subsequent schoolwork, as an alumnus protégé reported:

I think also in terms of providing me with the research experience. That is, having to define the problem, go through a literature review and then carry out some sort of research and then document that, even as short as that process is in two and a half months to do, I think the experience was quite valuable later on, when I had to write my own papers and grants in graduate school.

Increased confidence as a result of engaging in hands-on research

Protégés greatly valued the hands-on experience and opportunity to gain and then apply knowledge in real laboratory environments. They developed skills in collecting and analyzing data and gained experience working with laboratory equipment. Many learned to use computer applications, instruments, or techniques specific to a particular scientific discipline or specialization. These experiences were not seen as replicable in their universities. They also appreciated working with real scientists at UCAR on what they described as, not only genuine science, but also as cutting-edge scientific research. As an alumnus protégé described, training in use of technical instruments proved valuable in his career later on:

The other main thing that I got out of it is how research actually works. I work in a lab now, where we do [project type]. ..My favorite part was actually doing the *actual* testing, and the real hands-on laboratory work, was my favorite part... That was in the second summer... My favorite one was the second summer because I really got into the laboratory and got to work with a lot of things, and figure it out myself. And I got to learn to do a little bit of [project type]... which is used in the lab I work in now, and also is used in all the other labs everywhere. So I got to learn how things really work, and people were able to explain it to me, exactly how, break it down for me, and show me how the instruments work.

The exposure to and experience working in a real research environment gave protégés a sense of familiarity with the concepts, the tools, and the overall approach taken when conducting scientific research. This in turn bolstered their confidence. Beyond gaining an understanding of what scientific research is and what a potential career in research would look like, protégés learned about themselves and their abilities to be scientists. As one protégé described her increase in confidence:

Just getting the research experience itself, you gain confidence through your experiences and through your success, so just giving students the opportunity to participate in the actual research will build their confidence.

⁵ Some research in science pedagogy suggest that the idea that there is a single research process or scientific method actually inhibits many students progress in science.

Insight into science careers, particularly in atmospheric science

Many protégés were brought into a field that was new to them. They generally reported that they appreciated the opportunity to diverge from their own field interests and explore something new. Some protégés gained increased versatility in their identified field of interest when exposed to different fields, as some research techniques and skills were transferable to other areas. The knowledge and understanding of different fields also contributed to protégés' confidence, broadening their perceived range of potential career paths. As a new protégé explained, this was oftentimes life changing:

I'm the first person to go to high school, even, in my family so to go to college was even a bigger deal and still not well understood [in my family], but to go to SOARS, it was nice because I realized what I could do with it because yea, you're in school, but you don't really know exactly what you can do with your education and it showed me that I could go further than where I was, and I had never realized that before. And I'd never seen people, you know, I'd never met anyone who was in a higher position besides your professors at school. It's not the same. And I found that pretty exciting and just seeing that you can do it, and like I said doing the presentations or doing the work and seeing that you could actually achieve that. You know, that wasn't like a pipe dream and that you could do it on your terms, and you could do it is a big deal.

Many protégés also told us that an in-depth experience in atmospheric science, in particular, was greatly rewarding. Some had no previous experience with atmospheric science and were eager to learn about the various sub-fields and areas of specialization. This increased the interest of some to pursue atmospheric science. At the end of the summer, 4 of the 11 *new* protégés indicated they were considering careers in atmospheric science research, and 13 of *all* 65 indicated they plan to pursue careers in atmospheric science research. (Many more aspire to science-related and research-specific careers that they did not specifically identify as atmospheric science. Protégés' career and educational aspirations are discussed in more depth later in this report.) Research experiences also increased the enthusiasm and reaffirmed the interest of several already pursuing a career in atmospheric science. Both increased confidence in skills and knowledge, as well as developing networking connections throughout the field promoted protégés interest in atmospheric science. Two examples of how the SOARS research inspired career plans in atmospheric science, in particular, appear below:

I want to be a research meteorologist, kind of like what I'm doing now, like research. I don't know—I'm not very into broadcasting or operational but I'm thinking of doing operation for like a year or two, pay off my loans then go back to grad school and then go for research.

I'm going to work at a research facility, either here at NCAR, or NASA, or NOAA, or some research facility that will use my mathematical and computer skills, because I'm developing those also. So, then after I do that, I plan to become a scientist at one of these facilities, so I'll be there for a while. And then, after I become a scientist...

Thinking like a scientist: developing patience and critical thinking skills

SOARS protégés believed that they made considerable strides in their abilities to think like scientists. This is a commonly reported gain from undergraduate research opportunities (Hunter, et al., 2005). Two major ways in which protégés made these gains is in developing patience with scientific techniques, and in expanding their critical thinking skills.

Protégés learned from their research mentors to avoid approaching research with a single expectation, to approach problems with care, carefully considering all possibilities instead of quickly jumping ahead with one potential line of explanation. They came to anticipate and consider the multiple and unexpected factors that could affect their research. Protégés also learned to consider specific research problems in light of a more comprehensive meta-level view, asking questions as to the importance and relevance of what they were doing, relating detailed research to the larger picture. They were encouraged to always ask questions and let an inquiry process drive their practice:

I think the summer working with the scientists taught me a lot about critical thinking and taught me to ask more questions. And also I think it taught me how to study for tests better. You know, taking the time in the writing workshops to outline things, and pick apart articles, and things like that. I think it just increased my critical thinking and helped me outline and break down things better.

Protégés also learned to avoid seeing scientific explanations in simplistic, black-and-white terms. They came to recognize that there are many potential solutions for any given problem. Many protégés with whom we spoke expressed an enthusiasm and curiosity-driven enjoyment from scientific thinking. They relished the “puzzling out” aspects of problem-solving: visualizing problems, referring to literature, and testing to find a way to address research questions. As some alumni protégés said:

I approach a lot of things now with a more scientific approach. I think one of the things that being in SOARS has allowed me to do is, well I’ll start to think more when I’m doing research...Especially this summer, since a lot of things aren’t working, it’s not only am I having to think about the research, I’m having to think about the model itself, and the technical stuff. I’d be like, “Ok, let me look at this program, and just take it apart.” So not only am I thinking about the science part, but just, “What’s wrong with this?” I feel like I’m trying to fix a car, you know? (Laughs)

I think the next research topic that I have to do would get much more attention and be in much more detail than the ones that I’ve done before, because during the program we learned that...If it’s something that I have to—let’s say, sample air particles, then I’d probably, take more samples, so I could get a larger average or something like that...But I might spend a lot more time with the interpretation to see if I could really get something from it.

Furthermore, obstacles and problems encountered through the research process came to be seen, not as failures, but were instead accepted as part of a productive trial-and-error process. Errors and “unfruitful” data were accepted as part of the process of discovery. Participants became

comfortable knowing that scientific research always contains a degree of uncertainty. They learned to approach data methodically, and developed their enthusiasm for scientific discovery:

As far as the research, I learned that just because it looks like you have nothing, you might actually have a treasure, you know? Because when we were looking at all the graphs, I was just like, “What?” (Laughs) And, “So I’m printing out all these graphs because you’re telling me to, but what is it doing?” And I learned that it’s okay. It’s actually telling you a whole lot, even if it looks like nothing, it’s still telling you a whole lot.

Gains in analytical and critical thinking skills included learning to embrace the practice of asking questions. This was liberating for many of the protégés, particularly as their questions were met with patient, collegial responses from their peers, research team mates, and research mentors. With their experiences and the support of their colleagues, protégés came to approach scientific problems in a more systematic way.

It is not clear how long it takes to develop more scientific thinking, but protégés and mentors both reported that this process developed best as protégés returned for additional SOARS summer programs, as one protégé described:

The longer you’re here, the more you start seeing different things and more starts clicking. You start thinking like a scientist and everything starts falling into place. That’s what I wanted to learn when I got here: “How do people think?” And I’m starting to implement their ideas into my own, and I’m starting to formulate my own ideas, and I’m starting to get a big picture—like a big puzzle is starting to come together.

Increased understanding of how scientists practice their profession

It is important to the overall goals of SOARS that protégés come to appreciate what careers in science imply for their private lives. This is discussed elsewhere in this report, but relates here to the understanding protégés gained of scientists generally, and what kind of fit protégés envision for themselves in science. Protégés gained an increased understanding of the scientific community in general, and in particular, they learned about: the role of collaboration among scientists; of the proposal-writing process; the process of planning and conducting research; and generally working in a scientific community. They also learned who scientists are, as they became acquainted with science as a collaborative endeavor and individual scientists as real people.

Understanding science in political and global perspective

Protégés also gained insight into the relationship between science and social policy. This affected protégés’ understanding of who scientists are, as well. Not necessarily operating in a political vacuum, some protégés came to see scientists as active social agents and even as heroes, playing a vital role in society.

Furthermore, protégés came to value the sharing of scientific knowledge as they recognized how their work benefited society. While many of the protégés pursued science in school because of

their hopes to benefit humanity through science, they learned of a broader range of contributions that science makes:

I'm more interested in policy and how like my scientific research can be applied to policy and in terms of being like a research scientist as a career.

Specific Protégé Gains from the SOARS Experience

In this section we consider gains that protégés “take away” from the SOARS’ research experience. The protégés have detailed gains, which can be grouped into five main categories:

- Increased relevancy and preparation to undertake subsequent coursework
- Skills gained
 - oral presentation
 - writing skills
 - social skills
 - leadership skills
 - time management skills
- Increased interest in and likelihood of going to graduate school
- Strengthened graduate school applications
- Professional development
- Personal growth in confidence and responsibility
- Becoming a scientist

We consider each of these below.

Increased relevancy and preparation to undertake subsequent coursework

Many protégés felt better-prepared academically when they returned to school after their summer at SOARS. They noted increased confidence and motivation levels, as well as a greatly enhanced understanding of science concepts. Some reported a greater appreciation for the relatedness of science concepts to scientific research, which deepened their appreciation of their educations generally. They were more engaged with their coursework and received more value from courses as their interest in schoolwork was magnified with their new ability to relate coursework to scientific practices. Some reported going back to university with improved study skills and time management skills, planning and approaching their work with more determination and thoroughness. Many protégés also reported greater success in school because of skills they had developed through SOARS, such as writing and editing, public speaking, and working collaboratively, as discussed below. In addition, several protégés brought their research projects from SOARS to their schoolwork, either continuing their SOARS research through the academic year or basing academic work on their SOARS research projects. Protégés who were invited to give presentations at school about their SOARS experiences reported increased confidence giving these presentations and felt the presentations were of higher quality and were better-received because of the skills they had developing in making presentations while at SOARS.

Increased interest in and likelihood of going to graduate school

Encouraging protégés to aspire to and succeed in graduate school is central to SOARS’ mission. We specifically asked how their experiences at SOARS influenced their thoughts about graduate

school. Protégés generally described their experiences at SOARS as having a definite, positive effect on their graduate school plans. Protégés were assured by others in SOARS that they would be prepared for the demands of graduate school, and SOARS promoted an interest in or strengthened the confidence and resolve of most participants to pursue some level of graduate education. Specifically, SOARS encouraged protégés to pursue graduate school by providing:

- Encouragement to protégés to be confident enough to consider graduate school
- Information about various graduate programs and how they fit with specific interests
- Guidance in applying to graduate school and strategies for strengthening applications with references to SOARS and from UCAR scientists
- Connections and introductions to persons in graduate school programs
- Financial support when needed

Protégés received much in-depth information about going on to graduate school while in SOARS, and felt encouraged as they observed other protégés planning to go to graduate school, as well as SOARS protégés who had gone on to graduate school. Interaction with peers and mentors assured participants of their rightful inclusion within professional, elite programs. One participant came to realize that his questions and insights were valuable to the scientific community:

Last year I was sitting in a group, a round table with a lot of scientists and there was me and another protégé and the scientists were talking about the climate models and then I raised my hand and I said so why did you make this thing, you know, what's the whole point of this climate model, who are you trying to help? And they couldn't even answer that question, they had to sit there and ask each other for a second...I don't know I found that at the end of last summer that me asking those questions to them maybe helped them sort of get back to the whole big picture of things.

We identified several sources of information and influence with regard to graduate study: other protégés, mentors, and SOARS workshops and speakers. Once first-year protégés came to believe they belonged in SOARS, the next level of confidence that challenged them was to consider graduate school. As new protégés came to see themselves as equivalent to their peers, and as they watched these same peers aspire to, and go to, graduate school, they developed the confidence to aim this much higher. Several protégés told us that speaking with other protégés, and particularly with returning protégés already in graduate school, influenced their decision-making processes:

I also saw other protégés that after SOARS were willing to go to grad school, and they were getting accepted into these very recognized schools. Of course that motivated me to believe that I could be accepted...Seeing the others going into grad school, I said, "Well, I have to do it myself!"

Protégés helped influence each other through sharing information and building each others' confidence. The experience of doing research and meeting the challenges of the summer project also reassured protégés of their own capacities and merit.

Protégés also received information about graduate school from their mentors. Some protégés clarified their educational goals through discussions with mentors. Mentors offered information about graduate school in general, as well as advice relevant to specific fields and sub-disciplines. Greater clarification of their interest in various sub-disciplines within atmospheric science further served to encourage many of the protégés to consider graduate work. Protégés were often previously unaware of the options that exist for further study in particular areas of interest to them, and they also discovered new areas of interest while at SOARS. Learning of these options gave protégés the ability to refine what were once only vague interests. Protégés began to dream dreams they had not even imagined before. Mentors encouraged and, in some cases, even pressured protégés to go on to graduate school.

As protégés learned about potential graduate programs and the potential fit of these schools with their own career interests, they also learned about the application processes for admission. SOARS offered encouragement and help in exploring graduate programs and application procedures both through its protégé seminar on applying to graduate school and informally through discussions with the SOARS director and staff. A few protégés told us they benefited from attending graduate school seminar where they learned about the graduate process.

Enhanced preparation: Strengthened graduate school applications

Protégés came to realize that SOARS activities would both help them get into graduate school and then help them succeed once there. They discovered that their graduate applications and resumes were strengthened through their affiliation with the SOARS program, and that the various publications and presentations they produced while in SOARS would be helpful in their applications. Hands-on experience and familiarity with research were recognized as particularly beneficial in graduate school. Specific advantages noted by a few graduate protégés were that their research projects were of particular interest to colleagues or professors in their subsequent graduate programs, or that their projects provided them with a specialized and valuable knowledge or niche. Scientific methods and computer programming skills were also cited as valuable benefits of SOARS involvement. Other protégés spoke more broadly about how general scientific thinking skills gained at SOARS would be helpful in graduate school.

Protégés also benefited from making connections with graduate schools while at SOARS. For example, one protégé was introduced to a graduate school advisor while doing research with SOARS. Other protégés gained strong references from UCAR scientists or a competitive edge when applying to graduate school because of the support from and association with their mentors.

SOARS also offered a significant level of scholarship support to protégés, making it possible for them to go to graduate school if they did not have adequate funding from other sources. Protégés widely acknowledged and greatly appreciated all of the financial assistance provided to them both before and during graduate school.

Skill gains

Regardless of career ambitions, protégés developed useful skills while at SOARS. They believed the skills gained facilitated their ongoing undergraduate (or continuing graduate) schoolwork, future graduate school work for those going on to graduate school, future careers

regardless of discipline or position, and generally enhanced protégés effectiveness in social situations. Specific skills protégés cited were:

- Making oral presentations
- Writing skills
- Social skills in general
- Leadership skills
- Time management skills
- Computer skills
- Skills in working collaboratively

Making oral presentations

Protégés received formal instruction on making oral presentations and were given structured opportunities to give practice talks before making their final colloquium presentations at the end of the summer. They were taught, formally as well as informally, by their peers and their mentors, how to clearly explain their scientific research to a general, science-educated audience. By the time of their formal presentations, they had typically practiced and rehearsed with their peers and their mentors until it was all but inevitable that they would gain presentation skills and self-confidence.

Writing skills

Protégés increasingly appreciated their new writing skills over time. As discussed elsewhere in this report, alumni protégés credit training in writing as especially important, even if not appreciated at the time. Resistance protégés exhibited to the writing workshops (but not to the writing mentors per se) reflected their unhappiness with the pedagogy employed, and their feedback about the writing workshops was focused on these issues, rather than on learning gains. A few alumni protégés addressed this, telling us that they went along with the norm, of expressing to one another displeasure with the workshop, even if they did not individually harbor the degree of resentments they perceived others did.

Protégés reported that gains in their writing skills were helpful to them in school when they returned from their summer with SOARS, in graduate school for those who went on, and on the job for those who had progressed that far.

My [graduate] advisor told me, when I first gave him my first draft, he said, “I’m very pleased, with how you write. I’m really very worried about my new students. They usually don’t know how to write a scientific paper.” And he didn’t really know very much about my SOARS experience but he complimented my writing. Which is, a direct effect of SOARS for sure—those writing workshops, and knowing how to write a scientific paper. I know that all the students there, he usually says, “You’re going to have to work on your writing, you’re going to have to do this.” But with me he was able to compliment me on my writing!

Lord forbid, I hated the writing seminars! I’ll be honest, I hated them... It just seemed like... I learned a lot, so I don’t plagiarize on my paper, I’ll put it like that. But I was, during the summer it seemed like, “Oh God, I wish you would stop talking!” (Laughs)

Because we'd just get in our groups and talk amongst ourselves. But now after I look back it's like, "Hold up, I learned how to do this, and I understand this, I can write a stronger paper, I can take my poetry out my paper, I know that this is plagiarized, and I know how to cite this." So as I look back it wasn't that bad!

Social skills

Protégés gained interaction and general "people skills" while at SOARS. In addition to learning to make formal presentations, skills gained in the process of preparing for their presentations proved useful when working within group settings, developing relationships with professors and other colleagues, and mingling at professional conferences. The social and work environment at SOARS encouraged protégés to engage with many new people in new contexts, which served to push protégés out of their interaction "comfort zones." Many protégés noted they became more outgoing, personable, and open to new people and situations as a result of their SOARS experiences.

Because protégés were given the responsibility to try to work through interpersonal conflicts that arose between protégés or in their mentoring relationships, they also developed some conflict management skills. They learned to listen to one another more effectively, to care for both parties in a dispute, and to communicate more effectively:

Generally when we saw smoke arising, the peer mentors gathered in a little corner and said, "Okay, that's about to explode, let's deal with that." And if it was necessary, and in most of those cases it was, we informed Tom Windham as to what may have been going on or what may have been occurring, so that nothing would get out of hand. And in most of those cases, when we saw a little bit of smoke, we called in for a backup. We started to separate the students, or talk to one over here, and another, and just kind of try to see what's going on in each of their minds. Because in some cases it was issues of misconceptions, "I thought this person was going to do this," and they didn't, or, "He said, she said," so a lot of it was misunderstanding. But for the most part, in my experience, there hadn't been any major situations that weren't resolved, or attended to in an adequate amount of time, and reasonably well.

Leadership skills

Protégés also talked about changes in their self-identities as leaders and as role models. They developed a sense of leadership and felt prepared to be leaders. Protégés' mentoring experiences at SOARS had a profound effect on them and influenced their promotion and practice of mentoring beyond SOARS. Many were inspired to apply the type of support and guidance they received at SOARS to other situations, "giving back" to others the benefits they had gained through SOARS. Some participants took on an informal mentor role and helped individuals in classes at school when they returned home. Others developed more systematic mentoring practices with groups of students at their home universities. One protégé cited having support from the SOARS director when establishing mentoring practices in her home university.

Protégés also discussed the value of taking up leadership roles within communities and endorsed the notion of giving back to the community. Several protégés told us they took on leadership roles in their home towns, home communities, and schools:

I'm actually running a group that is at [school], because [school] is very diverse. I run a program for one of the low income—not a mentoring program, but that's basically what we do. It's college students who volunteer, and we go do community service. We teach them what's in their community, and I'm going to be the president of that group next year.

Protégés generally left SOARS with a stronger sense of themselves as role models and were conscious of their capacities to carry forth the values of mentoring, encouragement, and support. Participants in the program developed high standards of success and strove to meet those standards. They walked away from SOARS feeling more goal-oriented and motivated to pursue those goals.

Time-management skills

Very few protégés who took on extra responsibilities upon their return home after the summer of SOARS said that it was problematic or overly stressful for them (with the exception of a couple of first-year graduate students). We would attribute this, in great part, to the development of better time-management skills. Protégés gained greater independence as they developed time-management skills and the ability to take responsibility for their work. They anticipated that these new skills would stand them in good stead in their future academic and career endeavors.

That's actually one of the things that SOARS has helped me with is getting better about it because I would do it to a bad extent: I'd let things slip until the day before and then do it or let it slip and then forget or, but SOARS was very good for my time management... You have got to learn how to manage it or you won't get everything done.

And then with time management I wanted to say, "You know, I can't do this." I don't have time to do *everything* that I want to do. So, if something comes up, you kind of have to prioritize and figure out what exactly is most going to benefit you, what you're going to like the most, what—you're just going to have to prioritize your life as in activities, school, research. Just different things like that. So, that's another one of those things that I learned.

Computer skills

Nearly half the protégés we interviewed cited gains made in computer programming and computing skills. The reader is reminded here that computer programming was also one of the most frequently cited challenges or frustrations the protégés' experienced at SOARS. While they reported learning to program or learning a new programming language was frustrating and laborious, the gains made in the end were worth it.

The most challenging? Programming. Honestly... And it was really challenging because I'm not a programmer, but I had to learn. I had to start from zero and I felt so stupid sometimes. (Laughs) but I did it. I did it with a lot of help... but at some points I was able to program by myself so it was really challenging, really challenging because it's a little bit of doing things blindfolded. You're hitting the wall constantly, but I did it. I did it and it was valuable.

Skills in working collaboratively

Collegiality interwoven into the SOARS program impressed the protégés, who appreciated it, not only for themselves, but also embraced it as a value in itself.

Protégés talked about gaining an increased interest in and ability to work collaboratively with others. They came to realize this is a skill that would be relevant in their future workplaces. Collegiality bolstered self confidence, and inspired protégés to initiate collaborative working relationships in the future.

Interviewer: What do you think was the most valuable thing in SOARS for you, out of everything?

I'm not shy to work in a group anymore. And I think today's society is geared towards group dynamics and working in groups and sharing information. I was too competitive before SOARS and didn't want to do that. And now with SOARS I just got used to it. It became a habitual thing. I'm doing it constantly. So you're always trying to help one another, and now I do that. And you can still maintain your sense of competitiveness. You're not going to settle for second best. But I'm helping other people so that we're all at the same level.

Professional development

Several of the things that protégés described as benefits they had gained from SOARS fall into the category of professional development. We have already highlighted some specific skills, and in a sense all of the training protégés received contributes to professional development. However, there are a few benefits that are more clearly central to professional development:

- Publication of research work
- Introduction into professional circles
- Learning how to present oneself professionally in these circles

Publication of research work

Several protégés reported publishing papers with their research mentors. Protégés were surprised and excited to learn this was something they could do. Co-authorship allowed protégés to get their first publications and learn how the process works, and by working with senior colleagues it enabled them to publish in areas beyond their individual knowledge bases. Participants noted that some of these articles were placed in noteworthy scientific journals and co-authored with well-known scientists. This is another significant example of how protégés were incorporated into research teams, and accorded the collegiality of a fellow researcher. In addition to the excitement and prestige of publishing their work, protégés were assured of both short- and long-term career benefits. Publication would help them in their graduate school applications, and later in their job applications. As a couple of protégés pointed out:

The main thing that I'm really going to look back on and be glad I did, I think, is the fact that I'm working on something with a scientist and I'm going to have something that is basically published that I'm going to be able to put on my resume, and that's not really something, even if you intern at a place, that's not something you always get to

do...That's what I really think is going to be very valuable because that's going to look good when you apply places or on your resume.

I have one publication in a great journal. It's on the SOARS project, so that's one of the highlights of my career thanks to SOARS.

Introduction into professional circles

Some of the protégés noted that SOARS helped them gain entry into the professional scientific community. This was done through support they received to present work at professional conferences, through introductions to other scientists, and via connections made for them at graduate schools. Protégés learned that the prestige of both UCAR and SOARS would lend added credibility to their applications:

I guess just the connections to NCAR. I'm always going to have that with me throughout my entire career, and that's a big plus...I'm always going to have that on my CV—that I was part of that program, and that I had ties to NCAR and that I still have ties to NCAR through my communication with the new director and some of the administrative people at SOARS...

Oh my gosh, that was so important! Networking is the key of succeeding professionally. They sent me four times out to AGU conferences, and they sent me also to other minority ones, minority conferences. And it was great. That's something that they should always [do]...They should always save lots of money to send students for conferences.

Learning how to present oneself professionally

While we did not hear much about direct coaching from mentors with regard to professional demeanor, protégés did pick up some relevant pointers indirectly, including through their observations of the scientists around them. Skills in interpersonal interaction, conflict mediation, giving oral presentations, leadership training, and practice talking about their science with other researchers all contributed to learning about working as a professional with other scientists.

Protégés appreciated contacts they made in the working environment, at SOARS functions, through their mentors and peers, and while at conferences. They recognized many of these contacts as potential colleagues and a valuable resource of networked relationships. Just as importantly, protégés developed enthusiasm for, and the confidence to, meet new people and develop professional relationships:

Since I have more confidence, I'm able to speak more and speak for myself—that kind of thing. So, if I'm in a group with scientists, I'm not just going to stand there and look pretty. (Laughs) You know, just be like, "Hi. I'm a student." I'm going to go out there and introduce myself and talk about where I'm from, and then ask about where you're from, kind of thing, as opposed to just standing there in like a professional gathering or whatever...[N]otice that my sense of professionalism, and introducing myself, and talking to people and properly, too. And not being such a jokester. I can put on my professional hat and, you know what I mean. And still make some corny jokes that are

still appropriate. Like, still be myself and maintain that professionalism. So, I've been able to do that.

Personal growth in confidence and responsibility

New protégés initially felt too intimidated to talk to eminent UCAR scientists. They worried that they would be inadequate compared to what they assumed were much more capable SOARS participants, only to find they were all quite capable and entitled to fully participate. Indeed, the whole “imposter syndrome” made even being in the company of other protégés a scary proposition for newcomers. Individuals' shyness was another layer of intimidation, as even relatively self-assured protégés told us of the timidity they also felt early on. From the warm welcome their peers extended to them from the beginning, and the prompting they continually received to ask questions of everyone, including their research mentors and other scientists, protégés gained considerable confidence in talking with others.

Many protégés described what they gained from SOARS in terms of having a profound and dramatic impact upon their overall identity as well as their confidence levels. They were excited to discover their potential:

Tom always talks like everybody here has the potential—we were not accepted because we were most brilliant students in our university—we were here because we have the potential to be great and to be whatever we want to be. So this program really pushes you to find your potential and expand upon that.

In school, you don't really know exactly what you can do with your education. SOARS showed me that I could go further than where I was, and I had never realized that before. And I'd never seen people—I'd never met anyone—who was in a higher position besides your professors at school. It's not the same. And I found that pretty exciting, just seeing that you can do it

Protégés gained an increased sense of self-respect within SOARS that transferred to their confidence in potential graduate and career goals. Meeting the challenges and responsibilities of the SOARS summer experience through hard work strengthened this sense of empowerment:

That's one of those things where you have—where responsibility kind of kicks in, because your mentors are doing their own research too and they have conferences. They tell you what they want you to do for the summer, and get you started, and tell you you're supposed to go back, if you need anything or if you get done with something, to report, and stuff like that. But, if you're not responsible and you don't care if you get something done, then it'd be really easy to not finish a research project. Because I mean, you have a computer. There's the internet, and that's a distraction right there. So, if you're not responsible enough to know what you have to get done, then you can *really* mess up and fall behind. So, that's another thing that kind of comes into play. You just have to be mature and know that they're treating you like a scientist here so you need to act like one... And you can mess it up and not be able to come back for a summer. And lose the whole four-year deal... But it's good because now when you go home, like I'll have research back home and work-study hours so, I'll be used to having to report to work.

And if no one checks on me, I'll still come and do what I'm supposed to do, so I think it'll help in the long run.

I was not there because they pitied me. I was there because I worked for it, and that was the realization of all that effort. And it was a great prize. I think it was a great gift to see that even under those harsh circumstances [struggling with a personal problem], I could do something very valuable and important. That was most rewarding.

With increased self confidence and maturity, protégés described becoming more open-minded and having an expanded sense of agency in the world.

Becoming a scientist

In some important ways, protégés began to develop an identity as scientists. They recognized changes in themselves that helped them to begin to see themselves as budding scientists. Learning about the nature of the scientific process was central to this process, particularly as protégés embraced it and began to adopt characteristics in themselves that facilitate scientific methods. Chief among these is perseverance. For some protégés the fact that science is not a collection of established, black-and-white facts came as a surprise. Those few who were adequately disillusioned by this, no longer aspired to careers in science. Cultivating patience and perseverance came more readily for those who came to relish the puzzle-solving aspects of science.

Protégés reported gaining the ability to effectively deal with stress and frustration, as well as to persevere through difficult or challenging tasks. Unexpected problems became more acceptable with the realization that this is a normal part of the scientific process, and does not reflect inadequacies on the part of the researcher. As these protégés described their discovery of the nature of science, they accepted the inherent frustrations:

[I'm] learning the hard way, obviously, not everything, like nothing, in science goes the way you want it to go, and you design an experiment the best way that you possibly can, or that somebody else's designed for you, and there's still going to be problems, there's still going to be glitches, things are going to break and the equipment's going to go missing. (Laughs) It's just how it goes. And you have got to make the best with what you've got, and it's just frustrating at times, because if you're missing one piece of data, that could totally clarify things and there's no way you can go back in time, to fix it or if you lose a sample and that sample's gone, you can't get it back. But, that would be one of the most frustrating things.

I'm enjoying the program. But it can get frustrating, I can see it. I haven't gotten frustrated yet, but I could see how, if you couldn't figure something out because it's not clear cut...Another thing that I've noticed, it's slow...

Protégés also talked about an increasing sense of comfort and belonging within the scientific community.

I think, this one is the most rewarding, because I know more about the scientific process, and I know what I want out of it...and they treated me more like a real scientist, and so I really worked up to that. And I rose to the occasion. I ended up being on three different publications on that, I was just working all the time. But it was wonderful, I mean it was very very rewarding. I was just entrenched in the science and no one treated me like, “Oh, this little college kid...” They were just like, “Oh, you’re in college you ought to know this, (snapping fingers) come on let’s go, let’s go,” and I’m like, “Yeah , yeah, I know it, I know it, I’m doing it...I’m doing the equations, I’m working it out.”

Protégé Observations on the Work Environment

Overall, protégés reported that their work environments at SOARS were very pleasant. Their observations can be collected into two main categories: collegiality, and physical environment. While generally positive on both counts, protégés had much more to say about collegiality than about the physical work environment. Comments on the physical work environment concerned the practical support (space, resources, etc.) necessary to support protégés’ research experience. Having practical needs met, particularly as it mirrored other research team members’ work situations, was a measure, in itself, of the collegiality extended to protégés. We have separated collegiality from physical supplies/environment here in order to better illustrate the importance of both collegiality and the support of resources necessary to conduct research, and to demonstrate how meeting practical needs contributes to the collegiality of an environment.

Collegiality

Protégés indicated they were treated collegially in several specific ways, including:

- Friendly, welcoming interactions with scientists
- Efforts scientists made to level hierarchy and status differentials
- Spirit of teamwork as researchers exchanged information and support
- Inclusion of protégés as team members in research group meetings and workplace norms

Each of these is discussed in turn below.

Friendly, welcoming interactions with scientists

Protégés generally acknowledged the scientists and staff they encountered in their working environments were friendly, approachable, positive, and helpful. Protégés were particularly impressed with how friendly and outgoing the scientists were.

It’s real casual and I talk to my boss like just anybody else. It’s just a real casual work environment and I really enjoy that.

In general, protégés were initially intimidated by the scientists. Even as the scientists worked to make the protégés comfortable, the protégés did not forget that they were oftentimes working with famous, world-renowned experts. Protégés sometimes expressed surprised that scientists would go out of their way to introduce themselves or initiate conversations with the protégés:

People are so welcoming, and so willing to help us, and just always trying to make our experiences as good as possible. I think that really was the most surprising, or impressive, thing.

Protégés' initial intimidation did not entirely disappear over the course of the summer, but to the extent it did, protégés were surprised and pleased.

Protégés also noticed and appreciated the friendly support extended to them by the UCAR support staff. For example, one new protégé said:

The secretaries were amazing. They were great and [name]'s personal secretary too. Those ladies really helped the program, probably even more than the scientists. I don't know if they were acknowledged, but the secretaries were pretty amazing.

As noted elsewhere in this report, protégés also deeply appreciated the support of SOARS staff members.

Efforts scientists made to level hierarchy and status differentials

The prestige of UCAR and the talent of the scientists who work there served to motivate and inspire the protégés. However, the working relationships were oftentimes described as non-hierarchical. Protégés were treated as equals and colleagues in a friendly, comfortable, and relaxed work environment. Protégés greatly appreciated being treated collegially in the research process. They saw good relationships with their mentors as characterized by comfortable interactions in which the status differences between mentors and protégés were minimized, and often even felt non-hierarchical to the protégés. One protégé summed up his philosophical understanding of the leveling of hierarchy this way:

There is definitely a hierarchy in the positions when you're in graduate school, at least in my experience. But with the SOARS protégé and mentor, the whole goal was to try and keep from that hierarchy, and keep everybody kind of on the same playing field, on the same level, on the same team, and make everybody realize that we're all working on advancing science. And so our goal is the same: let's work together with that same goal, learn from each other, and forget who's supposed to be superior to who. Because that's not going to get you anywhere in making advancements in science.

Of course, the fact that protégés marveled at the leveling of hierarchy indicates their recognition of the status differential, and the generosity of the scientists in extending a leveled overture of collegiality.

Spirit of teamwork as researchers exchanged information and support

One indicator of a leveling of relationships was the approach scientists took to scientific problems as fellow explorers alongside the protégés. Protégés came to understand the ideal mentor-protégé relationship as a learning process that takes place in a two-way dialogue that is mutually beneficial for both protégés and their mentors. A couple of protégés reported teaching their mentors about computer programming techniques that protégés brought to the projects.

Inclusion of protégés as team members in research group meetings and workplace norms

Some protégés attended weekly meetings with other scientists as one of research team members. Collegiality demonstrated at these meetings was very much appreciated. Working alongside these scientists, interacting with them and better understanding how scientists work made some protégés feel like scientists:

I like the casual environment where everyone's on a first-name basis and it's like you're really an employee here, even though you are, but it's like you're a full-time employee or you know, it's not like, "They're just here for a summer." But, it's like you're a *scientist* here.

Some of the protégés emphasized that it was the responsibility of both parties to work together to establish norms for working together, establishing goals and what is expected in order to develop a productive, yet comfortable, relationship. Though not all protégés felt it necessary to develop a personal relationship beyond professional activities, several discussed the benefits of forming a personal, human connection.

Several protégés noted that their work environments were relaxed, and included flexible work schedules for the scientists, mentors, and protégés. A couple of protégés noted that their research work was well-scheduled and systematic. With the exception of the very end of the summer, the work load expected of them was thought to be appropriately balanced with personal time. Protégés felt that they could leave their work behind at the office and enjoy personal time during the evenings and weekends.

Another aspect of collegiality protégés appreciated in their relationships with mentors was the lack of pressure to meet deadlines. The responsibility of meeting SOARS deadlines was left to the protégés, maintaining a more relaxed, upbeat work environment at the work place, which the protégés understood as supportive. Providing frequent updates or summaries of their work to their mentors helped to keep them on task.

Some mentors remarked that protégés practiced good work habits and were hard workers. We were told that protégés were driven to work hard by high standards of achievement that are clearly valued at both UCAR and in SOARS. In addition, individual protégés demonstrated considerable dedication to their research projects and appreciation of the opportunity to participate in SOARS. Occasionally, protégés would work many hours or very-long days to finish up part of the research process or a piece of writing. It was noted, however, that work ethics did vary among protégés, and some did work harder than others.

The Physical Work Environment

The UCAR environment was comfortable for protégés, not only because of the collegial atmosphere, but also because protégés' practical needs were met, including:

- Individual work space allotted to protégés
- Access to computers
- Access to research and office supplies

A few protégés expressed their appreciation for having personal workspace where they could work productively, whether it was a cubicle or a shared office. Having one's own, dedicated, work station served as a physical indicator of one's belonging, and of the value attributed to one's work:

The work environment is very nice...I had my own PC, and my little cubicle, and I hadn't had that before, even when I worked for Professor [name]. I mean, I kind of worked in his office on the side. I mean I had everything I needed there, but you know... [Then], it's like, "Whoa, I've got my own cubicle!" Which, (laughs), it may not be a big deal to some people, but I said, "Wow, I can put up pictures!" You know! So that was very nice.

Having one's own computers to work on was especially valued. Access to computer support personnel was also important and served to illustrate the value accorded to protégés' work. Access to supplies necessary to conduct their research was also appreciated.

The equality of access among protégés and other research team members to computing resources and the other resources contributed to protégés' sense of being part of the research team at UCAR. It was an important indicator of respect for and investment made in protégés, and another way in which protégés felt treated collegially. Feeling valued by a demonstrated commitment to the necessary resources helped students to feel they "belonged" in the science community.

The facilities at the UCAR Mesa labs were particularly popular among protégés, as it is among everyone at UCAR because of its location in the beautiful Rocky Mountain foothills. The beauty and relative isolation of the UCAR work environment itself was well-appreciated by protégés. They enjoyed easy access to trails for quick walks and hikes. One interviewee suggested that the physical location of UCAR, away from the city and its distractions, lent itself to greater productivity among protégés. Whether or not this is true is unclear, but the physical location itself certainly boosted protégé morale.

The mentors also recognized UCAR as a particularly good environment for the SOARS program. Like protégés, mentors noted the supportive work environment, good lab facilities, and benefits of location near other research facilities. Like the protégés, they also talked about the benefits of working on site with real scientists in their actual working environments, whether in the laboratory or in the field.

In addition, mentors also discussed structural benefits of UCAR that protégés were unlikely to recognize. Among these is the flexible culture at UCAR in which innovation is valued. Innovations in general are valued, beyond scientific advancements as such, to include progressive ideas with regard to social and cultural changes. The numbers of scientists also contribute to a good range of science projects for protégés.

Problems with the Work Environment

Protégés cited very few problems or challenges with the work environment while at SOARS. Challenges that were reported to us were:

- A few protégés felt that they worked harder and with more consistency than other protégés, noticed particularly while sharing an office.
- A couple of protégés were concerned that protégés were given too much freedom and sometimes abused that privilege by wasting time with e-mail or surfing on the Internet.
- A couple of protégés reported that they had especially small or cramped workspaces.
- One participant felt the intellectual environment at UCAR was competitive and complained that she felt belittled by non-mentor scientists.

A handful of protégés believed that other protégés were misusing the free rein they experienced in a collegial work environment. As noted earlier, expectations about work norms did not appear to be clearly established.

Field Work Environments: Rewards and Challenges

Protégés who had the opportunity to conduct research in the field described these experiences as particularly rewarding experiences. They relished the chance to do real hands-on work in the field alongside real scientists. There was no question of the relevance of their work on site. Field work opportunities were considered rare and irreplaceable. As much as the authentic lab work at UCAR was appreciated, the variety that came with field work was also welcomed. In addition, field work entailed opportunities to travel, which was a rare and valued opportunity for most protégés.

Although protégés enjoyed many benefits from conducting on-site work, there were also challenges associated with field work. These were relatively minor problems, and in most cases actually highlighted the value of SOARS' on-site program elements, which were not transportable. In some cases (such as language barriers), problems were endemic of travel, itself, and not a reflection on SOARS' programs. The problems protégés cited were:

- Aspects of the supportive environment at UCAR/SOARS were fewer or missing in the field.
- Bonding with the protégés in Boulder was more difficult upon return from field work, because the protégés who remained in Boulder had spent considerable time bonding throughout the SOARS summer.
- The challenge of a language barrier while doing fieldwork in a foreign country.

- Workspaces while doing field work were sometimes cramped or uncomfortable, especially when compared with the research facilities in Boulder.
- One protégé who was working at a local lab other than UCAR felt isolated from other protégés.

Mentors' Concerns about Lost Opportunities

Mentors discussed concerns they had about protégés not getting as much as possible out of SOARS. They had four main areas of concern:

- Networking
- Learning about writing
- Learning about science and science methods
- Learning in general

These are discussed in turn below.

Networking

Several mentors expressed dismay that their protégés did appear to be taking full advantage of the mentors' efforts to introduce them to other scientists. Even though some of the protégés appeared to be too shy to want introductions, mentors hoped that the protégés would venture out of their "comfort zones" to meet others when they had the chance. In addition, mentors were concerned about lost networking opportunities as protégés tended to eat lunch exclusively with one another instead of meeting over lunch with some of the many scientists at NCAR also in the lunch room. Some mentors also said they felt that their protégés did not converse enough with or get to know the other scientists on their project teams. One mentor offered a suggestion for SOARS, a way to help protégés overcome their initial shyness around the scientists:

The other thing, too, that I think that I was not able to communicate to my mentee well enough, is that I offered on a couple of occasions to introduce her to scientists in her field, and I said, "You know, I know these people, and we can have lunch, and if you don't feel comfortable just going up on your own and contacting them, it might be helpful for you in your future career," and she said, "Ok, Ok," you know, "Maybe I'll do that." I don't know whether she was feeling shy, she didn't seem...I don't know why she declined, but you know, so much of your career is based on who you know.

Interviewer: Yeah, so she missed a real opportunity there.

She did. And so I was thinking maybe there should be some more formalized way-maybe they could ask for a different level of mentors? Like, in addition to people who actually will take the time to do all the mentoring, they could also ask people, "Will you sign up to just come to a mixer?" Just so that these people can get over their shyness. And then, because you never know which of these guys is going to be the brilliant guy that you're going to wish that you had helped.

Learning about writing

Writing mentors, in particular, expressed concerns about protégés not getting all they could out of the scientific writing training. They hoped that the protégés did not simply accept their edits, but instead really thought about the critique of their writing and how to improve it. When protégés repeated the same errors, writing mentors were especially concerned. Instances in which protégés turned in their writing too late to benefit from writing mentors' feedback was seen as a lost opportunity.

Learning about science and science methods

A few research mentors talked about feeling disappointed when their protégés appeared to approach their projects as “number-crunching exercises” without gaining as much insight into the underlying science concepts behind the numbers.

I just picked a project that I thought would be interesting, which was to correlate [project described]. And he got into it as a kind of a routine exercise, which of course a lot of all of what we do turns out to be routine exercises, but it was a subject that I didn't know much about, and he never evinced any interest whatsoever in trying to understand what the connections might be between [project related issues]... He never got curious as to what the scientific issues are...[It] was just data crunching from start to finish.

Learning in general

Similarly, a few mentors noted that their protégés appeared to lack basic scientific curiosity. The mentors reported that even though their protégés worked hard, and their performance would have been good in an academic setting in which a grade is the objective, they did not make the transition from “good student” to “good scientist” that the mentors had hoped for.

On a related note, some mentors voiced concerns about the SOARS program timetable as so demanding that there is little time for protégés to simply think. It is possible that with more time, and perhaps encouragement, protégés would develop more scientific curiosity:

Like I said, they're on a very fast schedule so I don't know if she really has time to think about it; maybe she does, maybe she doesn't. (Laughs) But she knows [she's] got deadlines, and she wants to get things in and wants to get feedback, but...

XIII. PROTÉGÉS' CAREER ASPIRATIONS

At the heart of the SOARS program is the objective to inspire protégés to pursue careers in atmospheric research. This includes the hope that protégés' will develop aspirations to go to graduate school, to study atmospheric science, and ultimately earn their Ph.D.s and become research scientists or professors in atmospheric sciences. In this section we examine protégé career and education goals, and factors that influenced protégés' decision-making process when considering careers and graduate school.

Career Aspirations

We asked all of the protégés about their career ambitions and the influences shaping these ambitions. The table below shows the relative breakdown of protégés' career goals and indicates the four categories of protégés' program status at the time of the interview: "new" or first-year protégés; "experienced" protégés had attended at least one SOARS summer and were still either active or eligible to be active in the program; "alumni" had finished their active status with SOARS; and "discontinued" protégés were those whose affiliation with SOARS had been terminated, either willingly or due to a failure to meet program requirements. Of those who have identified career ambitions, 55% aspire to research or academic careers in the atmospheric and related sciences (47% of protégés enrolled in, or who have completed, graduate school) or mathematics, engineering, or computer science (38%). A quarter of protégés are pursuing other STEM careers in the public and private sectors. Noteworthy is that half of these protégés seek to shape the future direction of their fields via careers in policy, administration, or outreach. Only 6% of protégés opted out of the STEM fields altogether. We explore protégé aspirations in more detail below.

Table VI. Protégé Status and Career Aspirations

Aspiration	New	Experienced	Alumni	Discontinued	Total	%
STEM research	4	11	3	3	21	32
STEM academia	1	9	4	1	15	23
STEM other teaching	1	1	0	0	2	3
STEM policy, administration, outreach	1	0	6	2	9	14
STEM industry research, forecasting, writing, other	3	3	3	0	9	14
Non STEM field	1	1	1	1	4	6
Unsure	0	3	2	0	5	8
Totals:	11	28	19	7	65	100

Career goals: STEM Research and Academia

Protégés who said they aspired to, or were already working in, careers in research or academia were generally impressed with their experiences at UCAR. Some sought a similar environment in their future careers while others wanted to combine both research and teaching. In particular, protégés gained from SOARS an appreciation for the research setting, process, and interaction among scientists and other researchers, and set high goals for themselves:

I can't wait for some day to have the [protégé's name] Theory or the [protégé's name] Equation of Buoyancy, or something like that. I definitely want to be on the caliber of excellence that you see the NCAR scientists have here. I want to be on that caliber.

More protégés (32%) said they had career ambitions to go into science research than any other career category. Interestingly, discontinued protégés reported aspiring to science research at about the same rate as did experienced protégés. As reported elsewhere in this report, discontinued protégés had many positive things to say about their experiences with SOARS and wished they were still in the program. Interviews with discontinued protégés did not differ significantly from those with experienced and alumni protégés—discontinued protégés also reported SOARS' influence on their career goals. We conjecture that, because most of the discontinued protégés had one SOARS summer experience prior to becoming discontinued from the program, the program had a strong positive influence on them as well.

A quarter of protégés sought careers in academe. They often valued both teaching and research. A few protégés aimed for prestigious universities in the Ivy League or the Big Ten. Two protégés said they wanted to teach engineering at the undergraduate level. Two protégés told us their goals were to eventually return to instruct at historically black colleges after achieving the high status as a professor at such prestigious universities:

I'd much rather spend my time in a classroom than spend my time doing research, so I don't really want to teach at a research institution, I want to teach more like at a more like a teaching college and get those kids out there motivated and knowing that they have opportunities too. You don't have to go to Harvard to have the doors opened for you, you know.

A couple of protégés reported being interested in science education and teaching at the K-12 or junior college level.

Career Goals: STEM Policy, Administration, or Outreach

Some protégés, especially alumni, were pursuing careers in science policy or administration. A few others were so moved by their experiences in SOARS that they aspired to lead successful outreach programs that promoted underrepresented groups.

Career Goals: STEM Industry Research, Forecasting, Writing and Other

Some protégés were interested in professional careers in the private sector. They were interested in doing research for industry, forecasting, and technical writing (which could also be a public sector role). Broadcast meteorologist was a common ambition for new protégés, when they

initially entered the SOARS program. Raising this aspiration to research in atmospheric science is one measure of progress on SOARS' goals. When the new protégés were interviewed at the beginning of the summer, about one third (31%) reported aspiring either to broadcast meteorology or were contemplating broadcast meteorology and another career option. At the end of the summer only one of the first-year protégés still aspired to broadcast meteorology. In all, two of all of the 65 protégés reported aspiring to broadcast meteorology.

Versatile and Interdisciplinary Career Goals

Some protégés valued versatility and talked about their career goals in terms of interdisciplinary perspectives and work. They were attracted to the idea of applying their knowledge in different areas or fields, as well as gaining from the exposure to different fields through various research projects. The research projects that they had worked on that involved team members with different specialties and skills contributed to protégés' appreciation of interdisciplinary work and the importance of broad-based skills. In addition, these experiences appear to have contributed to the confidence that some protégés expressed with their still undetermined career paths. They felt assured that their diverse skill sets were ultimately going to help them in the job market:

I think everything in life is a change and nothing's constant but change. (Laughs)
So it's important then to be open to change. It is very important to be able to adapt. And that's something that is very important in science as well—to be able to adapt to the technology.

Education Aspirations and Attainment

Protégés' educational achievements and ambitions are other good measures of SOARS' successes. "Aspirations" refers to the highest level of education protégés plan to achieve and "attainment" refers to the academic progress protégés had made at the time of the interviews. Two cohorts of SOARS protégés have progressed to a point where they could have secured a Ph.D. Given that Ph.D.s typically take a minimum of five years to complete, the first year that SOARS alumni could be expected to complete Ph.D.s was 2002 (note that the majority of the interviews were conducted in 2004). We did not collect information on the education level attainment, aspirations, or career goals for any protégés other than those interviewed, so the numbers we report are conservative—more protégés can be expected to have achieved graduate degrees than are reflected in this report.

Table VII. Protégé Status and Education Ambitions

	New	Experienced	Alumni	Discontinued	Total	%
STEM field Ph.D.	2	19	11	2	34	52
STEM field M.S.	6	4	7	3	20	31
Non-STEM graduate degree	-	2	1	2	5	8
Graduate degree, field unknown	3	3	-	-	6	9
Total	11	28	19	7	65	100

As indicated in Table VII above, the vast majority (83%) of protégés interviewed aspired to a graduate degree in STEM fields (with 52% of protégés aspiring to a Ph.D.). All aspired to obtain a graduate degree, but 9% were unsure of their plans for graduate school.

While the reader may be tempted to consider discontinued protégés as “failures” of the program, we were pleasantly surprised to discover in the interviews that, in many ways, the discontinued protégés also demonstrated benefits from their SOARS experiences. Their ambitious aspirations to pursue graduate school in *every* case, and graduate degrees in science in five of seven cases, plus their overwhelmingly positive feedback about the SOARS program, indicates that discontinued protégés should not be dismissed as “failed” protégés. As indicated in the Table VIII below, two of the seven discontinued protégés are currently Ph.D. students. Roughly half of the discontinued protégés we interviewed decided on their own not to continue with SOARS and the other half were not accepted for continuation in the program. We admit that it is possible, and even probable, that only those discontinued protégés who were happy with their SOARS experiences agreed to be interviewed. Nonetheless, those discontinued protégés we interviewed clearly indicated their high opinions of the SOARS program.

When analyzing protégé educational aspirations, it is helpful to consider their educational achievements at the time of the interviews. Table VIII below depicts this information. The thirteen Ph.D. students may or may not have earned a Master’s Degree en route to their Ph.D.s, so we did not list any of them under both “Completed M.S.” and “Currently Ph.D. student”—they appear in only one of the categories in the table. The three alumni protégés who are listed as having completed their Master’s degrees are distinct from the six who are currently Ph.D. students. The same holds true for Bachelor’s degrees—we assumed that protégés who had gone on to graduate school also held Bachelor’s degrees, and were not counted in the “Completed B.S.” degree category.

Table VIII . Protégé Status and Education Achievements

	New	Experienced	Alumni	Discontinued	Total	%
Currently Ph.D. student	-	5	6	2	13	20
Completed M.S.	-	-	3	-	3	5
Currently M.S. student	-	6	3	-	9	14
Completed B.S.	-	2	1	1	4	6
Currently B.S. student	11	8	5	2	26	40
Information Not Available	-	7	1	2	10	15
Total	11	28	19	7	65	100

Over a third (39%) of the protégés were graduate students at the time of their interviews. However, this paints a conservative figure of the protégé population, given that 26 (40%) of the protégés interviewed were still undergraduates. If we subtract the 26 protégés who were undergraduate students at the time of the interviews, *we find that 39 protégés were potential graduate students, and that 35 (90%) of them have gone on to graduate school. This is a dramatic indicator of SOARS success.* In contrast, nationally, data indicate 42% of black college graduates went on to earn an advanced degree (in any discipline) and 37% of Hispanic college graduates went on to earn an advanced degree (also in any discipline) in 2003 (compared with 52% of white college graduates who go on to earn an advanced degree in any field in 2003).⁶

As we see from the tables above, protégé aspirations for graduate school degrees were reported at a higher level than were their aspirations for science careers. Nearly half of the protégés (45%: 29 of 65) aspire to either science research or research and something more, while not quite double that number (83%: 54 of 65) aspire to a graduate degree in science. The difference between graduate school degree ambitions and career ambitions is not surprising, given that some of the non-research career options require graduate degrees as well—graduate school was a goal for virtually all protégés who had a career goal in mind. There was only a small difference between protégés who were unsure about their career goals (9) and those who were unsure about their education goals (6).

⁶ Table 214 “Educational Attainment by Selected Characteristic: 2003,” in Statistical Abstract of the United States: 2004-2005: The National Data Book, 2005, p.142.

XIV. INFLUENCES ON PROTÉGÉS' ACADEMIC AND CAREER GOALS

While protégés did not arrive at SOARS as “blank slates” with no other influences on their career and education ambitions, they did arrive with little information about career options, limited vision of going on to graduate school, and little confidence in themselves to succeed in graduate school. Only three of the new protégés reported having plans to go on for a Ph.D. prior to coming to SOARS and protégés commonly expressed surprise and delight to learn about specific disciplinary career options while at SOARS. Simply having more information about career options proved to be a powerful influence on protégé goals, and confidence they acquired in the program was tremendously empowering. In this section we examine these influences, as well as some important protégé career motivations.

Factors Influencing Graduate School Decisions

Protégés were generally still in the process of figuring out what their career paths would look like, and how exactly to fit graduate school into these plans. Some of the factors that weighed into their decisions included whether a Masters' degree would be enough for them to meet their career goals, or whether a Ph.D. would be necessary. They were concerned about the costs of graduate school in the broadest of senses to include time, money, family stresses, and intellectual rigor.

In contrast with some other research we have conducted (Smith, et al, 2002) in which we asked graduate students and scientists holding Ph.D.s how much getting a Ph.D. was a personal goal, in and of itself, versus a practical goal, the protégés reported very little other than practical reasons for pursuing a graduate degree or Ph.D. In other studies, of mostly white scientists, the majority of whom came from families in which relatives had typically pursued higher education, including Ph.D.s, getting a Ph.D. is sometimes a goal in and of itself—an educational goal even when the discipline of study was not yet determined. The protégés' focus on the necessity of a Ph.D. is informed by the newness of the Ph.D. as a possibility for protégés who were, for the most part, the first in their families to go to college, much less consider graduate school. SOARS introduced the possibility of graduate school to most of the protégés, which despite impressions other undergraduate research programs have of the influence of research on career school ambitions, is not commonly the case for Anglo students. The only studies that demonstrate undergraduate research as the mediating factor in students' decisions to go to graduate school, are research and evaluation studies of programs seeking to increase underrepresented groups' retention and persistence in the sciences; that is, for students who were *least* likely to be aware of education opportunities beyond the undergraduate degree (Hunter, et al., 2005).

Getting a job after completing school was a prime motivation for graduate school, as protégés raised their aspirations to a higher level, hoping to become scientists and academicians. For protégés with a clear understanding of their career path, specific graduate school ambitions became logical. For others who were still unsure of their career goals, graduate study offered an opportunity to delay such a decision and to test career options while gaining experience and an education.

Many protégés faced challenges making career decisions or clarifying their interests or goals. Several wanted more information about potential paths or wanted to remain open to options.

Others expressed difficulty translating their interests into specific jobs or careers. A few protégés noted that they wished to postpone career decisions until later in their academic path. Others were torn between choices such as pursuing research versus instruction, or research versus outreach.

Reasons for Limiting Graduate School Ambitions

Protégés also told us some of their reasons for not pursuing a graduate degree or going beyond a Master’s degree. In some cases a Ph.D. would be unnecessary for their career goals. For example, the few protégés with whom we spoke who were interested in a career in forecasting felt a Master’s degree would be sufficient and therefore limited their graduate school aspirations. Some others more interested in policy, consulting, or teaching also noted that a Ph.D., or perhaps even a M.S., was not needed. A few protégés even noted that only having a Master’s degree would not preclude them from instructing at the university level. A few protégés told us that, while they felt confident and prepared to pursue a Masters degree, they were not personally ready to try for a Ph.D.

Factors Influencing Career Goals

As indicated below in Table VIX, roughly half (31 of 65) of the protégés interviewed discussed ways in which they recognized SOARS’ influence on their career goals. We suspect that this is an understated proportion of SOARS’ actual influence. Other measures of SOARS’ influence discussed in this report include instilling confidence, strengthening graduate school and job applications, and building networks that will benefit protégés throughout their careers. If we were to add these gains, every protégé would report benefiting from SOARS.

Table VIX. Protégé Status and Recognition of SOARS Influence on Career Goals

	New	Experienced	Alumni	Discontinued	Total
SOARS Influenced Career Aspirations	8 of 11	12 of 28	9 of 19	2 of 7	31 of 65

All of the new protégés reported that they received encouragement to go on to graduate school. Three of the eleven new protégés said that they had planned to go to graduate school prior to entering the SOARS program, but it was a new idea for the other eight. First-year protégés said that SOARS influenced them to consider going to graduate school by:

- Introducing the idea initially, providing motivation
- By encouraging high career aspirations
- Instilling confidence that they could succeed in graduate school
- The promise of tangible, financial support

New protégés also reported developing the confidence to aspire to graduate school, and receiving the encouragement and practical help that made graduate school a real option for them. Finding themselves in science was exciting, and determining a career direction exhilarating:

I was just like, “Thank you SOARS!” you know? Because before I came here this summer, the point past graduation was just a big, black, beyond.” I had *no*

idea what I wanted to do. I'm just like, "Maybe I could go for the National Weather Service. Maybe I could work for [city] energy company." And I was like, "Maybe I could work for them. I don't know. I don't know what I want to do. I don't know if I want to go to grad school. I don't know"... But I came here and I was like, "Now I know what I want to do! Yes!" So that really helped a lot.

Two other patterns in career aspirations that we found to be of particular interest are altruism and a concern with career-life balance issues. These are discussed below.

Community, Outreach, and Altruism

As we have found in other studies of scientists' career motivations, "doing good in the world" is also a common motivator for protégés to pursue careers in science. Many career goals included reference to "giving back" to the community, or making contributions to society, in general:

I always want to know what the application is of my education and my skills ... and that it's going to better my community. And I could see the application of that in terms of global warming, but it was pretty indirect. Speaking in terms of the need for...leadership that we have in our community, and the role that I'm doing now ... I think is important. And I had a priority to do that.

A common aspiration was to save lives through forecasting or influencing policy decisions to benefit the public. Others were interested in combining science careers with outreach efforts. SOARS itself served as a model for such aspirations:

If I could work for a program like SOARS, I think I'd be pretty happy in life. If I could be Raj I'd be dang happy because I like working with the diversity and science. And putting them together is perfect. So, I guess in that sense, it's made me realize how much I would love to do education and be more involved like that. I can't see myself not being involved in some sort of outreach. I can't...I could do both. There's no reason why I can't do both. That's why it's cool to have this experience and like, "Look I'm a good scientist. I'm a good researcher!" But I love what these people do too. Like I have SO much respect for the [SOARS] staff it's ridiculous.

In addition, one participant told us that she wanted a Ph.D. because it would allow her to become a role model for others as she worked to combat racist stereotypes.

Concern with Career-Life Balance

Mentors reported that some protégés, both men and women, were interested in addressing the work-life balance of career scientists. This did not seem to be a pressing issue for other protégés. As we have found in other studies of science students, there is often a sense among younger students that work-life balance issues can be overcome, if they pose a problem in the future. As science students get closer to graduation and contemplate beginning their own families, work-life balance issues take on a much more defined, immediate, personalized form. Similarly, some mentors thought that protégés, because of their young age, were most interested in balancing

work and recreation. One mentor observed that protégé interest in balancing career and family varied across the protégé cohorts, with one group of female protégés having organized a symposium of women scientists from UCAR and NOAA to speak about the issues, which the mentor attended and found very impressive. This panel discussion was remembered by some of the returning protégés as providing good practical information, as well as fostering hope that it is possible to have both a personal and a professional life. Repeating such a discussion would be helpful to protégés at all levels..

About equal numbers of mentors discussed the topic with their protégés as those who did not, although some said they would be willing to if asked. A few female scientists, who strove to lead a balanced work and family life themselves, felt the subject was important to discuss and sought to encourage protégés to aspire to lead balanced lives. One mentor, for example, discussed with her protégé efforts some scientists make to balance work with personal time during the workday in order to incorporate exercise into their schedule.

Contributing in a meaningful way ought not take a toll on one's own family. Yet some protégés were concerned about balancing their personal and professional lives. This caused them to rethink their career ambitions and plans, as they came to question the possibility of managing a demanding career in science with paying sufficient attention to their future families. As a protégé said:

You get further along, about this time in your life, when you're looking at marriage and motherhood, and things like that. There are all those decisions a woman in science has to make about how and when to plan a, how that fits in with the Ph.D. career—how much you want to stay home with your children. And in my experience, having a Ph.D. makes it very, very hard to work part time—there's some choices and decisions [to be made].

XV. MENTOR GAINS, COSTS, CHALLENGES AND READINESS TO MENTOR AGAIN

Mentor Gains

Nearly every mentor cited gains from mentoring protégés during the SOARS summer. In addition to general comments about gains, there were six specific types of gains cited:

- Sense of contributing to a worthwhile cause
- Things mentors learned from the experience
- Benefits to mentors' work
- Rewards of the relationships with protégés
- Connections to colleagues at UCAR, and with UCAR overall
- Feeling appreciated

We address each of the types of gains below.

General Enjoyment of Mentoring

Several mentors made general comments about enjoying their mentoring experience, and some said they felt enriched by the experience. Most of them said they had considerable fun mentoring. For example, three mentors described how they had a lot of fun:

1st Mentor: I think the activity itself [mentoring] is its primary reward.

2nd Mentor: I hope she [the protégé] had as much fun as I did. I really enjoyed it.

3rd Mentor: So, as a writing mentor it's been a lot of fun.

Interestingly, one mentor expressed surprise at enjoying mentoring so much, speculating that the personal rewards are an unintended benefit of mentoring.

[In a focus group]: In talking to other mentors, most find it personally rewarding to be involved with that. I'm not sure that was a goal of SOARS coming in to be personally rewarding to the mentors.

[Another interviewee in the focus group]: But it is.

Quality of Mentoring Relationships

Many mentors were very pleased with their mentoring relationships and experiences with their protégés. Typical remarks included: "A very positive experience," "good quality," and "would do the same again." A writing mentor describes her positive experience, and the joy she gained from watching the protégé succeed:

He's just an amazing kid. These kids are incredible. It was just a very exciting experience, just worked out really well. [My protégé] just shined. He was great. So it was a great experience. I enjoyed it. I felt very rewarded because I watched this kid from [city] come to a town he didn't know anything about, a total culturally different

experience for him. And I watched him grow and mature a little. From when I first met him he seemed a little withdrawn, he didn't know what Boulder was all about, what Colorado was all about. And he wasn't sure he wanted to be in the program; I think he was a little nervous. Though he wouldn't admit it. And at the end he was pretty self-assured. And he wanted to come back.

A research mentor explains his pleasure with the protégé's ability to perform real, and complex research, which is also beneficial to the research mentor:

It's been a good match with [my protégé] from the point of view of her productivity and the project. She seems to be really interested in it and she *can* do the work and she's really prepared to jump in on some fairly difficult problems and she's getting good results.

Rarely did mentors experience relationships with their protégés that they deemed "very negative." Occasionally this happened, as when a protégé was non-respondent or even insubordinate. A few writing mentors reported that their protégés had contentious and tense relationships with their research mentors, with one protégé dropping out of SOARS. Dr. Windham advised protégés to take control of their situations and to find a way to correct any problems regarding the mentoring or research project. According to one manager, when protégés struggled a bit with a mentoring relationship, the protégé community helped them normalize the challenge and supported the protégé. As discussed, a few community mentors described their mentoring relationships as limited, with little meaningful interaction beyond a few emails, phone calls, or maybe a single lunch together. These community mentors generally expressed disappointment at not having done more to connect with and build more personal relationships with their protégés.

Sense of Contributing to a Worthwhile Cause

The sense of contributing to a worthwhile cause is a particularly interesting gain. As outsiders, we were struck by mentors' dedication, which clearly informs the tenor of the SOARS program at all levels. As mentors elaborated on their general motivations to contribute to a worthwhile program, they described their hopes to:

- Help protégés identify and succeed in their career aspirations
- Contribute to society in general
- Promote diversity in the sciences

Several mentors said they enjoyed helping their protégés and watching them grow and learn over time. (This is also a particular reward cited of mentoring the same protégé over more than one summer.) Mentors enjoyed encouraging an interest in science generally and in their sub-disciplines, in particular, as well as teaching and providing support in ways not available to students in classroom settings:

It was rewarding to see, to be a mentor, to help teach, to help foster professional growth in this student, to have the satisfaction that the student has learned something. Not just something like in a classroom or lecture. But, has learned on his or her own, you know,

what the science pr-, you know, through his or her own experience—kind of shepherding the student through that.

Providing specialized opportunities and support brought considerable satisfaction to mentors, some of whom likened their protégés to their own children, feeling pride in the protégés' accomplishments. As a couple of mentors described:

I just kind of enjoy seeing someone learn. It's fun. I mean I do it with my own kids. And someone in this situation here just seeing them and then all of a sudden at some point they say something that you know they just they never would've said if you weren't, if it weren't for this interaction that we had. You know that they picked up something and you're hearing it again is really, it's gratifying in a lot of ways that at least I have some clue about how to communicate and teach people. I think that's, it's a gratifying thing.

They gave a big talk at the end of the summer. And that was really neat. I was really proud of him. It just was very nice.

While mentors frequently described a kind of special reward that comes from helping someone directly, they also talked about their rewards in more global terms. They talked about the satisfaction they found in contributing to future scientists, as a group, and to society in general:

Interviewer: What did you find rewarding about being a mentor?

I think I got a lot of positive feedback from [protégé], that she enjoyed the summer and I think she probably learned some stuff and was exposed to some other new stuff. And also just whatever benefits from feeling like I'm somehow contributing to the community at large.

Mentors hoped for a kind of “multiplier effect,” as is discussed elsewhere in this report. The mentors hoped that their individual contributions would ripple out from specific protégés to people that their protégés go on to influence, themselves, and hopefully these “third generation” benefactors go on to influence, and so on. Many of the mentors specifically articulated the hope that, by making a difference in the lives of their protégés, they would be helping other people who are in a position of disadvantage, eventually increasing the number of people of color in the sciences.

Not only did mentors hope to contribute to science, to future generations of scientists, to people who are currently underrepresented in the sciences, and to society in general, some mentors talked about their desires to make a contribution more locally, to UCAR, specifically. They talked about their hopes that UCAR would become more diverse in the future, as well as their personal ambitions to be more connected, themselves, to others at UCAR. Interestingly, for one mentor, the fact that SOARS is supported by UCAR endeared UCAR to this mentor, who then wished for greater involvement with and promotion of UCAR. Similarly, some mentors appreciated that volunteering for SOARS provided opportunities for them to meet more of their

UCAR colleagues. They also were glad to learn more about other UCAR programs, especially education and outreach components.

Things Mentors Learned from the Experience

Another important gain mentors talked about was their own learning. We might expect that some learning would occur for everyone involved in conducting the very real science that comprises the protégés' research projects. However, mentors described learning more broadly. They discussed learning in general terms; learning about mentoring, itself; about scientific writing; about diversity issues; learning new skills; as well as about science itself. In addition, several reported a renewal of inspiration in their science and their work. In summary, things mentors said they learned, in addition to learning in general, were:

- Learning about mentoring
- Learning about scientific writing
- Learning about diversity issues
- Learning new skills
- Learning science
- Learning something about oneself
- Learning renewed inspiration for one's work

Mentors reported that, the more they mentored, the more their mentoring skills improved, and consequently, the more successfully they felt their mentoring was. In addition, mentors reported valuing the professional development they gained with their mentoring skills, which could then be applied to other aspects of their UCAR jobs.

Some of the writing mentors reported being pleased to have learned more of the formal rules of scientific writing, as well as gaining increased clarity in their thinking about their own research and writing:

I've actually learned quite a bit being a mentor. There were a lot of what I would call the more "technical" aspects of being a good writer. You have to deal with pronoun use or whatever, those kind of things that I was never, I didn't understand in a concrete, "this is a rule" kind of way—I just understood them from, I'd seen good writing and I've written this way and I just kind of knew it sounded better this way. It was that kind of a way of looking at it. And so I've learned a lot of that here. But my background was in science.

In addition, one mentor suggested that learning more about writing helped scientists to bridge the gap that typically exists between their abilities to "do" their science and to write about it.

Mentors reported increased awareness of diversity issues in general and valued learning about other cultures, including both ethnic and youth cultures. For some mentors, this was their first exposure to working with a person from an underrepresented group.

Mentors cited four specific skills they gained as a result of mentoring. Three of these are "soft skills," including enhanced communication skills, skills in working with clients generally, and refining expectations about student abilities, which was expected to inform their teaching in the

future. Another skill cited less frequently is learning to use particular software, something a couple of protégés taught their mentors.

Several writing mentors expressed enthusiasm about learning something about the scientific content of their protégés' research projects. Even though many of the writing mentors were scientists, themselves, they were not necessarily well-versed in the sub-specialties their protégés' projects addressed.

One mentor discussed with us that she had come to better understand and accept her own personal limits better, by virtue of observing her protégé's stress. In another case, a community mentor reported going places that he had never been before and would not otherwise have gone, were it not for taking a protégé there.

Several mentors talked about the re-invigorating experience of discussing the fundamentals of their disciplines with their protégés. In addition, observing the protégés' high levels of motivation and enthusiasm inspired mentors to push themselves in their careers, as well as to think in alternative ways about their own projects.

Some mentors described their learning in broad terms, saying that they, "learned as much from their protégés as their protégés learned from them." Others described it for us this way:

You end up explaining simple things that, let me see—my board here is filled up with things I drew for my student this year, explaining things simply and then [she'll] end up saying, "Well why does this work?" "Well I don't really know why it works." I always thought I did but now that I think about it maybe I don't as well, so when you when you teach something you learn the most. The teacher learns the most. So that's what I mean by "keeping fresh."

Mentors also said they continued to learn from past protégés with whom they maintain contact, as these protégés go on to explore other science and career avenues. In addition, the fresh, unique perspectives that protégés bring to their projects prompted mentors and other research team members to reconsider the work in new ways. As three different mentors explained:

I find as I do it it's good for me to have to explain things and to think about things in different ways and it keeps me in touch with why I got into [discipline].

I also learn a great deal from the protégés, because they come with a different viewpoint or a different perspective and they, in general, I always sit them down and say "I expect you to ask questions, and there is no such thing as a dumb question and if you, um, really think it's a dumb question, you better ask it because I may not of thought of it." (Laughs) And so I get an awful lot out of, "Well, why did you do it that way?" or "What's the thinking behind that?" And it makes me think, "Well, what *was* the thinking behind that?" You can get so entrained in your own mode of thinking that I get a lot out of that as well.

Well I learn about their lives, I learn about where I don't know stuff because they ask questions sometimes that I wouldn't think of...

Benefits to Mentors' Work

It is not the intent of the SOARS program that protégés serve as laborers in their mentors' labs. In fact, this is emphasized to mentors from their beginning of their involvement with SOARS. Instead, the program focus is on benefiting the protégés, themselves. Even so, research mentors oftentimes reported to us that mentoring *serendipitously* contributed in a meaningful way to their work. Even though some mentors noted that they could have performed the tasks the protégés performed in less time, there were other, multiple, benefits to their research:

- Protégés' contributions to one's work
- Opportunity to do research one wouldn't otherwise get to do
- Opportunity to teach
- Professional rewards
- Enhances one's regular work
- Makes one's work more fulfilling
- Variety, change of pace from usual work

Several research mentors reported that they gained from the scientific work that protégés did. Some gains were significant enough to produce publishable research articles. In other cases, progress was made on research that was important to the mentors' ongoing work. One research mentor described designing the protégé's project so that it could be continued the following year by another (or the same) protégé. In other instances, mentors said they were able to use materials from the protégés' work in teaching and other presentations they made. For example, these mentors described protégés' contributions to their research projects:

He actually did a very nice presentation. And the materials he produced I still use for my teaching now (Laughs).

I often just think of something that I really I want to get done or something I haven't had a chance to get to and I think a student's capable of...but they're also getting some research done for me you know, which is wonderful, and actually it got to the point where I got behind in writing up my research. I'm still trying to catch up on that.

Not only were mentors' "regular" projects advanced, some were able to take on new work as protégé projects were things that mentors wanted to do, but would not otherwise have the opportunity to pursue. In at least one case, this was work that contributed to a proposal for a new project—a proposal that might otherwise not have been written, due to time constraints.

Similarly, mentoring provided the opportunity for mentors to teach, something that is not otherwise standard in their work and that mentors listed as an important motivation for their involvement in mentoring.

While there are no official rewards at UCAR for volunteering with SOARS, and the costs and rewards that accrue to participants varies considerably, there were informal professional rewards

for some of the mentors. For example, even though mentoring is not officially considered when scientists come up for promotion, some mentors believed that it is informally noticed and appreciated. For instance, while SOARS has always sent notes expressing appreciation to mentors, in 2004 and 2005, notes were sent from the Education and Outreach (E&O) office to both the employee and her supervisor. Volunteering for SOARS can also be considered for service contributions in employees' personnel reviews. SOARS can also be listed on resumes and vitas, independently of UCAR's internal accolades or official comments. Funding and research partners, such as the National Science Foundation and NASA, also value research mentors' participation in SOARS, as SOARS is helping them meet their own diversity goals.

All of these indirect professional rewards were meaningful to research scientists in SOARS. SOARS is highly valued at UCAR, especially at the highest administrative levels, so contributions to SOARS are valued by managers at these high levels, as well. But, as one mentor pointed out, it would detract from SOARS if people volunteered *for the purpose of* career advancement. This person made the point that, for this reason, it was in everyone's best interest to keep rewards for participation at an informal level, minimizing participation of those not truly "called" to contribute.

Enhanced Enjoyment of Daily Work

Another gain that mentors talked about, and which came as a surprise to us, was the enrichment of their daily work. Mentors' usual tasks were supplemented with welcome changes in routine and opportunities to use skills not normally used. These breaks in routine allowed the opportunity to decompress from job stresses, as well as to reflect on the basic science underpinning their work, which had the effect of renewing enthusiasm for their work. In addition, mentors enjoyed "showcasing" their divisions and their roles there, which also served to enhance pride in their work and workplace.

Rewards of Relationships with Protégés

One of the most-cited rewards of mentoring was mentors' appreciation of their relationships with protégés. Research, writing, and community mentors alike spoke about how much they enjoyed the protégés, how the protégés were a joy to work with. In particular, they talked about valuing the new friendships they made and their appreciation of protégés' enthusiasm and good work ethic:

It's enjoyable to talk to these people, they're nice, very nice people and they're a pleasure to work with. They're enthusiastic, and that enthusiasm is infectious.

SOARS was the most fun thing that I did all year—the most satisfying, the most feeding of me as a person, because I could actually—I was working one-on-one with someone, learning something about some of the science that goes on here. I don't have the science background, so you know it was always the best, it was the best part of what I was doing...It's a really exciting population to be working with—that age group—and they're so bright.

They're bright, and they're all charming and, you know, I enjoy their youth.

Some mentors reported that they had more enthusiasm for their own work as a direct result of working with enthusiastic protégés. Several mentors also mentioned how glad they were to learn more about diversity:

And these people that are not involved [UCAR personnel who do not mentor] are missing a *big* treat. They're really, in my view, missing out...

Interviewer: What's the big treat?

Just getting to know these guys. And spending time with them. And I learn from them. Their different places [that protégés are from], their diverse backgrounds, their culture, what their interests are, what they want to do with their lives and their determination and dedication.

Mentors also spoke about the satisfaction they experienced in feeling they had made tangible contributions to the protégés' career success, and their hopes for ongoing updates about protégés' careers. A few of the more personal kinds of rewards cited include one mentor who said that mentoring protégés was especially rewarding since her own children had grown up and left home, and another who said he found it personally rewarding to seek out protégés of his own ethnicity and give them extra attention.

A few mentors noted protégé characteristics that made them especially rewarding to work with. For example, one writing mentor said that she preferred working with first-year protégés, because she was able to interact more with them than with returning protégés. A couple of mentors said that they especially enjoyed working with advanced protégés. For example, some research mentors especially appreciated that returning protégés already know the research projects and how the SOARS program works. A writing mentor found returning protégés easier to work with because they tend to be more proactive, initiating discussion with him and taking the initiative to meet program expectations. The advice returning protégés give to first-year protégés (noted elsewhere in this report) is for them to take the initiative with their mentors and ask questions or suggest ideas would seem to be echoed by mentors in these cases.

Connections to Colleagues at UCAR and with UCAR Overall

Several mentors (including research, writing, and community mentors) talked about the rewards of enhanced community they experienced at UCAR as a result of volunteering in SOARS. The sense of family and community among protégés was specifically noted by mentors, but some mentors talked about enhanced relationships they had with other mentors, and even with other people at UCAR who were not active in SOARS. These mentors reported interacting with their peers at UCAR more frequently than they would have without their SOARS involvements, and came to feel a greater sense of community at UCAR as a result:

I also interacted with the scientists who I otherwise would not have interacted with and so it provided an opportunity to kind of broaden my sphere at NCAR, and that was a good thing.

This summer I actually got to know some of my colleagues in [division name] a little better. That was fun.

Feeling Appreciated

Several mentors said they felt their efforts were appreciated, and that they felt they were valued in the SOARS program. In particular, mentors talked about how good it made them feel when their protégés contacted them after the summer session to thank them for the good mentoring. Mentors felt appreciated when protégés told them that they had a good time over the course of the summer, and of course, mentors were gratified to be asked by a protégé to be their mentor in the following summer. Mentors also noted that expressions of gratitude that UCAR offered them were meaningful:

She [the protégé] wrote me afterwards and she said that she felt that the writing she did in this program was some of the best technical writing [she's] ever done. Which made me feel very gratified. In fact, a number of the ones I've worked with have written me back and, and said thanks for my help and what a good time they had, and it's been very beneficial in their career.

Other Rewards

Another, less mentioned, reward was satisfaction from the sense of “giving back,” repaying future scientists the benefits they had received from their own mentors when they were first entering their careers. For them, SOARS offered the opportunity to return the favor. In addition, a few mentors said that they became mentors as a personal favor to the SOARS director, Dr. Thomas Windham. “Doing it for Tom” was rewarding to them as they wished to “give” to Tom.

One more reward, mentioned once, but of particular interest, is the reward of being involved with a prestigious organization (SOARS). SOARS' status made affiliation with it personally rewarding as others aware of SOARS' prestige would associate some of this value with individuals participating in the program. There are personal rewards of being part of a high status organization.⁷

Mentors' Costs

The tremendous value that mentors placed on their work with SOARS is evident throughout the interviews. Their belief in and commitment to the program and its goals is the context in which this section should be understood. We asked all of the interviewees to discuss with us any concerns they had about SOARS, what they found challenging about working with the program, and any suggestions they had about improvements that could be made. In this section we address the challenges mentors discussed, both in terms of their overall, systemic perspective of SOARS, and in terms of their own, individual challenges. Clearly, the challenges did not overshadow the benefits or value of SOARS in the minds of the interviewees, whose continuing

⁷ Sociologists recognize this social phenomenon as an extension of status. When a negative status is conferred on someone affiliated with a stigmatized person, it is known as a “courtesy stigma” (Goffman, 1963).

involvement seems assured. About half as many mentors cited costs they accrued when mentoring, as those who discussed gains (71 cited gains and 34 cited costs).

No Real Costs

When specifically asked to recount costs of being a mentor, a few said there were no significant costs, although they may have discussed what they considered minor costs at another point in the interview. Some of them said that any costs were minor in comparison to the value of the program and the rewards they accrued as mentors. One post-doc mentor even said that, instead of mentoring being burdensome, it was a welcome change after doing his thesis, giving him time to decompress.

In all, four types of costs to mentors were mentioned:

- Time
- Stress
- Financial costs
- Unclear expectations

Of the four types of mentoring costs discussed, two are of particular interest: costs in time and stress. Time was most frequently mentioned, and several of the mentors made mentoring a top priority during the 10 week summer programs. This often meant devoting personal time (e.g. vacation time) to work with SOARS protégés. Sometimes it meant foregoing alternative optional projects, temporarily moving main work projects to a back burner, or adding on to the regular work day to get both regular and SOARS work done:

Research Mentor: It really takes an enormous amount of time when the SOARS student is here...that is your first priority. And everything else gets put aside when it has to be put aside.

Interviewer: Wow. What percentage of your time would you say you spend helping the SOARS student or involved somehow in mentoring?

Research Mentor: (Pause) It's not so much spending *that* much time with the SOARS student kind of one-on-one. It's that that project becomes my first priority. [Spoken emphasis]

And as a writing mentor explained:

Writing Mentor: I just regard it as something I do, and, obviously I still have to meet the requirements of my position, and sometimes there's a conflict there (laughs).

Interviewer: So what do you do when there's conflict?

Writing Mentor: I try to make very sure before I go into this period to alert the program director, and my supervisor that this is coming. Actually, I try to tell the whole staff because I think it really is important, and I think they should realize that it's important, and what its accomplishments are, which are not inconsiderable.

Stresses of time constraints posed by the brief 10-week program were also mentioned:

As I said, I fell behind. There's a cost in terms of time. You know everyone here is over-committed, and I don't know a scientist who doesn't work at least fifty hours a week. So there was more of a time crunch for me, working on my own projects.

Costs in terms of stress were more varied, and less frequently mentioned than were time issues. The emotional toll of mentoring included feelings of guilt when protégés did not appear to become interested in the research project or atmospheric sciences more generally; frustration with protégés' needs for training in computer languages; guilt when mentors needed to be away from NCAR and the protégés during parts of the summer, and stresses of feeling responsible for making the summer a success for the protégés:

I consider it sort of a personal failure I suppose. But I couldn't see anything to do about it. I couldn't get any real rapport with them [protégés who did not indicate an interest in the work or the discipline], any sense of them being interested in what they were doing aside from being interested in doing it well, which was quite discouraging to me. I'm much more pleased with [other, engaged protégé].

Other costs included money mentors spent, although in all cases mentors said they did not mind doing this; and stresses felt when one's mentor role was not clear. It was also pointed out to us that costs are higher for mentors when their protégés do not appear invested in the project or do not put forth adequate effort on the work.⁸

Mentors' Challenges

Being Present For Protégés

Mentors (notably writing and community mentors) and protégés expressed frustration with other mentors (research mentors, in particular) who were absent from UCAR on business trips or for personal reasons such as vacations. Students also cited examples of mentors who were on site but unavailable to attend particular events, such as practice or final presentations. All mentors—research mentors, writing mentors, and community mentors—expressed feelings of frustration at the amount of time spent *away* from their student researchers and their anxiousness about providing enough direction. For example, a writing mentor commented:

Interviewer: When you were mentoring him, what were the most challenging things that you encountered or the most frustrating for you?

Writing mentor: Most frustrating for me was travel schedules. Mine was a frustration, but I felt like I made an effort to work around it.

⁸ Faculty participating in the research conducted by Seymour, et al. also discussed how “draining” it was to direct an unenthusiastic research student.

As discussed earlier, there was not a consensus among community mentors, at least, of what constituted adequate time with their protégés. Some, such as this community mentor, wished they had spent about more time with their protégés:

I've been really busy and so it's been hard to get a lot of time to initiate contact so that's one thing I would... probably initiate contact more often than I have....Send him an email every week or something asking how things are going and just have more of a running conversation throughout the summer whereas it really was more of, [he'd] send an email and we'd exchange a few emails. [He'd] ask something and we'd exchange a few emails, I'd send him an email and we'd exchange a few emails but it was however many, five times over the summer and so I think just a little bit more, just try to be a little more obvious that I'm there and interested.

As a couple of research mentors said:

I was, unfortunately, gone a fair bit this summer, so that, I think was somewhat, detrimental, and I would have liked to have been here more.

On the other hand, one research mentor expressed frustration with the need to structure work for his protégé—having to think ahead and plan for the protégé's work on the project—if he planned to be absent:

If I go to a one day meeting somewhere in Mesa lab I have to think about whether she has enough things to do or do things. It's not like you have an associate scientist, or other people working with you, who you know will find something to do.

The SOARS director has asked mentors to make every effort to remain on site during the 10 weeks of the program, and to make arrangements to compensate for their absences when travel is unavoidable.

Clearly not all research mentors had complete control over their travel and their mentoring time. It is also possible, even likely, that research mentors made arrangements for mentoring to continue in their absences within their work groups, and possibly also with the SOARS director, but did not communicate these plans to the writing and/or community mentors. For this reason, some of the unhappiness expressed by writing and community mentors about research mentor absences may become moot with improved communication. Some writing and/or community mentors expressed disapproval of being volunteered by other project team members to stand in for absent research mentors.

Attempts to bridge physical distance included: substitute mentors, the use of team mentoring, independent work during periods of absence, and increased e-mail and phone contact.

If I could just add a little bit more, you were asking, "What does it take to be a good mentor?" I think it means somebody that can kind of talk to someone and kind of help them out and to be available. You know, it's much easier now because I'm on the road

all the time too, and that's another complication, but with e-mail, I can stay in close touch very easily.

Mentoring New Versus Returning Protégés

Differences between first-year and returning protégés have been recognized and addressed in SOARS in several ways. The most notable change made is that first-year (but not returning) protégés were assigned both community and peer mentors.

First-year protégés were more challenging for mentors, increasing start up time and effort, and delaying the onset of substantial research, in the following ways:

- Socialization into the SOARS program, itself
 - Returning protégés have a better understanding of SOARS' structure and expectations, and how to work successfully in the system
 - First-year protégés need to learn to value the writing tasks and writing mentors
- Research skills are less developed
 - First-year protégés need more training in research skills
 - Returning protégés have greater skills in statistical analysis
 - Protégés' abilities improve noticeably over the course of a single summer as well as over multiple summers
- Designing and tailoring research projects is more difficult for inexperienced protégés
- Social interaction is more streamlined with returning protégés
- Fewer skills in computer programming and use with new protégés
- First-year protégés have a steep learning curve for scientific writing and presentation
 - Returning protégés' skills in presentation are greatly improved
 - Returning protégés have more confidence in their writing and presentation abilities
- Returning protégés with the same mentors and research projects can continue with work already begun, delving deeper into the science
 - Returning students with the same research mentors can delve deeper into their research and do more significant, higher quality, research
 - It is challenging for mentors to get to know protégés, and they must initiate more interaction to monitor protégé progress, so that working with a familiar returning protégé is easier for the mentors as well.
 - The research projects themselves can be chosen based on knowledge of known protégés' interests and can be more in-depth for returning protégés known to the research mentors.
- Returning protégés better understand the world of science, research, and life of a scientist

The benefits and drawbacks of matching writing mentors with protégés according to their first-year versus returning status were also discussed. Returning protégés were seen as easier for writing mentors than were first-years (attesting to the fact that first-year protégés learned a considerable amount about writing). It was also seen as preferable to have the same protégé for more than one year, as writing mentors could see particular students' progress over time and could tailor their mentoring more effectively. Writing mentors noted that, because it was easier to mentor returning protégés, matching new writing mentors to returning protégés may make for an easier introduction for first-time writing mentors. At the same time, periodically matching veteran writing mentors with returning protégés helps to ensure that writing mentors are less likely to feel overly stressed or burned out from mentoring. In all, a mix of experienced and first-year writing mentors and protégés was seen as good, with particular attention to both first-year writing mentors and those who have mentored for several subsequent years (see more about mentors and burn-out later in this report).

The greater time and energy investment mentors made in their first-year protégés were balanced out in following year(s) and mentors could see and appreciate the growth their protégés had achieved from the first year to the second (and third and fourth). It was suggested that having a second year with a first-year mentor (and subsequent years even with experienced protégés) also helped to mitigate burn-out among mentors.

Other input about new versus returning protégés addressed the difficulties of sending first-year protégés out into the field. Upon their return to the SOARS community, the still-new protégés had difficulty establishing and re-establishing their relationships with protégés. This was much less of a problem for experienced protégés, who more readily re-entered their more established roles and relationships in the protégé peer community. Relationships between protégés could be supported and improved by helping protégés returning from the field to make the social adjustment back into the group, attending to the fact that protégés, regardless of their tenure in SOARS, will miss their peers and would benefit from support in re-integrating into the group upon their return.

Burn-out

One of the concerns we were asked to address in the evaluation was mentor burn-out. The discussion of mentor burn-out was cast (by interviewees) into a context of “exchange”: the ratio of the costs of mentoring to the subsequent rewards directly influenced burnout. As mentioned above the costs of mentoring included fitting mentoring commitments into other, ongoing work pressures, as well the range of effort required to provide an appropriate level of mentoring for individual protégés. The rewards that came from mentoring, as discussed above, included: the intrinsic rewards of believing that mentoring is important and is effective in meeting SOARS goals; personal rewards that come with doing work that is meaningful; and professional benefits such as recognition by colleagues and supervisors. This latter, particular reward was on the light side, as mentoring and other contributions to SOARS were not consistently reflected in performance appraisals. We posit here that, with other factors being equal, to the extent that the rewards were equal to or greater than the costs, mentors would not feel burned out. As mentors pointed out to us, recognition of their efforts is personally rewarding, it can be professionally rewarding, and it can make the difference between mentors feeling appreciated for their efforts,

or feeling burned out from unappreciated efforts. Burn-out, then, can be a function of imbalanced costs and reward.

All mentors were asked if they felt burned out as mentors and many discussed their ideas about burnout with us. In sum:

- 30 mentors discussed burnout
 - 13 research mentors, 14 writing mentors, and 3 community mentors
- 17 specifically reported not feeling burned out
 - 7 research mentors, 8 writing mentors, and 2 community mentors
- 9 talked about strategies to avoid burn out
 - 4 research mentors and 5 writing mentors
- 8 talked about time pressures potentially contributing to burnout
 - 5 research mentors and 3 writing mentors

We were happy to find that burn-out was not a significant problem for mentors (although a couple of mentors said that they feel burned out at work as a matter of course). No one reported feeling burned out by their SOARS involvements, and 17 mentors specifically stated that they were *not* burned out:

I wouldn't call it "burnout." To me it's much more of a time management issue, and the issue that I see is that when you agree to mentor a SOARS student, you should be prepared to commit the time to that student. The problem is, with the rest of the organization—the rest of the organization doesn't stop (Laughs) with its expectations of you and your role as a scientist... It's very very demanding time-wise. And so when you're mentoring a student, and yet all of your normal responsibilities are still in place, they can be very—they can be very stressful on the mentor. I mean, "burn-out" to me implies that you reach a point at which you just don't want to do this, or don't put the time or energy into it. And I've never sensed that. It's just more of a struggle of trying to balance one's own professional life, which is ongoing as the demands continue to go, with those against the student.

The reader is reminded here that we interviewed both current and "past" mentors, so that the level of participation (number of summers mentors volunteered and how recently) was a major stratification criterion, something we systematically considered in the course of the interviews. We concluded that burnout is not a significant reason for mentors to discontinue volunteering in the program. Taking a summer or more off from mentoring is one of the strategies mentors listed as *preventing* burnout. In all, nine mentors described 10 strategies to avoid burnout:

- Managing time and energy devoted to mentoring with other work to avoid becoming overextended and creating the need to work excessive hours to catch up
- Sharing the challenges of mentoring with colleagues who are also SOARS mentors to relieve emotional stress
- Accepting the support offered by colleagues in one's department
- Delegating responsibilities to others
- Taking occasional summers off from mentoring and going on vacation

- Carefully choosing and limiting which activities and committees to volunteer for
- Maintaining interest in SOARS by having a different protégé each year
- Maintaining interest in both SOARS and work by keeping a variety of activities going
- Considering the value of volunteering in such a high profile organization keeps level of interest and commitment up
- Valuing the differences in each year's experiences keeps mentors engaged

Several mentors were aware of things that have the potential of contributing to burnout. These things are:

- Excessive time pressures
- Especially needy protégés
- When protégés do not put in adequate effort or time
- When it seems that time is wasted
- When feeling physically taxed

In addition to intrinsic rewards, it was suggested that professional recognition, such as consideration of mentoring work in the context of performance appraisals, would add to the benefits of mentoring, and thus lessen the burnout effect.

Readiness to Mentor Again

The best measure of mentors' willingness to volunteer again is the rate of repeat mentoring—something SOARS staff members already track. We also asked mentors we interviewed about their intentions to mentor again in future summers, and found that most did anticipate mentoring again (67 of 73 mentors answered this question):

- Yes, will mentor again: 55
 - 27 research mentors, 17 writing mentors, and 12 community mentors
- No, will not mentor again: 12
 - 4 each: research, writing, and community mentors.

Of the mentors who said they would not mentor again, 6 could not for family or health reasons, and the others could not due to career time constraints. Eleven mentors said they would mentor again in a different mentoring role that better suited their interests and available time.

Mentors told us that taking on the responsibilities of a research mentor role requires a higher level of both time and confidence, as compared to either the writing or community mentor roles. For this reason, some mentors have already declined to volunteer as a research mentor and have instead opted for either a writing or community mentor role. The decision to mentor also depends on several other factors:

- Enough time during a given summer
- A suitable research project for a protégé
- The support of mentors' supervisors
- The energy to devote to mentoring in addition to regular work tasks
- Adequate funding (to allow time for mentoring instead of proposal-writing)

Having a returning protégé, as opposed to a first-year protégé, also prompted some mentors to volunteer again. (This may also be related to the strong appeal of being directly asked by a protégé to be her mentor.)

When mentors said that they did not intend to mentor again, it was most often because their status with UCAR had changed so they did not feel it was either possible or appropriate to mentor again. The other main reason was lack of time. Even so, several of the mentors who said they did not plan to mentor again, themselves, recommended mentoring to their colleagues.

Post-Summer Mentoring Relationships

Whether a relationship between a mentors and protégé continued beyond the SOARS summer research experience has been optional, and the frequency and form of ongoing relationships has varied considerably. Almost half the mentors reported on-going collegial correspondence, or even continued mentoring their protégés following the summer, and, in some cases, even after the protégé had completed the SOARS program. A research mentor describes his on-going relationships with protégés:

We did a lot of email exchange and that was partly because, first he needed to finish his paper, but then I wrote up the work into a paper for a journal and so we were exchanging the paper back and forth. Then he was coming back [to SOARS] to work with someone else and I tried to help him find another mentor that would be more in line with his interests. So yeah, it was a very friendly relationship and after he went to graduate school I didn't keep in contact as much but every now and then I saw him. And still if I saw him now, it would be very friendly but it's not a need-to-talk kind of relationship. And my relationship with [my other protégé] was a lot like that too. We would email often. I wrote reference letters for her to get into graduate school and, and to get the fellowship, she had applied for fellowships so she would have a research grant, so there were a lot of contacts with that, but it's now gone down to more of when we have an opportunity we get together. I guess the last time I saw her was at a conference. She invited us over to dinner, so it was still very friendly.

A few mentors reported having developed valued personal friendships during the SOARS summer and continued to engage in in-depth conversations with their protégés, sending holiday cards, and otherwise maintaining these relationships as they did with other friendships.

I've stayed close to one of my, protégés, we're still in touch. She still calls, we write to each other every two, three months and, she came back to Boulder once. We just stay in touch 'cause she's a darling, and I adore her. And that was a lovely relationship that started from that, what was it—four or five years ago.

A few protégés and mentors maintained an on-going professional relationship via e-mail, in which protégés received professional or career advice from their mentors. Some mentors had occasion-specific interaction with their protégés, such as at conferences or other professional events, while working in the same subfield, or writing a journal article. Mentors also reported e-mailing articles of potential interest to their protégés. Over time, on-going interactions tended to lessen in frequency, although, for some, the quality of the relationship did not change.

In only one case, however, a protégé misunderstood the limitations of the post-summer writing mentoring relationship and falsely assumed he was entitled to receive editing help for school. His writing mentor informed him that on-going editing was beyond what she expected and intended to provide as a mentor.

Mentors appreciated when their protégés initiated contact with them after the summer sessions. Mentors greatly appreciated receiving updates from their protégés on what and how they were doing after having left SOARS. The mentors were very pleased when they received e-mail updates, were given hearty hellos by protégés they ran into unexpectedly, or rekindled their relationships. Mentors generally wanted their collegial relationships to continue after the summer ended, especially if the protégé was pursuing the same career field:

I think it will also foster a collaboration interaction that will extend on for some time at some level. I don't know what level and not in every case but certainly in some of these cases I could imagine that this person goes off to graduate school, gets a degree, they're going to remember who their mentor was... significant in part of their early graduate career and had some overlapping interest probably so there may be something continuing, you never know. I mean, I hope that's what happens in this case.

Others hoped to see the protégé during a subsequent SOARS summer. A mentor who had not mentored in many years also still enjoyed updates on how the program and its protégés were doing.

Many mentors who had lost touch with their protégés reported that they wished they had on-going contact with their protégés:

Interviewer: Do you ever keep in contact with your protégés, after the end of the summer?

Mentor: No, not very much. Sort of, the SOARS office would, when they heard from one of them, would forward a message to the mentors. It was nice to know well, at least where they went and that they were doing well.

A few mentors felt frustrated about not receiving any response when e-mailing their protégés after they had left for the summer, or when the protégé response was very brief. A few mentors talked about not knowing how appropriate it was for them to initiate contact with their protégés after the protégés returned home at the end of the summer. While both mentors and protégés generally hoped for ongoing communication, a few protégés and mentors talked about their hesitance to initiate contact, because they were not sure about what was appropriate. For mentors who wanted updates on their protégés, but who were not in direct touch with their protégés, the SOARS newsletter helped fill in the gap, providing information and stories about the protégés and their academic and career successes. Nonetheless, it would be good for mentors and protégés alike to have some direction on what is considered appropriate.

XVI. SUGGESTIONS FOR PROGRAM IMPROVEMENTS

When specifically asked, a considerable number of mentors and protégés said that they could not come up with any specific recommendations for improvements to SOARS. However, these interviewees often offered advice at other points in their interviews. Both their overall endorsement of the program, as well as their particular suggestions, were duly noted and are discussed here. Virtually all of the suggestions for improvement offered by SOARS mentors and protégés are seen as minor issues that could be “tweaked” to enhance an otherwise successful program.⁹ Some of the interviewees were quite concerned about aspects of the program they felt needed revision, but were nonetheless generally positive about SOARS overall.

Interviewees raised various concerns about the structure of SOARS and of the program in general:

- Time constraints
- Tensions between supporting protégés in a supportive atmosphere and preparing them for the harsher, more competitive environments they are likely to face as scientists
- Tensions between increasing diversity and socialization of new scientists into the culture of science
- Financial support for SOARS
- Protégé selection and matching with mentors
- Needs for additional training for both protégés and for mentors
- Mentors’ needs for formative and summative feedback
- Other suggestions

We address these concerns in turn below.

Time Constraints

No one complained to us that the 10-week program is too long. It is also noteworthy that no one suggested that too much time was spent on the research. Those who talked about the time frame of the program inevitably said that the allotted time was too brief. Specifically, many said that the culminating weeks of the program, when protégés are required to finish their projects and get their writing done, were very intense. Some questioned protégés’ commitment to meetings (other than meeting with their research mentors), even though many recognized the value of these meetings. Some suggested that the program be lengthened if possible.

Protégés were generally sanguine about the time pressures, accepting them as part of an exceptionally rich experience. They did have ideas, however, about how to optimize their time. Both protégés and mentors looked for potential shifts in activities and/or in time devoted to specific program aspects that could ease the time pressures. Protégés most often suggested that the writing workshops and the SOARS group meetings for presentations and other activities be trimmed. A few mentors suggested that the writing training could be shortened (discussed below) and protégés could spend less time on non-research program activities:

I would think that the SOARS program has too many activities. But if they really want some research experience, they probably need to sit down there a little bit more, but

⁹ As an exception, one mentor we interviewed was less positive about the program. The input in this interview is in distinct contrast with the overall positive endorsement of the other interviews.

that's just my speculation. Because, I think more than half of the time, we are just, in kind of presentation and with groups and all this sort of things. It's good for the student, but on the other hand if you really get them involved in research....

A couple of the mentors said they thought the protégés needed more time to think, and reflect on their research projects:

I'll actually cite this as a criticism of the SOARS program. It seems like the SOARS program is so, um "scheduled." There's so many writing projects and so forth that have to get done, that my concern is, I don't know how much time these students have to just sit back and think about or...now, you know, maybe it's designed that way because I've never been in a job where I actually have an opportunity to think about something before I have to do it, but I sensed that there's a lot of things that are expected of these students during that 10-week period other than doing this basic research project, and so when it really boils down to it, maybe about a third of that 10 weeks is really all the time they have to actually devote to the project itself, rather than say writing about the project or preparing presentations to talk about the project and stuff like that.

Mentors also addressed challenges of time in terms of balancing time between research and writing. The time spent on writing workshops was also questioned by both protégés and mentors, as addressed below.

While mentors and protégés alike looked for ways to better use scarce time, a few mentors and protégés made suggestions for new offerings they would like to see included in the 10-week program. A few mentors suggested that SOARS be lengthened, adding time at the beginning or the end of the summer. A few considered the benefits of a semester-long program during the school year. However, few offered these ideas and most accepted that 10 weeks during summer is the best that can be done.

Protégés' Observations on Time Demands

There were mixed feelings among protégés about meetings they were required to attend: some wanted fewer meetings, even while recognizing the value of the meetings. One protégé even suggested using weekends as extra time to prepare for courses or seminars. In general, deadlines were seen as stressful, as was the short summer session.

Balance between Research and Writing

Protégés' Observations on the Writing Workshop

Several protégés suggested that the writing workshop be scaled back, either by condensing it so that there were fewer meetings (leaving more time for research), or limiting participation in the writing workshop to first-year protégés. There was also a considerable amount of unhappiness among protégés with the pedagogical approach taken in the writing workshops.

Mentors' Observations on the Writing Workshop

The writing component of SOARS was generally seen as a demanding aspect of the summer experience. Neither protégés nor mentors suggested that there be more writing added to the program. Mentors most often questioned the balance of time spent in writing workshops and on writing assignments versus time spent on the research project itself. A few suggested that time devoted to developing students' writing skills would be better spent later in the summer and allow more time for research work early on. In particular, there was some concern about the theoretical nature of the writing early on in the program as writing exercises relied on project content arrived at later in the research. Mentors pointed out that any developments or changes in the projects would necessitate unnecessary rewriting. Similarly, it was suggested that too much protégé time and effort went into the form of their presentations (specifically Power Point presentations), and that the time would have been better spent on the science itself. Mentors' suggestions that the writing be reduced in some form included:

- Less writing overall
- Less writing in the beginning of the summer
- Less time given to the writing workshop for returning protégés

Specific ideas offered by mentors included: more time reading related journal articles in lieu of some of the writing; modifying, if not foregoing, the writing workshops for returning protégés; and including more protégé input and participation in the first hour of the workshops (currently devoted to lecture). Mentors' suggestions about the writing workshop were given both in response to protégés' direct complaints about writing, and their own concerns about sufficient time for research-specific activities.

Those new to SOARS often expressed surprise about the emphasis given to developing students' writing skills, especially in contrast to time spent on the research project. The writing workshop was strongly defended by the original SOARS director, who cited reports from past protégés that singled out the writing component as the most valuable piece of the program. It is thought to be especially valuable because scientific writing is not specifically taught in most science programs, whether at the undergraduate or graduate level, while research methods and projects are the clear focus of most programs. Even so, many mentors discussed their initial, and less commonly, their ongoing, reservations about the time devoted to writing:

I brought this up with Tom a couple of different times and finally last year I said, "Look, you have got to cut back on the writing because they're not having time to do their science. Very few of them are able to finish their project or the project that they do is so small as to be barely significant." And he said, "I'll tell you what," [mentor laughs at the memory of the conversation]. He says, "You know here's how it turns out: of all of the protégés who've gone on to graduate programs and gone on into careers as scientists, they always, when they come back to us, we ask them what is the most important thing that you got out of the program?" And without fail they say it's the writing. Learning to do the writing was what, not the project itself, not the content of the project, not doing the science. The science is like this context in which they learn to do the writing. And the writing is focused on science...And what these people said is the writing is the biggest thing they got out of it."

Interviewer: Does that surprise you?

Yes! [Laughs] It surprised me at the time, but in retrospect it makes perfect sense.

The original SOARS director was occasionally thought to be overly committed to the format of the writing training, in part because, as we have pointed out, he understood that challenges to the writing component were most commonly made by participants least familiar with SOARS, overall. It is likely that much of the feedback we received reflected the original SOARS director's commitment to the writing component as such, even as changes have been incorporated over time.

From analysis of the interview data, it is evident that the debate between time spent on writing and time spent on research evolved over time. Opinion has settled more on the need for varied levels of training, with first-year protégés needing more writing practice than do returning protégés. Recently (since the end of data gathering for this evaluation) some innovations have been introduced, including a differentiation in the writing instruction given to first-year, versus returning, protégés.

Defenders of the writing program cite, not only the dearth of training in scientific writing outside of SOARS, but also the challenge of writing as a major contributor to the failure of scientists' careers. The writing-to-research ratio balance issue appears to be an issue most commonly raised by newcomers to SOARS, but was an issue mentors commonly addressed at some point in their experiences with SOARS.

Over-insulated versus Sheltered Support of Protégés

Some of the mentors expressed concerns about giving the protégés an overly rosy view of science careers. Mentors expressing this view saw SOARS as creating overly-idyllic conditions for protégés, and that the mentors' collegiality with one another is not a general norm in the sciences. At the same time, some mentors recognized the benefits of insulating the protégés from the harsher aspects of science careers during their summers at UCAR. Creating a "sheltered" experience for protégés was more often seen as appropriate and necessary to create a sufficiently inviting initial impression for students from underrepresented groups:

Before I was as well acquainted with the program and its goals as I am now, I really felt like, "Boy, they are coddling these students!" And I know I've said to at least one protégé, "Graduate school is not going to be like SOARS." But as I worked more closely with the program, I really see why it's set up the way it is. You know, you're working with students who—they are very much at risk for not continuing in this field and they are getting what I consider [to be] the normal kind of graduate school beat-down even. I mean even if they're undergrads, I think there's still some of that, I don't know, some of that more negative kind of pressure, and so I think maybe what I was viewing as, "Boy SOARS is really coddling these people," is more of a "SOARS has to provide a different kind of perspective and a different kind of vision for these students" or they really will leave.

The multiple layers of mentoring was also occasionally questioned by newcomers to SOARS, not so much because it seems unrealistic in the larger scientific community, but because it appeared to some as unnecessarily rich in mentoring. However, as mentors came to appreciate the distinct roles of the various mentors—how they lighten the load of other mentors, and how they ensure a supportive network for protégés—they reported greater appreciation for the multiple-mentor structure of the SOARS program. Those reporting initial skepticism came to see multiple mentors as necessary (benefits of the multiple mentor feature are discussed more fully elsewhere in this report):

I think what really surprises me is how well it works. Because when I first came here, we had these fledgling attempts to bring more money in, to bring summer students in. Without the focus of the SOARS program, they really didn't do well. It was very hard to get visibility or support for them, and when SOARS started, I looked at it like, "This is overkill! Why do you need all these...?" I couldn't understand then the idea of all these mentors for a few students. But it's clear that that's the level of support and guidance that's going to be successful.

In summary, mentors, especially early in their experiences with SOARS, were concerned that SOARS may be casting the life of a scientist in an overly rosy light. They indicated to us that protégés needed to see the following issues in clearer context:

- The level of support from SOARS is not typical in graduate school
- The level of collegiality experienced at SOARS is not typical of UCAR, nor of other scientific communities
- The timeframe in which they conduct their summer research is abbreviated; research typically takes considerably longer than 10 weeks to conduct

Tensions between Increasing Diversity and the Culture of Science

Closely related to the dilemma of how best to give students a "realistic" experience of science research that supports rather than deters them from the profession is the issue of preparing new scientists from diverse backgrounds by simultaneously helping them to adapt to the culture of science and incorporating the richness of their diverse backgrounds into that culture. Mentors and managers noted that science has its own culture, albeit a changing one. Mentors expressed concern that protégés might feel pressure to abandon their own cultures in order to assimilate into the culture of science. They hoped, instead, that the culture of science would benefit from increasing diversity:

Hopefully there's not a feeling that they're being worked on to conform. That would be a tough thing, because as more and more broader based, broader cross section of people, get into the sciences—which is happening as science proliferates around the world, and people from different countries and ethnic groups are always increasingly represented in some fashion or another—it's difficult to say exactly what it's going to bring to the table. But what I wouldn't want to see is that, everybody has to conform to a certain mode of being.

Another mentor expressed a similar viewpoint:

I don't think there's much, a conscious problem there that I see. I think it's more, that it's just a culture clash of the science culture, versus whatever culture a protégé may come in from. For example, there was a Native American guy who talked real frankly when he was here early on, about just the difference in thinking of the way the world works through, in his tradition versus science, and he was aware of those two...and he wanted to hold both of them, keep them both as valid, you know, things, rather than having to replace one with the other. So I think the more we can think that maybe the more SOARS can present the science culture, it's not the way you have to be, but just, "Here's another way of working in the world, and this is the way scientists work in the world, and if you want to be a scientist you have to learn how this world works."

Comments such as these speak to concerns about realizing social change, while simultaneously grooming agents of change to succeed in an established culture of science. The tension between preparing newcomers to science to both fit in and alter the culture is a sociological dilemma that is not yet fully addressed even at a theoretical level. There is discomfort in working on the unsteady ground of promoting change, but there is likely no progress without such pioneering efforts.

Financial Support for SOARS

Mentors and managers discussed with us their concerns about ongoing funding for SOARS. There was concern about being able to maintain the high level of funding SOARS has had to date, particularly as some funding sources have been discontinued. Some mentors worried about funding renewals for a continuing—albeit demonstrably successful—program and competition from new, innovative programs. Others mentioned the stresses and strains arising from the program's success: as more and more students are encouraged to continue on to graduate school, there is increased need for funding support for protégés' graduate school expenses. Too, some worried that graduate programs might limit their financial support of SOARS protégés, having come to expect SOARS' contributions in support of these students.

At the same time, a few mentors questioned if the high cost per protégé was necessary. A couple offered the notion that the high investment was necessary to "jump start" change, and that once more role models were in place for people from underrepresented groups, such expensive programs would no longer be necessary. A couple comments suggested that more funds need to be spent in the first 12 years of students' education as a means to increase the overall number of students entering college. Most mentors, however, did not question the resources SOARS uses, particularly as they see it as a highly successful program. More commonly, mentors hoped that, with time, SOARS' efforts would reach many more individuals from underrepresented groups:

I guess one of the questions that they ask, sort of regarding the program is, "Is the cost worth the benefit?" ... It's a lot of manpower, and it's very few, very specialized students. You know, we're trying to make an effort to increase the number of underrepresented minorities. Now, maybe we have to do it this way, and hopefully, you know, you start getting, minorities into the program that can serve as role models, and other minorities start saying well, "You know, I should continue to work in this way," or

is it a huge effort for every protégé you have? You have three people trying to help them along, who are spending a lot of their time and, maybe, aren't, as we talked about, gaining professional benefits that are necessarily commensurate with that. And, is that a wise thing? I don't know that I have the answer, but I think it's a type of question that needs to be looked at. I mean it takes a lot of effort to run something like this correctly.

There were also some concerns voiced about finding resources from UCAR to support appropriate workspace for protégés' work, provide more computers, and better access to main-frame-supported computer programs not accessible to protégés via their PCs.

Protégé Selection and Matching with Mentors

A few mentors expressed some concern about selecting qualified students with adequate science training and familiarity with and enthusiasm for the SOARS program. The concern here was with protégés whose commitment to atmospheric science was not certain, and with protégés who needed more than the average amount of tutoring in science to be effective in their projects. One suggestion was to ask SOARS candidates to identify and write about three research projects they would be interested in, rather than addressing general topics as is currently done. This exercise would encourage candidates to think more deeply and in a more focused way earlier in the program. However, it was also suggested that mentors' involvement in the selection and/or matching process would be inadvisable: it would require more of the mentors' time, and some mentors might be tempted to cherry pick the "best" protégés.

Information on Protégés Ahead of Time

Research mentors often said that it would help them to know more about their protégés before the protégés arrived at NCAR. In particular, they wanted to know about protégés' computer, math and writing skills as well as students' preparation for science research. This information would enable mentors to better plan the research projects. It was seen as beneficial for research mentors and protégés to meet as early in the summer program as possible. Protégés also suggested that they would benefit from research projects tailored more closely to their skills, experience, and interests.

In addition, some of the peer mentors said that they thought it would be helpful for them to know something early on about the first-year protégés with whom they would be working. They hoped to befriend and bond with their peer protégés by communicating with them prior to their arrival and also hoped to have some ideas about mutual interests for initial conversations. Several peer protégés also recognized the benefits of communicating with new protégés prior to their arrival at UCAR. E-mails and/or phone calls between peer mentors and their mentees before the summer program began would help peer mentors prepare for the arrival of new protégés so that they would feel welcome and less nervous about their first trip to UCAR. Peer mentors would benefit from the opportunity to get acquainted with the new protégés and help them to develop more ideas about how to best support them once they arrived. Peer protégés suggested that the process could be facilitated by providing them a brief biography of the new protégés.

Protégés' Observations on the Recruitment and Selection Process

Protégés had three sorts of related suggestions to make about the recruitment and selection process. The most common suggestion was that the protégé population should be modified.

However, clear recommendations on what the best protégé population would look like are missing and there is no consensus on what characterizes the “ideal” protégé. One suggestion was that more Native Americans ought to be recruited, as they are the least represented among the ethnic groups. Another was to include Caucasian women as an underrepresented group. A third idea was to advertise more broadly on each campus and in more communities. The issue of who to include as protégés is a potentially significant issue, as the focus and purpose of the program are brought to bear when re-thinking the protégé population.

A few protégés suggested that new protégés be allowed to their own research mentors and projects. Their concerns were based on their experience of having research projects assigned which did not fit well with their interests. One protégé also suggested more opportunities for gaining field-based experience.

Protégés were concerned that mentors be chosen with care, and that mentors who are willing and able to commit adequate time to SOARS and the protégés be selected. They characterized good mentors as those who are committed to their protégés, who listen to their protégés, and are responsive to protégé needs.

Peer Mentors’ Challenges with Field Work

Protégés pointed out that peer mentors have unique challenges keeping in touch with their mentees when either one of them are located off-site. First-year protégés face an extra challenge in connecting to their peer group when they return from field work. Peer mentors could use some advice about how to make this transition easier. Protégés did not offer suggestions about how to respond to these challenges, and would apparently appreciate some thoughtful attention to these challenges. As mentioned elsewhere in this section, field work was particularly valued by protégés, even in their first year.

Level of UCAR Scientists’ Involvement

There was a call for more involvement in SOARS from UCAR scientists, generally, as well as from mentors already active in SOARS. It was suggested that protégés would benefit from introductions to more UCAR scientists currently involved in SOARS (and their respective projects) and that year-round communication between mentors and protégés would enhance SOARS’ benefits to protégés. There was also a related concern that too few scientists, including some SOARS’ mentors, attend students’ presentations. A larger audience would provide a more genuine experience for the protégés. There was also a desire to see more informed participation on the part of community mentors, in particular. Community mentors were seen as least likely of the SOARS mentors to attend the protégés’ presentations, as well as too little involved with their protégés, more generally. We have described elsewhere in this report problems concerning the unclear expectations and defined role of the community mentor.

Challenges When Mentors and Protégés are not Co-located in Boulder

While mentors advocated involvement from mentors and scientists not already involved in SOARS, some mentors lamented their inability to be as present or involved with their protégés as they would have liked. In particular, mentors whose offices were not located on the same campus as their protégés’ oftentimes found it difficult to organize meetings. Events that were held “off site” at another campus also meant more time for travel, and sometimes made the

difference between attending or missing an event. Mentors not co-located with their protégés said that it resulted in fewer meetings. A couple of mentors who were co-located with their protégés said that this made it possible to meet more frequently. In addition, more casual, natural meetings were also possible. It would seem, then, that co-location can affect more than the quantity of meetings, but also the quality of meetings. As one writing mentor noted, co-location with the other mentors also facilitated the mentoring team's efforts:

Writing mentor: I knew the scientists and the, what was it, the community mentor. They were in the same building so we were able to talk at times. So-

Interviewer: So you actually got together with the other mentors then?

Writing mentor: Briefly, yes. We always wanted to get together to talk about it, but the scientist [name] and I got together, she told me what the project would be, what she expected from [the protégé]. And [she's] a great scientist. And [name] was the community mentor, so we kind of knew each other, I've been here a while. So, we knew each other and it just worked out really well. [Protégé] just shined.

As another writing mentor noted, simple, casual greetings on an on-going basis also have value:

It was a fabulous situation for us because this person that I was mentoring was in my office...well he was in the office adjacent to mine, but we share the same suite, so I was there. We were able to touch base, I don't know, every other week, and often it was just "How's it going?"

A couple of mentors discussed strategies they used to overcome lack of co-location, including one who arranged travel for the protégé to come to the mentor's office, traveling with another protégé. Since traveling together facilitated meetings in this case, it is possible that other, similar arrangements can help overcome other location challenges. The shuttle did not appear to be a sufficient solution in all cases, as the timing of shuttle service did not always coincide closely enough with transportation needs.

Needs for Additional Training for both Protégés and for Mentors

Mentors' Suggestions for Additional Protégé Training

Mentors spoke about different sorts of training they would like to see for protégés. In particular, mentors were often concerned about protégés' lack of training to work using various computer languages. Suggestions made to address this need were:

- To assess the protégés' needs for computer training prior to their arrival in the summer so that either tutoring materials could be sent to them before they travel to Boulder or the research mentor can take this need into account when planning the research project
- To provide a technical mentor to protégés especially lacking computer language training
- To promote training in and use of NCL (NCAR-created and -supported graphics and analysis software, available across UCAR)

- To provide training in computer languages would better-prepare protégés to use other specific computer programs
- To match mentors and research projects according to protégés' level of computer skills, as some projects are more computer-intensive than others

In addition to computer expertise, mentors also identified other areas in which they would like to see protégés' training extended. These included:

- More information about the social context of science beyond the particular experience that is Boulder
- More training in preparing and presenting posters, as they are so commonly used in atmospheric sciences
- More preparation for future job interviews

Additionally, a few mentors offered ideas about three types of presentations for students' professional development that NCAR scientists could give to protégés. These were:

- Descriptions of various sub-disciplines in atmospheric sciences to inform protégés about potential career options
- A panel of scientist to discuss work-life balance issues that they face as scientists (which can be intimidating for protégés, particularly women, to initiate)
- Presentations about what life is like for scientists in Boulder

Mentors suggesting these offerings saw them as opportunities to provide important information to protégés in a non-threatening way, to expand these benefits to more SOARS' protégés, and as a way to save time in the individual mentoring relationships. Group discussion of this type were viewed as more effective since it obviated the need to cover such issues individually.

Protégés' Suggestions for Additional Protégé Training

Protégés, eager to learn how to succeed in science careers, asked that SOARS provide additional training in the following areas:

- An optional seminar to prepare for the Graduate Record Examination (GRE)
- Advising and support in selecting appropriate graduate programs
- Information about and support in applying for scholarships for graduate school
- Grant proposal-writing, perhaps in a workshop format
- Publication advice
- Making group (as opposed to individual) presentations
- More field experience opportunities
- Math tutoring

While several protégés noted that they benefited from first-year projects that were considerably far afield from their core interests, most wished for a more tailored fit even early on. Similarly, protégés asked for more input on their research proposals, especially in their first year or two.

Mentors' Suggestions for Additional Mentor Training

Mentors asked for six types of training/information to enhance their effectiveness:

- More information about what is expected of the mentors, including: clarification of the community mentor role; need for a policy statement about mentors being present over the course of the summer; more information about the time commitment expected of mentors; and information about student “milestones” to look for when mentoring
- Advice from more experienced mentors—for example, sessions with more experienced mentors to provide general advice
- Information about expectations SOARS has of protégés, including student schedules, deadlines and weekly activities, and clarification for research mentors about not using protégés as “labor”
- Guidelines about choosing/designing research projects
- Training more generally, such as UCAR’s management training and information about multiculturalism, team work, and mentoring—all of which would facilitate mentors’ UCAR jobs
- Splitting current training sessions into two—one for new mentors and one for experienced mentors—as each need different information

The desire for more interaction with other mentors was not characteristic of any particular type of mentor. At least one of each type of mentor—research, writing, and community—said that he would like to meet with other mentors to exchange ideas about mentoring.

Mentors’ Needs for Formative and Summative Feedback

Mentors occasionally asked for more feedback from SOARS, with four distinct types of feedback in particular:

- Information about how past protégés are progressing
- Feedback on their own mentoring efforts
- Evaluation information about SOARS
- Specific work that their protégés produced

Mentors wished to know how their protégés from past years were faring. A couple of mentors, in particular, said that they would like to know if their protégés needed help at this point in their careers. They also said they would like more feedback about the effectiveness of their own mentoring, especially if they perceived their protégés to be doing poorly or had discontinued their participation in the program. When protégés did not return for subsequent summers at UCAR, mentors were particularly likely to be concerned that their mentoring efforts had failed and they wanted to know how they might improve their mentoring:

Last year the student I worked with [name], who didn’t come back, you know. I don’t know if she found it too hard, or I don’t know what her reasons were, and they kind of don’t let you know in SOARS, under those conditions, or they didn’t let me know about her in particular. And, so that makes you wonder if there was something more you could have done there. But, there’s not a lot of drop outs. And, as one mentor said, being invited to mentor again may indicate adequate mentoring, or it may be an indicator of too few mentors volunteering.

The desire for feedback about their performance as mentors also illustrates the desire mentors have to be useful. We had several discussions with mentors in which they described their concerns about being effective mentors, as one mentor said:

I occasionally lie awake at night and think, “Does [protégé name] feel like he’s getting short-changed by me?” or something like that. I mean, he seems to really enjoy the interaction with [mentor’s name] and that works well, but sometimes I just, I’m just not sure how he feels about that structure.

Mentors also asked that information from this, and any other evaluation conducted for SOARS, be shared with them. The mentors were interested in both short-term and long-term outcomes of the program:

I always wonder, and I don’t know, maybe they do it, but I always wonder what happens when the kids leave? What happen when they, they come to NCAR for a year, they have a six month, seven month, or you know, some of them repeat [return to SOARS for another summer] because I know that it’s a lot of repeating. And I know too that there is a lot of interest in people coming back again. But I wonder, how, what kind of program does, what do they do, in order to get from the beginning to the end. Or maybe even just to track down how many people actually made it. That’s my only concern because a kid can come here, have a wonderful experience, and change, but that kind of person that...can change over six months is very rare. Or overcome their difficulties or... I’m more interested in knowing well, for example, I know that they track down where the undergraduates are, what their interests are, but did they get there, did they do it? So, long term....

Mentors also wanted to see protégés’ completed assignments—beginning with their initial research proposals, as well as the final research project report. In some cases, mentors wished to gauge the helpfulness of advice they had given to protégés. A couple of mentors, in particular, were delighted (and perhaps relieved) to learn that their efforts as writing mentors were appreciated, particularly over time as protégés discovered the value of training in scientific writing. Knowing that one’s efforts are appreciated is also effective in preventing mentor burn out, as discussed elsewhere in this report.

Mentors also expressed appreciation for information on protégés that is available on the SOARS website. They were especially grateful for personal e-mails and other contacts made by the protégés, themselves. Protégés, too, appreciated communication with their mentors. However, protégés and mentors, alike, were unsure of the propriety of initiating and maintaining contact with one another. Clarification from SOARS staff about this would be welcomed by both protégés and mentors.

Mentors also wished to have summative feedback on the SOARS program in order to better “sell” mentoring in their departments, facilitate good public relations outside of UCAR, and to inform SOARS’ selection of good mentors. A couple of practical issues also emerged regarding feedback. In one case, asking overly-stressed protégés for feedback too close to the frenzied end of the program was problematic. In another instance, a mentor expressed frustration at the

amount of time needed to fill out surveys for SOARS. However, mentors were happy to speak with us, even though the interviews took more of their time than a survey would have. We suggest that willingness to take time for an interview is influenced by perceptions of the usefulness generated by conversation with the interviewer and expectations of receiving feedback from the data gathering process.

Protégés' Perspectives on Formative Feedback

Protégés expressed appreciation for the role of formative feedback in SOARS. They were pleased that it is gathered regularly and truly listened to, and that suggestions for improvement were subsequently incorporated into the program. The responsiveness of SOARS managers to formative feedback contributed to protégés' perseverance, helping them to be patient and hopeful when glitches in the program arose. New protégés also observed that returning protégés were curious to see whether feedback was truly incorporated into the program and impressed to find that, in many instances, it had been.

Protégés made a couple of suggestions about enhancing the feedback system already in place. These included having mentors and protégés get together as a group to discuss the research project, overall, in order to generate useful feedback and advice and including feedback from alumni protégés.

Other Improvements

Suggestions for program improvement are discussed throughout this report. The most common ones have been outlined above. Other suggestions, made less frequently, and that do not necessarily fit with more thematic ideas, are listed below.

Mentors' suggestions included:

- Facilitate protégés' access to computers, either by providing laptops for summer use, or coordinating computer availability through research mentors
- Revisit mentor-to-protégés ratio. Greater mentor involvement with protégés was mentioned. Too, organizing protégés into small research teams under the direction of single research mentors was also suggested as a means to enhance the mentor-protégé ratio.
- Consider offering the program during the school year to avoid conflicts with mentors' summer schedules and to make the program more accessible to protégés with children
- Revisit the hierarchy of mentors in which there is inferred or assigned status, with research mentors at the top, writing mentors in the middle, and community mentors at the bottom
- Consider whether too much is demanded of the protégés, especially given time limitations

Protégés' suggestions:

- More structured interaction with SOARS staff, particularly with the director
- Ensure that mentors have good experiences so that they wish to continue mentoring in the future
- Protégé roommate selection should be done with the goal of improving protégé interactions and relationships, whether this means deliberately matching protégés across ethnic groups, or leaving roommate selection up to the protégés themselves
- Improve access to early morning shuttles (needed to attend meetings)
- Assign laptop computers for protégé use over the summer to facilitate their work
- Minimize “top down” management of SOARS program components, giving protégés responsibility and ownership wherever possible

Additional Improvement Opportunities Suggested By the Evaluators

Areas to consider improving are: ways in which the SOARS program is marketed, and how protégés are recruited and selected. With one in four applicants being admitted, the program is only somewhat competitive. In addition, the pool from which potential applicants is drawn could be increased by building stronger ties to university minority populations.

Other opportunities for improving the program include:

- Broaden the diversity of the staff with people who have lived the minority experience in higher education
- Broaden the Steering Committee population to include more racially diverse members
- Consider making race an explicit topic in protégé seminars to facilitate retention of cultural/racial pride and reduce risk of assimilation to dominant science culture over time
- Make new mentor training mandatory
- Provide greater clarification of role responsibilities to community mentors
- Make UCAR recognition and rewards for mentors consistent across the organization
- Continue improving the Peer Mentor and Leadership Training to meet protégé needs and increase protégé understanding of the value of such training
- Continue promotion of the benefits of the program and justification of the costs per protégé to UCAR managers
- Continue improving writing workshop pedagogy and protégés' roles within it.

XVII. SOARS' RESPONSIVENESS TO FORMATIVE FEEDBACK

It is important to consider that the overwhelming majority of feedback collected was positive. From our 201 in-depth interviews and 100+ hours of observation, we heard and observed candid, distinctly positive, feedback. Friendly feedback is always easy to hear; negative commentary less so. The criticisms we heard about SOARS were in nearly every instance phrased as constructive criticism intended to “tweak” a generally warmly-received program. The more penetrating question then, is “How does SOARS respond to negative feedback?” Our attention in this section to this question should not distort the reader’s perception of SOARS as the broadly praised program that we found it to be.

Unlike the laws of physics in which “bodies in motion tend to stay in motion,” social processes tend toward inertia in a different way. Administrators of organizations tend to find routines with which they agree, with which they feel most comfortable, or even those they come to accept as inevitable. It is to the credit then, of administrators who deliberately reconsider familiar, perhaps comfortable, patterns of action and maintain receptivity to innovation. SOARS has an internal reputation for soliciting and acting on feedback from all participants in the program. This openness to feedback contributes to the steadfast loyalty of participants who, when unhappy with a particular feature of the program, nevertheless trust that concerns raised about it will be duly considered. Belief in the fairness of the organization makes manageable what are then seen as “transitional” problems. The “mileage” this program gains from such receptivity to suggested improvements to the program is considerable.

Summative feedback from protégés and staff is routinely gathered at the end of each summer. In these generally freeform sessions, protégés brainstorm and discuss issues they would like attended to, as the staff listen and respond. In one such session we observed, the types of positive and negative feedback were as follows:

- 32 comments about possible bias in selecting who among the protégés got the most desired apartments and roommate relationships
- 32 comments about the writing workshops, 18 of which addressed what were perceived as significant improvements over time
- 29 comments about needs for mentor training
- 25 comments about protégé leadership training (most about the sessions running too long or resource materials being unhelpful)
- 23 comments about staff issues, 8 endorsing Dr. Pandya’s transition, and the desire for more social interaction with staff
- 15 comments about protégé seminars taking away too much time from research projects
- 35 comments about other issues

Staff members embraced the value of continuous, formative program evolution as well. Some of their motivations for constantly seeking feedback included:

- To keep the program “fresh” for returning protégés
- To take into consideration the specific needs and characteristics of each year’s group of protégés

- To improve, but not fundamentally change, SOARS

The staff members' feedback, just as with any other participants' suggestions, was listened to. At the same time, theirs were particularly vulnerable positions for two reasons. First, openly-voiced criticisms, such as protégés' feedback in the freeform sessions at the end of the summers, would most likely reflect on staff members' efforts. For example, criticisms of the writing program were the most common. As the writing program was largely managed by one individual, that person was directly in the "line of fire." Some of the staff acknowledged their sense of personal vulnerability in open forums. At the same time, the candid communication of problems in the SOARS community created a situation in which those voicing criticisms were quite aware of the impact of their criticisms on individual persons. While this would increase the motivation of those airing concerns to employ tact and to weigh more trivial points to determine if they should risk potentially hurting another's feelings, it would also have the effect of quieting those most shy or considerate of others from raising legitimate concerns. The merits of open discussion must be considered against the costs of open wounds. Given SOARS' credibility in welcoming and responding to feedback, it may be a risk calculated as worth taking, but a risk worthy of ongoing calculation. If some topics were censured from open discussion, the credibility of the feedback dynamic would change significantly.

Second, staff members are especially vulnerable in program evaluations, because as their feedback is encouraged because of their unique positions in SOARS, they questioned if they really had an option, as employees of SOARS, to participate in interviews and observations. This then prompted them to question how freely they should speak. We appreciated their candor in pointing out to us this dilemma, which we answered with reassurances of confidentiality and respect for any hesitance to speak with us. We also offered individual interviews, which could be declined anonymously.

We have presented a dilemma for SOARS in this section, as we acknowledge the merits of SOARS' receptivity to feedback while noting that this very receptivity is not without cost. We are fully aware of this difficulty.

SOARS' Response to Reports of Sexual Harassment

In keeping with legal requirements, E&ER personnel reported to the SOARS director allegations of sexual harassment in the program that were reported while maintaining the anonymity of all parties involved.

The new SOARS director (who had only held the position for a short time) promptly met with the legal representatives from UCAR, and subsequently a larger meeting was convened that included the SOARS director, UCAR legal staff, E&ER research managers and personnel, and a representative from the University of Colorado's Human Research Committee (HRC) met to discuss how the two entities (UCAR and CU's E&ER research team) ought to handle these reports. Following further consultation with legal representatives from both UCAR and the University of Colorado, the appropriate courses of action were determined and acted upon.

The evaluators successfully encouraged those making the allegations of sexual harassment to speak directly with the SOARS director. The SOARS director reported back to E&ER evaluators that the allegations were laid to rest, and that the parties making the allegations were satisfied with both SOARS' and E&ER's responses. The evaluators also spoke with those reporting the harassment and were assured that the matter had been resolved.

SOARS responded in a timely, appropriate way, and subsequently improved and increased their sexual harassment issues training. Mentor, staff, and protégé training in response to allegations of sexual harassment were re-addressed in response to evaluators' report of such allegations. The only remaining recommendation that E&ER is making in this report to SOARS management is that informal mentors, who may not be directly involved in these sexual harassment training sessions, also be made aware of SOARS and UCAR's sexual harassment policies.

The careful, serious, timely attention SOARS gave to these concerns are additional indicators of the responsiveness of SOARS to feedback. We would also like to note that Dr. Pandya, who had been the SOARS director for only a brief period of time acted with all due diligence in this matter. He expressed great concern about all the parties involved, and addressed the issues thoroughly and sensitively.

XVIII. THE EVOLUTION OF SOARS OVER TIME

Mentors did not recognize changes to the SOARS program over time as particularly significant: most of the changes were considered minor, but the fact that change was embraced was seen as very important, in itself. Nearly all of the feedback about SOARS' evolution over time was described as improvements in the program. We note below some of the more substantial changes made to the SOARS program since its inception, either as discussed in the interviews, or as noted via our own observations:

- Extending the research network to include other labs who host protégés, including NOAA and NASA
- Leadership training for protégés was added as a separate component
- The peer mentor role was added and refined
- The community mentor role was limited to first-year protégés
- Training for the mentors has been refined over time
- Addition of a computer support person for protégés, as well as a software training session at the beginning of the summer
- Introduction of off-site research opportunities for protégés
- Changes to the writing training:
 - Additional writing assignments were added, i.e., a research proposal
 - The audience to whom protégés write their papers has changed from outside scientists to SOARS' participants
 - The Writing Workshop curriculum has been provided to all mentors
 - Writing assignments are more closely related to the research projects
 - Writing assignments are distributed more evenly over the summer
 - Mid-summer practice talks have replaced practice sessions the week before the final presentations
 - New resource used (Mayfield scientific writing manual)
 - More peer leadership in the writing seminars

XIX. EXPANDING SOARS

We asked interviewees to discuss with us their ideas about how SOARS could be expanded at UCAR and replicated elsewhere. They provided several ideas about expansion and replication, including some ways in which expansion may already be occurring, as well as some advice about ways in which SOARS should consider reducing its current scope. These are discussed in turn below.

Expansion

Mentors and protégés had overlapping suggestions about expanding SOARS, as shown in Table X below. They both addressed growth through inclusion of more scientific disciplines and categories of students; protégés also suggested both developing industry partnerships, and increasing involvement at the graduate school level. In general, these suggestions were not detailed propositions, but ideas that had been offered spontaneously. Three of the 10 ideas for expansion were departures from the program as it is now (shown in *italics*), while the remaining seven were extensions to the current program. The departures are different in that they expand on SOARS' goals, themselves, rather than extending the efforts SOARS is already pursuing.

Table X. Suggestions for Expanding SOARS

	Mentors' Suggestions	Protégés' Suggestions
Expansion via More Science Disciplines and Departments		
Include more scientific disciplines (<i>some in addition to atmospheric sciences</i>)	X	X
Include under- or un-involved departments at UCAR, such as IT and geo-science	X	
Include other, non-UCAR programs and labs	X	X
<i>Include industry</i>		X
Expansion via Relationships with Graduate Schools		
Strengthen existing ties to graduate schools		X
Increase funding for graduate school		X
<i>Include post-doctoral students who need to learn about grant-writing</i>	X	
Expansion via Including a Broader Range of Protégés		
Include high school students	X	X
Include more graduate students	X	X
<i>Include other categories of students, such as Anglo students</i>	X	X

These suggestions can be grouped into three categories of suggestions: expansion via more science disciplines and departments; expansion via relationships with graduate schools; and expansion via inclusion of a broader range of protégés. Each of these is addressed below.

Expansion via More Science Disciplines and Departments

Suggestions for including more science disciplines, both inside and outside of UCAR were raised as a means to improve and expand the program. Mentors in a focus group agreed that expanding SOARS within UCAR, in its present form or building upon particular aspect of SOARS, would be good to consider. As mentors discussed in a focus group:

I was actually just sitting here wondering if you could take the SOARS model and put it into some of the other disciplines in the organization, beyond science. I know some of it probably fits best with science and research projects....

Another mentor in the same focus group:

Well, SOARS came out of the old SEP program, the Summer Employment Program. I think there may be some opportunities to have something—it wouldn't be SOARS—but to open up summer employment perhaps, maybe—it's not tied to scholarships and things—that is a little broader to try and bring in some folks in IT that look different than the folks you've got. I think that opportunity is always there, and actually SOARS is sort of taking everything away from that. We may want to come back and look and say, "Are there places through the organization that we could do something a little different? Internship programs or something?" [The first mentor expressed agreement as the second spoke.]

Expansion via Building Relationships with Industry

The suggestion to partner with industrial organizations was a departure from the current SOARS program. The alumnus protégé who made this suggestion said:

When I was there [at SOARS], I thought it was perfect. Now that I graduated, now that I'm out, I know what can be different, and it's mainly that SOARS should partner with private companies, and have students go to those industries, not only government.

This is a departure in that the focus of protégé involvement is currently research projects in research settings. It is not clear if industrial mentoring arrangements would involve research or research and development in the same way.

Expansion via Relationships with Graduate Schools

The second suggestion for expansion addresses SOARS' relationship with graduate schools, including increases to existing funding to help offset costs of protégés' graduate school; and reinforcement of ties to graduate departments.

Expansion via Including a Broader Range of Protégés

The third suggestion concerned expanding the pool of protégé candidates, itself. Suggested ages for new protégés ranged from K-12 students to post-doctoral students. Including protégés from

high school would fit with SOARS' goals of promoting an interest in careers in atmospheric sciences, including students already in or through graduate school would promote the goals of ensuring success of students already on the career path in atmospheric science

It was also suggested that post-doctoral students who need to learn about grant-writing be included in the program. Expanding SOARS to include students this far along in their graduate work would speak less to the goal of encouraging students from underrepresented groups to consider careers in atmospheric science, and more toward ensuring the success of those already well along this career path. The mentor suggesting this explained:

I've often thought that we should have better support for new minority faculty, especially in the areas of grant writing, and how to manage a project, how to manage a grant. I was a junior professor once, I came from a private industry where I've managed many projects, so I was off and running, and I saw other new faculty where I was, struggling with that... There are some from SOARS already, who are getting teaching jobs, and say, "Ok, we'll work with you one more year." I mean one could be an extension. But the other side of that is if SOARS, or in general, the NSF funding, is to keep diverse populations in science, helping them succeed in their first year is probably critical.

The last suggestion listed in Table X, as part of this third group of suggestions, presents the greatest of departure from SOARS' current goals. The inclusion of Anglo students in the SOARS program challenges the central goals of SOARS—that of promoting students from underrepresented groups to pursue and succeed in careers in atmospheric science. It is important to note that only a few interviewees (one protégé and two mentors) promoted the idea. A decisive majority of interviewees did not think this was a good idea, as they endorsed SOARS' goal to remedy the current imbalance of too few people of color in sciences.¹⁰ Inclusion of Anglo students, when it was offered, was suggested with caveats to include *underrepresented* Anglos: white women and Anglos from lower SES backgrounds, both of whom are underrepresented groups in the sciences.

Research mentor: I know that this [SOARS] is for minorities, but you know, I could also see doing something like that for more underprivileged people too.

Interviewer: In what sense? What kind of underprivileged?

Research mentor: Well, you know, just financially or something like that, being able to go into some small college, like [protégé] was from. I'd never heard of [school name] until she showed up. But you know, more, smaller campuses and things like that, where somebody who may not be able to afford to go to the big state school or something like that—that's what I mean. Of course those people tend to be minorities too.

¹⁰ The reader is reminded that interviewees were not all asked exactly the same questions; as issues emerged to be more or less important and those that turned out to be irrelevant in subsequent interviews were dropped. Relevant issues that interviewees spontaneously brought up were pursued in subsequent interviews. For this reason, the numbers of interviewees who made any particular point are not reported, as statistical parameters were not met. If every interviewee was asked to speak to particular issues, the findings reported here would be expected to be strengthened. Relative numbers of interviewees speaking to particular issues are pointed out as they indicate strong trends.

Most interviewees favored including women from racial minority groups in SOARS over including Anglo women, and emotions ran high on this issue in some cases, particularly as some Anglo women have been admitted to SOARS. As one protégé said:

There has always been a great number of applicants to the program that were Caucasian females and I would say if we're going toward the groups of people that we really want to identify, my preference is, if it's a Caucasian female or it's a female with the same sort of qualifications but from a different ethnic group, I would tend to go with the latter... Trying to diversify because we're not, yes, they're women, but their cultural perspective is really the same as what we're... trying to diversify.

It was also suggested that, if included, the numbers of Anglos be kept small, as their inclusion would ideally round out, but not dominate, the program, and would provide Anglo protégés an opportunity to learn about diversity from the perspective of under-representation. Also, in small numbers, Anglos would contribute to the dynamics of promoting diversity and inclusion of underrepresented minorities among the dominant Anglo culture without replicating the system as it is. The suggestion made by a couple of interviewees to consider Anglo protégés is included here in the interest of examining the full range of suggestions offered to expand SOARS.

Only one other sort of suggestion was countered by other respondents: including protégés as early as late high school or of limiting participation to the last year of college and the first year of graduate school. Again, only a couple of respondents addressed expansion in terms of younger or more advanced students. The other suggestions were more representative of respondents' ideas, and involved no other conflicts of opinion.

In sum, ideas for expansion include: a broader range of science and work options; expanding the program to better integrate graduate school connections; and including a broader range of students as protégés.

Expansion via Participants' Individual Actions: The "Multiplier Effect"

Several protégés reported that they had already taken some action that, in effect, promoted SOARS' ideals. They talked about how they had "passed it on" via becoming mentors for others upon returning to their communities, or had otherwise assumed leadership roles back home—roles learned as SOARS protégés. In a few cases, protégés reported advocating for mentoring programs and/or SOARS-inspired program features in their universities' academic programs. In all of these cases, protégés were promoting goals of SOARS by encouraging others to pursue science, to aspire higher than they otherwise would have, to develop more supportive learning environments, and by inspiring others to achieve more. Some protégés who had not yet engaged in such activities talked about their interests in and intentions to do so. These methods of promoting science and raising career ambitions among students from underrepresented groups were regarded by protégés as mechanisms of expanding the influence of SOARS, as well as "paying back" the advantages they appreciated gaining from the program. This sort of expansion has the potential of growing exponentially, as increasing numbers of people "pass it on," and may prove to be the source of greatest expansion. As a couple of alumni protégé said:

Generally through the SOARS program, through how they set up—for example the mentoring program—you’re mentored by someone, and the second year, the older SOARS students, or those who had returned, were mentors to the younger students for example. And setting up that kind of what I called a “mentoring pyramid,” was something that I kind of took with me, and actually applied to various settings. I was mentored by older graduate students or professors, and I have mentored younger graduate students, and now I’m mentoring middle school students.

I’m trying to emulate, as part of this [X] position, I’m trying to emulate the SOARS mentoring program. I spoke about it in my interview, and I think that’s what gave me the edge to get this position...So I’m in the process of developing my own mentoring for this program.

In addition, both protégés and mentors saw Dr. Windham’s (the original SOARS director) move to the National Science Foundation as positioning him to promote SOARS’ and similar programs’ goals, and hoped that SOARS influence would be extended this way. It was hoped that Dr. Windham’s charisma and dedication to SOARS and SOARS’ goals would inspire others at the NSF to support similar, new, and existing programs, expanding nationally and across science disciplines. As one mentor put it:

I do feel like SOARS makes a difference, maybe on the small scale now, but I think something that’s optimistic about Tom going to the NSF, is that his visions that have made this program what it is now, can be on a national and a generic science scale, not just atmospheric science. I mean it’s just going to get broader.

Mentors recognized that some of the alumni protégés had begun modeling what they had learned about mentoring in SOARS upon return to their home communities, as discussed above. Mentors also noted that mentoring was becoming increasingly valued at UCAR, heralding a welcomed cultural shift in the organization. Mentors pointed out to us that one UCAR division, in particular, has started its own SOARS-like program. Some of the mentors noted that SOARS had built on and expanded from a previous student intern program at UCAR, the Summer Employment Program (SEP). To the extent that SOARS has developed from a previous program, it was seen as part of a larger trend toward mentoring and promoting diversity.

Some of the mentors expressed the hope that current protégés would return to UCAR to apply for positions once they finish their educations, and that protégés would also recommend UCAR as a good place for other scientists from underrepresented groups to apply for positions. At the time of writing this report one protégé has returned to UCAR.

Limits on Scaling Up

Several mentors were concerned about over-extending the resources of SOARS in efforts to expand the program. They feared that over-taxing these resources could endanger the current SOARS program, and derail future gains it would otherwise make. In particular, mentors voiced the following concerns:

- Good mentors are limited in number and would “burn out” if their responsibilities were magnified;
- The SOARS staff can be effective and responsive to a limited number of protégés
- The community among protégés in which a family-like camaraderie exists can only be maintained within a limited number of protégés
- The SOARS director can maintain individual relationships with only a limited number of protégés
- Effective interactive dynamics of classroom and seminar gatherings are naturally limited to about 25 participants
- Adequate financial support can be extended to a limited number of protégés
- Institutional support would diminish with an overly-large program

This mentor’s representative comment about the limits of scaling up follows:

There’s probably a maximum size that’s SOARS can be, even given all the money in the world. I don’t know how big that is. We’re 27 this summer. It seemed like we handled that pretty well. I don’t know what fraction of those students were not at NCAR, of course some of them were...somewhere around the order of 30 should be manageable for the NCAR-NOAA-CU-CSU complex where most of them have typically been...I think if you scale the program up, it at some point would fail. It would be better to create sister programs or brother programs that were of similar size—thirty, maybe it could go up to 50—I don’t know how big it could go. Tom would know though, I think, because he knows his time budget. I don’t think that it can get that much bigger than it is now. But I think you could have another program that was similarly structured at another institution that was about the same size. And you could have “SOARS” but I don’t know that you could have a “mega SOARS.”

In addition, SOARS was seen as sufficiently large to have a “critical mass” in which the program is well-received and effective at UCAR. Because SOARS is large enough for this, expansion offers limited benefits.

Protégés also generally recognized limits on scaling up, but had little by way of concrete concerns or suggestions.

Scaling Back

Not only did many mentors voice reservations about expanding SOARS, several also gave suggestions about scaling back some aspect of SOARS, whether in this program or another, if replicated:

- Mentoring fewer protégés over the whole four years, and/or perhaps more in the first year or two, in order to save money
- Refocusing on a two-year program that spans the senior year of college and the first year of graduate school, which would be a more focused, more effective, use of resources
- Deleting “overly-structured” aspects, such as the writing workshop
- Scaling down as other institutions and programs are developed that replicate SOARS

The general fears that inform mentors' proposals to scale back aspects of SOARS are that programs of this type are likely to receive diminished financial support in the future, and that organizations of this scale are more vulnerable to collapse without continued support on a large scale. There was no indication that those who advocated scaling down also reflected a lack of support for SOARS. On the contrary, these suggestions were intended as methods of "triage" to keep the core of SOARS vital.

XX. REPLICATION OF THE SOARS PROGRAM MODEL: STRUCTURAL ELEMENTS IDENTIFIED AS CRUCIAL TO SUCCESS

Asking about replication elicited highlights from other discussions in the interviews, serving to narrow what were broader discussions to areas that interviewees wished to emphasize. No new insights were uncovered here except to cast in high relief issues interviewees felt most strongly about, and thus wished to see replicated. Most respondents indicated they would like to see SOARS replicated, but many wondered about duplicating some of the unique features at UCAR that made SOARS work so well. Some tried to find ways to compensate for these unique aspects, so that a new program would work as well.

One of those unique features was the original SOARS director, Dr. Thomas Windham, who, as discussed earlier, was oftentimes credited with SOARS' successes when both protégés and respondents felt challenged to pinpoint particular features that contributed to the successes of such a complex program. These multiple features were glossed as "Tom," whose charisma was inspirational to participants even before they knew enough about SOARS to differentiate for themselves how its many intertwined features worked together. This is not to detract, in any way, from the enormous contributions that Dr. Windham made, that were vital to SOARS' initial, and perhaps, ongoing successes.

Another phenomenon that contributes to the recourse of painting the picture of SOARS' success in the single broad stroke of "Tom" is that the "whole of SOARS is greater than the sum of its parts." That is to say that the effective articulation of these multiple program components, plus the steady infusion of new ideas as gathered through ongoing feedback mechanism, together produce a sort of "organic system," whose vitality depends on the health of various "organs." Identifying the organs separately is valuable, but is incomplete outside of the context of the whole.

As Table XI below illustrates, there were five main areas that interviewees addressed when talking specifically about replicating the SOARS program. They were: careful selection of participants, high quality of research projects, specific components of the program structure (focus on goals, multiple mentoring design, protégé presentations, and living arrangements that facilitated a sense of community among protégés), strategies for managing time well, and ensuring institutional support. Each is discussed in turn below.

Table XI. Suggestions for Replicating SOARS

Suggestions for Replicating SOARS		Mentors' Suggestions	Protégés' Suggestions
<i>Participant</i>	Find a director like Dr. Windham	X	X
	Select mentors who value the goals of the program and will devote ample time	X	X
	Select protégés who have a genuine interest in science	X	
	Appreciate individual protégés and celebrate diversity		X
	Care when matching protégés with mentors		X
	System of committed staff is vital	X	X
<i>Research Components</i>	Offer high quality, authentic research	X	X
	Maintain significant, but achievable challenges in the program	X	
<i>Program Structure</i>	Maintain focus on goals of the program	X	
	Replicate multiple mentoring roles	X	
	Replicate SOARS' writing program	X	
	Continue to have protégés present their research at professional conferences	X	
	Provide protégés opportunities to practice their presentations		X
	Gather and incorporate feedback		X
	Protégé living arrangements to promote bonding	X	X
<i>Managing Time</i>	Multi-year design	X	X
	More unstructured time	X	
<i>Institutional Support</i>	Need for institutional support and good public relations	X	
	Maintain adequate funding support	X	

Participant Suggestions for Replicating SOARS

The SOARS Director

As detailed earlier in this report, the particular attributes that interviewees appreciated about Dr. Windham included his: dedication to SOARS, passion about SOARS, creative vision, personable interaction with all involved, intelligence, wit, energy, his effectiveness as a spokesperson for SOARS, effective leadership style, his natural and honest interactions with others, and his status as a role model for protégés. In addition, respondents pointed out particular elements of Dr. Windham's strategies that were important to SOARS' success: constantly assessing what does

and does not work and then acting on those insights, drawing upon the support of NCAR and funding agencies; emphasizing a culture of inquiry, and encouraging protégés to ask for help when needed. Interviewees also appreciated Dr. Windham's facilitation of the community engendered by SOARS, his genuine interest in both NCAR and SOARS, his full time commitment to SOARS, and acting as a personal source of support to persons in SOARS. Protégés were especially appreciative of Dr. Windham's wisdom and commitment to them and to the program, as one protégé explained:

And also, be sure and get somebody that understands different backgrounds. You know, somebody that has the experience, like a "Tom Windham" who came from kind of an urban, or big city, type background, went to a rural community, and a very racist rural community at that...African Americans were not very welcome in [community], and so...somewhere along the way, he learned to accept different backgrounds, and why people think the way they do, and basically just to have that wisdom. Because he was able to relate to everybody in the program. When you have that kind of leadership, I think that when somebody who cares about young adults [like that], you know we picked up on that right away—that he really did care. When you have leadership like that it makes all the difference in the world...When somebody is genuinely caring like that, it makes a huge difference.

The Importance of Selecting Good Mentors

Mentors recognized qualities of good mentoring and defined as vital elements important to SOARS' success. Good mentors were seen as: concerned about the protégés' growth, altruistic, willing to contribute the necessary time to the program, and embraced program values and objectives. Good mentors are *not* focused on using protégés as labor, are not judgmental, nor self-focused, do not need UCAR recognition for their mentoring, nor do they see SOARS as a chore:

I think it's a good way to tap into the expertise and the scientific experience of a large number of people. And I think NCAR is filled with kind of over-achievers, people who really excel in their field, and a lot of these people really do want to help the next generation, and they want to see a continuing legacy of strong scientific excellence. And so this seems to be a good way of tapping into that feeling. I think that's certainly the strong point of the SOARS program.

The importance of communicating to mentors that their involvement in SOARS would entail intensive mentoring, and not simply having a student to work for them for the summer, was recognized. Clear role expectations were seen as key, as one of the SOARS staff members pointed out:

This is not the only place on the planet where this would work. I think the key is having people who are willing to be mentors, getting really good research mentors who have an idea how to work with these protégés...I've talked to some scientists and they're like, "Oh! You mean we could get free summer help?" I'm like, "Well, yes in exchange you'll do this." "Oh" [scientist's response], and I think the SOARS staff does a really good job of making sure, especially the research mentors, know what they're getting into. That

they can follow through with the commitment, that they're not just going to put a protégé in a room and have them run Fortran code and come out 10 weeks later. That's not how SOARS works.

Protégés were also concerned that mentors be truly invested in the program were able to devote sufficient time to the projects and to their protégés, and that mentors also be good teachers. Protégés also thought that their team of mentors needs to work well with one another, and with the protégés, themselves:

They have to make sure that they pick the right mentors, because I think they are really important. They have to not only pick, you know, "Okay these are the mentors who really know a lot about this topic." That doesn't mean that they're really good mentors, because mentors really need to know how to teach [protégés] who don't know anything out of the topic and kind of like guide them, so they have to really be careful in choosing their mentors

Number one is the mentoring—try to figure out how you're going to get the best group of individuals dedicated to the incoming students. Work that out, definitely, so that you don't have, like, mentors that start off mentoring and then you know kind of lose touch and leave or whatever...that really stick by it and are dedicated and not just because they're in that environment [where mentoring is encouraged].

Making Good Matches

Both protégés and mentors recognized the crucial part played by protégé selection and matching with mentors in the overall success of the program, but both protégés and mentors were largely unaware of the process through which protégés were selected and matched with mentors, but Steering Committee members, who participated in the protégé selection process and who worked to make the protégé-mentor matches, pointed out the benefits of relying on a Steering Committee whose members are familiar with the mentors.

Protégés emphasized the importance of making good protégé-mentor matches that reflect the protégés' scientific and career interests. They considered the best matches to be those that facilitated collaboration with both research areas and personalities being well matched. SOARS replications should also include an appreciation of individual protégés, their individuality, motivation, range of backgrounds and abilities, varying needs and potentials, and ethnic backgrounds. SOARS was credited with empowering minorities, giving them ownership over their achievements—a feature to be replicated.

The Importance of a Competent, Dedicated Staff

One of the keys to the success of SOARS was seen as the system of committed people, including the SOARS staff. Their allegiance to the program and personal interest in the welfare of the participants were seen as important. As three different mentors said:

Obviously Tom and the SOARS program office do a good job. I think they're extremely involved and motivated to have the thing work—really more so than maybe an average project would be...So the number one thing is the protégés themselves, and then the

SOARS office being so committed....Well I mean you can just tell they're very emotionally involved. Like, every time you'd see Tom he's hugging everybody and, everybody actually sort of, it seems like they feel like the SOARS protégés are part of their family...I don't know if you could duplicate that. Actually, that is really Tom, because his whole, all his staff then pick up on that from him, I think.

They take care of everything. These people—Tom and his group—have not, at least in my opinion, have not left out a thing. They have it covered, he's got a great staff. They're dedicated. I can't think of anything to change, nor would I want to even. I wouldn't even think to comment on it because these people are professional from the start to the finish. There's nothing left undone. It's amazing. They work so hard all summer to make it successful. I wouldn't change a thing.

The Research Project

At the heart of SOARS is the research project. Protégés advised that new programs maintain authentic, meaningful, research. They were also especially appreciative of the opportunity to conduct science in a genuine laboratory, as opposed to a university laboratory, and to work with real scientists:

I would say it has to be in an institution like this one. It can't be a college because they're getting paid, like I said. The research community is completely different and I think you can say that you've been in college and doing research in college and maybe looking around here you see it's completely different. It has to be definitely in a place that is like NCAR. It has to be in a laboratory. A lot of scientists doing research. I don't think it will work in a college or university, like other programs.

Mentors and protégés also pointed out of the value of incorporating related program components, such as writing a research paper, presenting it to one's colleagues and to the research community at scientific conferences, and perhaps even publishing the findings. They also recommended replicating the networking inherent in making presentations.

Program Structure

Focus on the goal of increasing diversity in science

Another structural considerations discussed in the context of replication was maintaining a focus on the goal of the program. Clarity and vision were seen as crucial to success of a SOARS-like program. A few mentors emphasized that keeping the focus on undergraduate protégés, even if the replicating programs included younger or older protégés, is key to making meaningful change in the diversity of the scientific community. Mentors saw clear goals as key to all participants' involvement. Mentors' motivations for volunteering with SOARS reflected the value they placed on SOARS' goals:

I think it's a great program. I believe in its goal. That's what drives me is that I think that there's benefits to including diversity with the atmospheric sciences, not only for those who have been—"I won't say "restricted," but "impeded,"—perhaps over the past decades to enter into the atmospheric sciences. It's not a good situation for any party,

whether you're the people who are in the positions of power at this point in time or whether you're trying to integrate. It doesn't help.

Mentors' motivations included: wanting to "give back" some of the advantages and support they themselves had received as young, aspiring scientists; desires to help develop the next generation of scientists, the desire to help others generally; and wanting to work with students—an opportunity that is relatively uncommon in their largely non-academic research endeavors. Mentors' beliefs in education and outreach, and in race and gender diversity, were matched with their growing realization of how few people of color are working in science. Mentors believed that needed change would not happen without programs like this.

At the same time, "success breeds success." Mentors regarded SOARS as an effective vehicle for making needed changes. They observed that protégés benefit immediately, that they appear receptive to and grateful for mentors' efforts, and the efforts put into SOARS were generally more than met by results. SOARS was also seen by mentors as well-connected with protégés' schools and other scientific research facilities, helping to ensure ongoing success. The perceived successfulness of SOARS contributed to mentors' willingness to devote their time and energy.

Mentors expressed pride in SOARS, and believed that UCAR is a better place because of SOARS. Some also pointed out that they believed their efforts were more effective in SOARS than in other volunteering opportunities they had in the past. In addition, UCAR was seen as aligned with SOARS' values: as a forward-looking organization where people care about equality; and are generally interested in fostering creativity.

Protégés discussed the tremendous sense of accomplishment they felt at the end of the summer as key to their motivation. They left UCAR feeling empowered, having met significant challenges. This prepared them to feel confident in other situations and enabled protégés to achieve more. Protégés and mentors alike often referred to a philosophy inherent in SOARS: to construct a series of significant, but achievable challenges for protégés. One protégé explained his feelings when asked by the interviewer if he felt overwhelmed:

No. When I first entered the program Tom gave us a chart, and it said that during our experience our mentors were asked to push in a way to where the moment we started feeling really stressful, we could go to them for help but they still wanted us to try and see what we could do on our own.

The fact that protégés were aware that the difficulties they faced were carefully engineered with their growth in mind, along with their trust that problems in the program would be attended to, enabled them to maintain a sense of encouragement.

Multiple mentor design

Both mentors and protégés emphasized the importance of the multiple mentoring model. Mentors talked about the advantages of having a team for protégés to turn to, particularly if the protégé felt intimidated by a particular mentor. A team of mentors was also useful in coordinating particular needs that protégés had, and in helping to resolve any conflicts or problems that arose. The team approach also facilitated the efforts of individual mentors, who

could focus on one area of work with the protégé, and did not have to try to cover all the bases with their protégés. As a mentor pointed out:

Well, you know, one person really can't do it all. I mean, I think that, team-mentoring is fabulous and, I don't think they had the peer-mentoring to start with, but I think they added that in fairly quickly and that was an excellent, excellent idea. I love the whole multiple mentor concept. I think it's really important. It gives just that much more exposure for the protégés to people within NCAR doing different things and just different aspects of what they're doing, and it's not fair to have one person do it all. And it's not fair to the protégés really. Like I said, it just gives them a much broader exposure to people in the organization. So, I really like it, I think it's great.

While some protégés mentioned that they appreciated having a single, primary mentor, they often pointed out that having a mentoring team is important:

The mentoring structure, I think, is probably its strongest suit. You really have to try hard to get lost, to be honest. Like, say, you have four different mentors that you can talk to...you basically would have to not take advantage of anything to get completely lost, you know what I mean? And the fact that the people who are there are so willing to help....

The writing workshop

Even though the writing program drew considerable criticism from protégés who felt that it was too time-consuming and was repetitive at times, it was still among the “short list” of program features interviewees recommended for replication. While the writing workshop was thought to have room for improvement, the general concept and many of the specific lessons learned were highly valued. Mentors often saw it as an essential part of the program, as it filled a void left in undergraduate and graduate school training, and, because it is important to the practice of professional science, was considered crucial to the success of individual scientists.

He [Dr. Windham] was worried in particular about writing. And I don't quite know why he focused in on that—that struck me as kind of strange at the time, but it's turned out that being able to write a solid two-page report on what you've done or whatever you know what turned out to be very important. And we never had anything like that. I mean we were just going to be working an instrument or recording data, or some sort of stuff like that but this is supposed to be an educational program that helps them get through their undergraduate and graduate training. Tom was able to spot fairly early on that writing was going to be a problem, so that's one of the mentors. These people have two mentors at least, and so one of the mentors is really interested in this communication business...So I would say that anybody ought to have a good reason why they wanted to cut some of that out, it seems to me. I'd hate to see, just because of cost, having some of these things taken away.

Protégés increasingly came to value the writing workshops as well. Many of the alumni protégés in particular cited it as the single-most practical gain from SOARS participation that, in retrospect, was seen to be a critical benefit. As one alumnus protégé said:

The writing was something that I didn't get as much of as an undergraduate, writing about mathematics, writing scientific papers. So, that was definitely a crash course that I needed—writing precisely, writing an abstract, writing an introduction. And we had I believe, every week a writing workshop and it was like, “Okay, this is boring,” but at the end of the days, my first year of graduate school, one of my professors said, “Write up this stuff.” I'm like, “Okay, I could do this.” (Laughs). “I've seen this before. Write an introduction. Write an outline. Okay I can do it.” ... So, that was very important, because something that we don't see, and something that I complain about now on the other side of it in scientific and mathematical education, we don't see a lot of writing at the undergraduate level. When these students are coming into graduate school, they're not really prepared for the writing that is necessary for a Master's thesis, or a dissertation. And that really stifles a lot of students. I know that was one of the points that was a little hard for me, because I had never written at that magnitude... So that's something that I think was very important—getting students acclimated to writing scientific papers...the writing was definitely, I guess a “double star.”

Alumni especially reported the benefits of their writing gains, later, when in graduate school.

The presentations

The presentations were another program aspect often recommended for replication. The value of presentations made at professional conferences was especially noted, although the in-house presentations were largely supported as well. Practice presentations with feedback were appreciated by the protégés. Mentors appreciated how conference attendance provided opportunities for protégés to see how scientists practice their profession. Presentation and good communication skills are also seen as essential elements of professional practice. Too, mentors were aware of gains in confidence that students took away from these experiences:

One of the things that the protégés get a lot out of is this notion that they're going to present at a conference. I think that's a professional opportunity. I think that lets them see themselves as professional. It gives them research. I think the UCAR presentation feels a little fake by comparison, a little inauthentic. I think it's good, I think it's important. I'd like to see more scientists going [to attend the UNCAR presentations]. But I think it's the external one that feels real to them. I think that's a good thing. So I guess those would be the essential things to replicate.

I think that the most important feature of SOARS is the communications aspect, training them to use their research as a means for written and verbal communication, and teaching them how to get their scientific points across. I think that one of the real strengths of the SOARS program is in that, because I think that when you teach somebody how to speak about their research, you're really teaching a lot more than just how to speak about your research. You're teaching them how to feel confident in yourself. It's a kind of a scary thing to get in front of people and talk about this kind of stuff, and it's a very supportive atmosphere for that. And the fact that they've had to do this several times, not just one time—all the practice talks and their research talk and all that, I think is something that was very important part of the SOARS program. And so I would say that the best part of

the SOARS program is that they are given the time and given the training to work on this particular aspect of the whole experience.

Presentations enhanced protégés' communication skills, confidence, as well as their conceptual grasp of their science projects as they were challenged to present their work in everyday terms free of scientific jargon.

The protégés' living arrangements

The protégés were especially appreciative of the living arrangements in which they stayed in a single apartment complex where they spent their free time with one another. The community of support this engendered was of tremendous value: The protégés described forging life-long supportive bonds that will keep them networked in the scientific community of the future:

We interact with each other all the time and that's how, I mean it's fun too and you get to learn so much from other people and for us to live like together so close you know it's another support for you because when somebody's in trouble everybody helps out, like everybody hears about it and everybody tries to help. So I think it's a really good idea that we are that close and we're not separated off and we are our community in our apartments.

The protégés forged what will probably be life-long supportive bonds that will keep them networked in the scientific community of the future.

I think it's key that we live together. Because living together helps us to interact with each other on a personal level and not just be, "Oh, I saw this one at work today," and that's it. We build friendships. We build bonds. We build partnerships. We build relationships, and I think, it would help later on in life, especially when you're in the science field, because you might have a problem and you know someone who could help you because you know them because you met them in SOARS.

Mentors also recognized the value of attention to protégés "off time." Protégés' living arrangements and opportunities to spend free time well are important to consider, as the holistic approach to supporting and mentoring are seen as most effective. They also advocated that new programs encourage the inclusion of protégés in work group activities, both in the lab and during personal time. Besides promoting protégés' collegiality with one another, mentors were oftentimes aware that protégés needed to know how scientists balance their time and lead full lives. Information about scientists' free time was recognized by many of the mentors as important to protégés as potential scientists. Several mentors spoke about their wish to dispel stereotypes protégés might have of "nerdy" scientists without social lives.

Managing Time

Multi-year design

The multi-year design of SOARS was seen as central to the success of SOARS, by most of the protégés and mentors, alike. Protégés had different challenges in their first year of the program, and the significant learning and development they gained in the first year prepared them for a

qualitatively different level of work in subsequent years. The multi-year design facilitates a depth of research, as well as personal and professional development that would not be possible in a single year. With a multiyear program, a sustained commitment is made to the protégés, to which they respond, as a mentor explains:

I think that the fundamental element of success is that it's a multi-year program. You can't do it all at once. And most of the other programs are single summer and typically once students have done it they're not eligible to come back because the idea is to provide a lot of them. So, I think that, if you had to pick one single innovation in the program, it's the multi-year nature, that there's a sustained commitment. I think students respond. You make a sustained commitment to them, and they respond.

While protégés who experienced only a single year of SOARS reported significant learning and personal gains, nearly all protégés expressed a desire to have returned for more years. They recognized they missed the opportunity for uniquely enriching experiences as returning protégés:

It keeps you into the pipeline. Like when you get so fed up with school and everything and you come back to something with such a supportive community, like it gets you back on track. And for them to keep coming back and Tom knows you by your second year so that relationship just kind of grows as you go along. So that's really important to have program that's for four years. It's a good way to retain students and it's a good way to push them to keep going to grad school, too because you form relationships with people here so you get to see how well they progress.

It has to be multiple years because you develop relationships with your mentors, with people. In one summer you're just kind of getting used to things. When you come back you can really start making contributions to the program, to helping the program evolve. If we didn't come back, and tried to implement those things that we suggested, then the program would have probably never have evolved. Because I had multiple years my mentors were able to write a great recommendation letter for me for graduate school. Which, at first I wouldn't have thought was a big deal, you know, "Oh a recommendation letter..." It's huge for graduate school! Developing these strong relationships with the people who will help you in the future, down the road...

Institutional Support

Public relations

Senior-level support by UCAR and encouragement of the SOARS program was seen as critical to SOARS' success. Generally, mentors were aware of the role that good public relations played in the establishment of SOARS, and noted that this would be crucial in successful replication elsewhere. The SOARS directors and upper management from UCAR worked to keep SOARS a high-profile program internally, and one clearly valued by the top administration.

I clearly think that the personal involvement is the secret. And even the personal involvement, of management, the president of UCAR is very involved with the program. So I think that impresses the students, and the other thing of course, is the follow-up.

When they leave town you can't forget about them. But other than that I don't- I mean, I have more thoughts, because I think SOARS as it is, is quite successful. [The program is promoted] in several ways. One, of course, is the president talking about how important this program is to him, and to NCAR and UCAR. Another thing is, when they have SOARS events, the picnics, the president, is there and the director of NCAR is there, and the first year formed a touch football team, playing the SOARS students, until one of us got hurt (mentor laughs). Pulled a hamstring and then our team was done, but you know, things like that. The students know, at their university, they've never met the president of the university. They come to UCAR, which is an organization of as many employees as a moderate sized university, and they play touch football with the president. So I think that makes an impression on them. They [management] encouraged the involvement and support of department managers, and personally invited several mentors to become mentors.

They also promoted the participation of other highly regarded scientific institutions, such as NASA and NOAA. This includes international scientific organizations, scientists, and students. SOARS directors traveled extensively, promoting SOARS at scientific conventions, colleges, and universities, often meeting with local protégés during the school year, and including them in recruiting efforts. Protégés reported feeling honored to be sought out for a personal visit from the SOARS director and were happy to promote SOARS among their school peers and other students attending conferences they attended.

If he [Tom Windham] has business to do here in the [X] area he used to call me and then I would go do various appearances with him...It wasn't a burden on me. Tom and I had a real great relationship. And I believe in the mission as well so that's the reason why I've agreed to do some of the things that he asked me to help him on...I think he's a great guy.

Financial support

SOARS was considered an expensive program by both protégés and mentors. However, substantial funds were seen as necessary for a program of its ambition, character, and success. As one manager said, "It wouldn't be SOARS without this level of funding." Protégés expressed gratitude for the level of financial support they received, as stipends while working at UCAR, for travel to participate in SOARS and in associated research and conferences, for living expenses covered while at UCAR, and for graduate school expenses.

Mentors offered some strategies, both for SOARS' future and for replicating SOARS. They suggested that the NSF values innovation more than supporting ongoing, albeit successful programs, so they need to see the value of supporting such a successful program. In addition, mentors noted that UCAR made it possible for mentors to volunteer their time and attention to SOARS, with its general financial support given to employees. There is no financial reward to volunteering with SOARS, but there is financial support in the sense that there is more general support for scientific work at UCAR, so scientists can concentrate more on the work and less on grant-writing, compared with other research institutes. Some UCAR divisions also helped SOARS to meet its budget shortfall one year.

In summary, the five main areas that were highlighted as aspects of SOARS to replicate were:

- Careful selection of participants
- High quality research projects
- Specific components of the program structure (i.e., focus on goals, multiple mentoring design, protégé presentations)
- Living arrangements that facilitated a sense of community among protégés,
- Strategies for managing time well
- Ensuring institutional support

This collection of ideas serves as a good overview of SOARS' structural aspects that interviewees especially valued and considered essential to a SOARS-like program.

XXI. CONCLUSIONS

Factors Contributing to SOARS' Successes

In this section we briefly review the gains protégés made and then address specific factors we conclude have contributed to these gains. We also discuss factors we attribute to the overall success of SOARS and suggestions for optimizing the program.

As detailed in this report, protégés described their gains from SOARS in broader terms than the formal goal of SOARS to increase the number of participants from underrepresented minority groups in the atmospheric and related sciences. Protégés' self-reported gains fall into five main categories, including seven specific types of skills. Mentors' observations of protégés' gain from SOARS addressed these same benefits:

Over-arching protégé gains from the research experience include:

- Learning how science research is done
- Increased confidence as a result of engaging in hands-on research
- Insight into science careers, particularly in atmospheric science
- “Thinking like a scientist”: developing patience and critical thinking skills
- Increased understanding of how scientists practice their profession
- Understanding science in political and global perspective

Particular types of gains from the SOARS experience are:

- Increased appreciation of relevancy of, and preparation to undertake, coursework
- Increased interest in and likelihood of going to graduate school
- Strengthened graduate school applications
- Enhanced presentation, writing, leadership, time management, computer, collaborative, and social skills
- Professional development
- Personal growth in confidence and responsibility
- “Becoming a scientist”
- Ongoing support from the protégé community and SOARS' director, staff, and mentors

Overall, we found that SOARS has achieved its primary goal of increasing retention and participation of students from underrepresented groups in the atmospheric and related sciences. Our study revealed that 83% of protégés aspire to, are pursuing, or have already completed a graduate degree in science, technology, engineering, or mathematics (STEM) fields (47% in atmospheric and earth science, 38% in mathematics, engineering, and computer science, 7% in other sciences, 7% in other fields (UCAR, 2005c). Furthermore, 55% of protégés aspire to, or are already working in, research or academic careers in the atmospheric and related sciences (and in some cases, other STEM fields). A quarter of protégés are pursuing other STEM careers in the public and private sectors. Noteworthy is that half of these protégés seek to shape the future direction of their fields via careers in policy, administration, or outreach. Thus, two-thirds of protégés are pursuing careers where they are likely to have a “multiplier effect” and help further SOARS' goal. Almost all protégés (94%) aspire to, or are already working in, STEM careers.

There is not a single reason for the many successes SOARS has achieved. There is instead a **complex system of thoughtfully connected individual program elements that work together** to produce SOARS' outcomes. The purpose of each component is clearly communicated to all participants, as are the methods used and the outcomes aimed for. Such good “**signposting**”¹¹ is vital to the success of such a complex network of program features.

The program's founders, Dr. Richard Anthes (President of UCAR) and Edna Comedy (past Human Resources Director of UCAR), conceptualized two essential ingredients to SOARS' success: **multiyear and multi-mentor support of protégés**. Experiences with UCAR's prior Summer Employment Program (SEP) also informed the planning of SOARS. The original SOARS director, Dr. Thomas Windham, drew upon his training and expertise as a psychologist in designing basic aspects of the program, conceptualizing the essential ingredients of **a learning community complete with peer mentoring, a collaborative and collegial culture, and an organic structure**. While the program has been strongly associated with a single person, the original SOARS director, it is to his credit and to the staff persons and UCAR management, that the program itself is not dependent upon his involvement. Instead, the leader used his charisma to build a strong program, as evidenced in the successful transition of SOARS to the new director, Dr. Rajul Pandya. Both Dr. Windham and Dr. Pandya have set a strong example of deep dedication to SOARS, and their obviously genuine interest in the welfare of the protégés and SOARS overall, inspire others to live up to their expectations and to model their own allegiance to SOARS in a similar fashion.

The people who have organized, managed, and participated in SOARS have maintained a **steady focus on the goals of the program** and devoted themselves to achieving these goals. Despite the complexity of the network of systems that make up the parts of SOARS, the clear focus on program goals has made it possible for both the long-term dedication of participants and the welcome inclusion of newcomers. The complexity of the program could have mired the program a bureaucratic tangle. This did not happen, in great part, because of the clarity of the program's central goal: to promote the success of the protégés as they pursue careers in atmospheric science. Fidelity to the philosophical underpinnings of SOARS has kept the complex network of program features organic in nature. The **spirit of collaboration and promotion of protégés' interests** helps program staff keep an open mind to program innovations. Human connections at every level are kept in high relief, including in relationships among program participants, ideals of protégé empowerment, high standards of work expected of protégés, acceptance of protégés' human frailties, and the expectation that all program participants will rise to each challenge.

Deliberate facilitation of the protégé community and intentional creation of perennial networking connections for protégés have been successful in establishing **a long-term supportive community**. Year-long communication with protégés demonstrates the ongoing commitment of the program to the protégés, and sets the tone for continuing communication between other SOARS participants. Protégés, mentors, and SOARS staff all place great value in their continuing relationships with one another. These are voluntary relationships that are sustaining to

¹¹ Elaine Seymour, Ph.D., a senior researcher at E&ER, coined the term “signposting” to refer to the clear descriptions of a strategy, before it is implemented, as it is implemented, and at its conclusion. These descriptions provide clarity of goals, methods, and outcomes that inform and facilitate the full participation of everyone involved, and promotes optimal outcomes.

protégés even after their formal “graduation” from SOARS. Individuals’ maintenance of these relationships, based on SOARS’ values and goals will facilitate the multiplier effect we have discussed in this report, extending the program benefits through time and across relationships.

Careful attention to each program feature is maintained. It would be easy to relax such vigilance whenever some part of the program appears to be working well. Instead, **continuous, formative feedback** is gathered and “routine maintenance” given to all the working parts—not just to parts that appear to be in need of tuning. Feedback is continuously solicited from program participants, and then carefully considered. The program has been enriched over time with the suggestions and insights of its participants. The organic nature of the SOARS program, in which formative feedback from all participants is steadily gathered and faithfully considered in SOARS’ evolution, has ensured that it continuously incorporates lessons learned, ideas generated, and is able to address problems that come up.

The **authenticity of the research** is appealing in its own right. Protégés appreciate that they are making real contributions to real research in real laboratories with real scientists. The challenges they face and discomforts the challenges entail are also real, not contrived. This makes the SOARS experience a genuine sampling of science research careers to determine if such careers are good fits for individual protégés. One of the appeals of science to typical undergraduates is the notion that science is a neat collection of “facts.” Science appears at first to be a series of black-and-white facts that fit neatly together. After all, this is how textbooks generally depict science at introductory levels. Real experience conducting scientific research reveals the messy, gray areas of science. For some protégés this sparks enthusiasm, as they learn to relish these puzzle-solving aspects of science. With this enthusiasm they go on to develop patience to engage in the discovery process of trial and error. For others, discovery of the nature of the challenges in scientific research provides insight into their lack of fit with the process. For these students, the ambiguities of science are disappointing and uncomfortable. In either case students make important personal discoveries. While one measure of SOARS’ success is the inspiration instilled into protégés to pursue careers in atmospheric science research, it is a personal success for protégés to discover, one way or another, if this path suits them as individuals.

As a central philosophy in the program, the **intentional challenging of protégés beyond their intellectual comfort zones** is clear and deliberate. These challenges are not arbitrary, but are embedded in the authentic research projects on which protégés work. It is a matter of monitoring the depth of immersion into the natural challenges of the science, itself, and not a construction of artificial barriers set up to impede protégés. This discomfort is made meaningful, and therefore tolerable, to protégés through good signposting. Protégés were made aware that mentors would challenge them to stretch beyond their comfort zone, as does the SOARS program as a whole. The SOARS experience challenges protégés to experience heightened growth in professional and personal development and as leaders within the protégé community and active participants in their own lives. Meaningful struggle leads to confidence in one’s successes, which in turn leads to the fortitude to aim higher and persist in new, ever-larger challenges. In this way protégés are motivated, encouraged, and then supported as they aspire to do more and to be more.

SOARS’ philosophical **belief in individuals’ potential and good character** extends beyond protégés to include all participants in the program—eliciting the best efforts of participants

across the board. Mentors have reported to us their appreciation of Dr. Windham's and SOARS' latitude in **supporting mentors' individual mentoring styles** and management strategies of their protégés and the research projects. Dr. Windham "managed by walking around," personally visiting mentors, protégés, and research teams as they worked, checking in with them to see how things were going, collecting feedback, and offering support in his warm, low-key style. Dr. Windham's sensitivity to the needs of individual protégés and mentors alike has been reflected in his **leadership by empowerment**, rather than by "managing" people in the system. The lightness of the SOARS management's supervisory influence, matched with the strength of their support for protégés and mentors alike serves to inspire creativity and best performance.

The **SOARS directors, staff and Steering Committee have demonstrated true devotion to the protégés and the program**, as they work hard to ensure protégés' successes. **Fidelity to the protégés** is demonstrated in SOARS multi-year program design and the follow-through that occurs as SOARS commits to the protégés over time. Protégés know that SOARS participants, from staff persons to mentors, will maintain interest in them individually over the course of their college years and into graduate school. In addition, the option of returning to SOARS each summer, for up to four summers, to work as active SOARS protégés is a significant motivation for protégés to succeed in the program. This high level of commitment to individual protégés helps to motivate them to live up to the belief invested in them.

Another important reason for SOARS' successes is that it **successfully recruits talented, caring mentors**. The majority (82%) of mentors said that they intend to mentor again, and indeed, most of the current mentors had mentored in the past. Some said they would mentor again, but in a more suitable role. The reasons mentors cited for not mentoring in the near future were time or personal constraints. Mentors volunteer because SOARS' goals are important to them and they perceive that SOARS is effective in working toward these goals. The intangible nature of the many gained reported by mentors is consistent with the altruistic motivations that mentors bring to the experience. Mentor training, on-going support, and responsiveness to mentor needs and feedback enhance their experiences with the program.

Also critical to SOARS' successes is the staunch, visible **support that UCAR management has extended to the program**, especially from the President of UCAR. A full third of upper level UCAR managers have volunteered at one time or another as mentors, and many of them have signed up more than once. UCAR also promotes SOARS by featuring program news prominently in UCAR internal communications and sending out annual advertisements for mentor volunteers. Upper-management support of SOARS is also reflected in financial support that UCAR has extended to SOARS, such as funding the SOARS' director's salary.

SOARS Steering Committee members, many of whom are senior scientists from across UCAR's departments, bring valuable insights to mentor-protégé matching. Their knowledge of individual scientists' research expertise and personalities facilitates good mentor-protégé matching. The senior scientists, as UCAR departmental managers, are also in a position to endorse SOARS and personally recruit scientists to participate in SOARS. Because of their advanced positions at UCAR and in the atmospheric sciences these scientists also bring valuable insights that are beneficial to shaping the direction of the SOARS program to the advantage of the protégés. Protégé members of the Steering Committee also provide great value, providing a

connection to present-day experiences of students that enhances the selection of protégés and matching of protégés and mentors to take into account protégé needs.

Sufficient funding of SOARS has enabled it to have tremendous impact on individuals' lives. The wealth of opportunities and benefits SOARS offers to protégés makes it the significant program that it is. Genuine opportunities are made possible to protégés, who are paid a competitive wage for their work, receive travel money to attend and present at professional conferences, and have all of their practical needs met, freeing them to focus their own resources of time and energy on their research. Money invested in SOARS has bought time, specialized training, professional development training, conference experiences, pleasant living conditions, competitive wages, graduate school opportunities, and an elevation of opportunity.

The evaluators therefore conclude that SOARS has successfully met its goals and that its financial and time investments in the protégés are well worth the outcomes. SOARS is highly successful in facilitating students from underrepresented groups to pursue (and, it appears from emerging data, achieve) graduate degrees in the sciences. 87% of protégés aspire to an advanced career in science, mathematics, engineering, or computer science. Half of these protégés have received, or are currently pursuing, graduate degrees and the other half are still undergraduates. The program is also fairly successful in encouraging students (46%) into science research careers. Non-research science careers relate to SOARS' goals to the extent they cast protégés in roles in which they would serve as role models and educators of future generations of scientists or shape science organizations to further promote a diverse workforce. One could argue that if protégés gain highly visible positions as broadcast meteorologists, that perhaps television viewers who are racial minorities would be inspired to pursue a similar path, which might lead them to science careers of various types as it has for some protégés. The "multiplier effect" that protégés have and will have in the future on other people from underrepresented groups, while difficult to predict, appears to have great potential for inspiring and encouraging others. SOARS' success cannot be measured by quantities alone. This study has also shown tremendous gains, for protégés as well as other SOARS participants, in their quality of experiences and outcomes.

Suggestions for Possible Program Changes

The suggestions we offer for possible program changes are basically prompts for SOARS to bring more signposting to particular areas of the program. While the overall level of signposting is impressive, there are a few places in which more would be helpful. These have been discussed more fully in the main section of this report.

Community Mentor Role

Community mentors and protégés both report the need for a more clearly defined community mentor role. Although flexibility in the mentor role facilitates creative solutions for unique protégé needs, there does not appear to be enough role definition by way of broad guidelines for the community mentors.

Informal Mentor Role

Informal mentors can play an important role in protégés' overall experience with SOARS, and as such ought to be considered for training opportunities made available to official research

mentors. Training on sexual harassment needs to be a part of informal mentors' broader incorporation into the program. It is also recommended that SOARS consider recognition of informal mentors, especially those who make exceptional efforts on behalf of protégés.

Costs and Rewards for Mentoring

Mentor recognition is important, especially as there are no formal avenues (such as monetary or status promotions) to compensate mentors. Some mentors had provisions made for their volunteer work in their regular schedules and received recognition of their mentoring efforts while others did not. The recognition ceremonies for mentors that SOARS has conducted in the past have proven to be very important to many of the mentors, and ought to be continued. The current tenor of mentoring is one of altruistic intentions, which could be undermined if people become involved with the main goal of furthering their own careers. In addition, a greater level of assured support from UCAR generally, and their respective department heads, for SOARS mentoring efforts would serve to protect mentors from potential punishments for their efforts.

Leadership Training for Peer Mentors

The leadership training for peer mentors may contain some significant elements of leadership advice, but peer mentors do not recognize them as such. Better signposting of these leadership features would clarify for peer mentors how they can optimize the training they are given, and will in turn make their feedback on the leadership training more clear and of better use to program administrators.

Protégé Work Ethic Expectations

We do not recommend that SOARS attempt to monitor protégés' work efforts to standardize them. This would interfere with the autonomy of the research mentor-protégé relationship. However, SOARS administrators should be aware that there is some questioning among protégés about what constitutes an appropriate work ethic, and how to understand individual variations. SOARS administrators would do well to consider this among themselves to determine how well intrinsic rewards of varied effort serve to reward protégés who work harder.

Norms for Ongoing Mentor-Protégé Communication

Protégés and mentors both expressed a need for a more clear understanding of what is considered appropriate, and even what is expected, with regard to ongoing communication between them after the SOARS summer. Both protégés and mentors indicated they appreciated and wanted more ongoing communication, but there was considerable uncertainty about who ought to initiate it. As with other aspects of the program, broad guidelines would be more helpful than specific suggestions about type and content of ongoing communication.

Issues to Consider on an Ongoing Basis

Discussion of Race Issues

The question of whether to promote discussions with protégés of racial barriers in science careers bears ongoing attention. Since it has received mixed reactions from protégés, and unclear response from mentors, it appears to be an unresolved issue among all SOARS participants. Addressing the questions of whether or not, and how to address, discussions of racial barriers, with each cohort of protégés appears to be the best recourse.

Writing Workshop

One of the more dynamic features of SOARS is the writing workshop. It is clearly an issue of central importance to SOARS participants and needs regular attention. Close monitoring of its effectiveness will remain important to SOARS, and a distinction between short and long term gains needs to be kept in mind. Efforts to keep elements of the writing program aligned with the course of the research projects themselves will contribute to the legitimacy the workshop is accorded by protégés and mentors alike. It is important to continue signposting the goals of the workshop and the methods used to meet these goals.

Mentoring New Versus Returning Protégés

Over time, various adjustments have been made in SOARS' program components to account for the different needs of new versus returning protégés. These adjustments appear to have been helpful overall, and ongoing awareness of the need for accommodations is recommended. The writing workshop is one area in which variations in protégé abilities and needs would be profitably considered.

Recruiting and Selecting Protégés

The main goal of SOARS—to increase the number of people from underrepresented groups in the atmospheric and related sciences—could be increased with broader geographical marketing, more direct recruitment of students with interests related to atmospheric sciences, and more goal-specific criteria used for selection. Enhanced recruitment may require additional funding devoted specifically to targeting potential protégés, communication with more schools, and travel to promote the program. With more applicants there will be a need for a more focused selection process to identify students with specific interests in atmospheric science.

Promote Diversity in SOARS Staffing and on the Steering Committee

Consider increasing the number of SOARS staff persons and Steering Committee members, who are from underrepresented groups. The experiences that people from underrepresented groups have had in higher education and the professional world would prove especially valuable to the Steering Committee.

Mentor Training

It is important that all mentors receive some basic information about SOARS and about mentoring in general, and thus increasing mentor participation in mentor training is important: Sexual harassment issues need to be reviewed with all mentors, including informal mentors. Discussion of the problem of absences of mentors during the summer (especially of research mentors) needs to be re-addressed each summer. Expectation-setting for research mentors regarding protégé abilities is also a crucial aspect of the mentor training.

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APPENDIX

SOARS Evaluation
Principal Investigator Liane Pedersen-Gallegos, Ph.D.

PARTICIPANT INFORMED CONSENT FORM May, 2004

Please read the following material that explains this research study. Signing this form will indicate that you have been informed about the study and that you want to participate. We want you to understand what you are being asked to do and what risks and benefits—if any—are associated with the study. This should help you decide whether or not you want to participate in the study.

You are being asked to take part in a research project conducted by Dr. Liane Pedersen-Gallegos, Dr. Sandra Laursen and Dr. Ginger Melton, researchers in the University of Colorado at Boulder's Center to Advance Research and Teaching in the Social Sciences (CARTSS), Ethnography and Evaluation Research, 580 UCB, Boulder, CO 80309-0580. Dr. Pedersen-Gallegos can be reached at 303-492-1104. Dr. Laursen can be reached at 303-735-2942 and Dr. Melton can be reached at 303-492-0085.

Project Description:

This research study is about the effectiveness of the SOARS program. You are being asked to be in this study because, as a participant in the program, you are in a unique position to describe your experiences and observations of the program. We will interview all of the current and former protégés in the SOARS program. In addition, we will invite a representative sample of other participants in the SOARS program to be interviewed, including current and former mentors, support staff and administrators. Participation in this study is entirely voluntary.

Procedures:

If you agree to take part in this study, you will be asked to participate in an interview to describe your experiences with the SOARS program and your expectations and observations of benefits and/or costs incurred as a result of your participation in the SOARS mentoring program.

The interview should take about an hour of your time. We will conduct the interviews: on site at the SOARS facilities; University Corporation for Atmospheric Research (UCAR); at our offices in the Administration and Research Center at 3100 Marine Street in Boulder, Colorado; or by telephone. We will make every effort to conduct the interview at a place and time that is convenient to you.

Subject's Initials _____

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As a protégé, you will be asked questions about your career goals, educational and personal influences in making or working toward these goals, and in particular, the influence of the SOARS program. Here is an example of an interview question: "How has the SOARS program influenced your career aspirations?"

As a mentor, staff member, or administrator, you will be asked about your experiences and observations in the SOARS program and any advice you may have for the program. Here is an example of an interview question: "What have you observed to be the most effective aspects of the SOARS program?"

Risks and Discomforts:

The only foreseeable risk to you if you take part in this study is that some of the questions may cause you to feel uncomfortable.

Benefits:

We do not anticipate any direct benefit to you. Potential benefits to this study include the improvement of this and/or similar mentoring programs.

Source of Funding:

Funding for this study is provided by a grant from the National Science Foundation. This study is being funded by a federal agency that requires that data be collected in a form that may be analyzed for differences between men and women and races or ethnic groups.

Subject Payment:

You will not be paid for participation in this study.

Study Withdrawal:

You have the right to withdraw your consent or stop participating at any time. You have the right to refuse to answer any question(s) or participate in any procedure for any reason.

If there are any new findings during the study that may affect whether you want to continue to take part, you will be told about them. Deciding not to participate will have no effect on benefits you receive from the SOARS mentoring program.

Confidentiality:

We will make every effort to maintain the privacy of your data. Tape recordings of

Subject's Initials _____

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interviews are transcribed verbatim for analysis at the Ethnography and Evaluation Research offices at the University of Colorado. Upon completion of the project, all interview recordings are erased or otherwise destroyed. All interview data will be kept in a secure location. Code names will be given to tapes and other information connected to you and your participation to aid in maintaining your anonymity. All results from this project will be reported in aggregate form, and any quotations cited will be used only so long as the participants remain anonymous.

Other than the research team, only regulatory agencies such as the Office of Human Research Protections and the University of Colorado Human Research Committee may see your individual data as part of routine audits.

Any report of sexual harassment made to us cannot be kept confidential. As University of Colorado researchers, we are bound by law to report any such claim to the appropriate personnel for further investigation.

Invitation for Questions:

If you have questions about this study, please ask the researcher before you sign this consent form.

If you have questions regarding your rights as a participant, any concerns regarding this project or any dissatisfaction with any aspect of this study, you may report them -- confidentially, if you wish -- to the Executive Secretary, Human Research Committee, 26 UCB, Regent Administrative Center 308, University of Colorado at Boulder, Boulder, CO 80309-0026 or by telephone to (303) 492-7401.

Authorization:

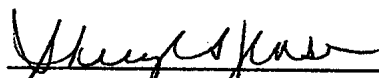
I have read this paper about the study or it was read to me. I know the possible risks and benefits. I know that taking part in this study is voluntary. I choose to be in this study. I know that I can withdraw at any time. I have received, on the date signed, a copy of this document containing 3 pages.

Name of Participant (printed) _____

Signature of Participant _____ Date _____
(Also initial all previous pages of the consent form.)

For HRC Use Only

This consent form is approved for use from 6-25-04 to 6-25-05.


Committee (Signature)

Executive Secretary, Human Research

INTERVIEW PROTOCOL

For Current Protégés

1. What is your major or area of expertise? What year are you in school?
2. How did you learn about SOARS? Why did you choose to apply?
3. What year did you first become a protégé? How many summers have you returned?
4. What do you see are the goals of the SOARS program?
5. What aspects of the SOARS program are the most beneficial for your career?
6. What aspects of the SOARS program help create an environment conducive to learning and personal growth?
7. What have you found the most rewarding about your research project? What is the most challenging? What is the most frustrating?
8. What do you like about the writing and presentation assignments? What don't you like about them?
9. What is the work environment at UCAR like for you to work in?
10. Is the process for matching protégés and mentors effective? How could it be improved?
11. What is your relationship like with your research mentor? Writing mentor? Community mentor? Peer mentor? SOARS staff? (what do you find most valuable about the relationship and what was the least valuable, where do you click and where not and why)
12. What aspects of being a protégé in the SOARS program do you like the most?
13. How has being in the SOARS program changed you personally and professionally?
14. In what ways could the SOARS program be improved for the protégés?
15. What, if anything, has been surprising to you about SOARS?
16. If you could go back in time to the point right when you became involved with SOARS, knowing everything you know now, is there anything you would do differently? Anything you would make a point of doing again, the same way?
17. How has the program changed since you've been involved?
18. What advice would you like to give re the SOARS program? Any advice for other organizations planning a similar initiative?

For Past Protégés

1. How did you learn about SOARS? What made you want to apply?
2. What year did you first become a protégé? How many summers were you actively involved as a protégé?
3. What are you currently doing professionally? What is your area of expertise?
4. What do you see are the goals of the SOARS program?
5. What aspects of the SOARS program have been the most beneficial for your career?
6. What aspects of the SOARS program helped create an environment conducive to learning and personal growth?
7. What did you find the most rewarding about your research project? What was the most challenging? What was the most frustrating?
8. What did you like about the writing and presentation assignments? What didn't you like about them?
9. What was the work environment at UCAR like for you to work in?
10. Is the process for matching protégés and mentors effective? How could it be improved?

11. What was your relationship like with your research mentor? Writing mentor? Community mentor? Peer mentor? SOARS staff? (what did you find most valuable about the relationship and what was the least valuable, where did you click and where not and why)
12. What aspects of being a protégé in the SOARS program did you like the most?
13. How has being in the SOARS program changed you personally and professionally?
14. In what ways could the SOARS program be improved for the protégés?

If a peer mentor:

1. How were you selected to return as a peer mentor?
 2. Have you had training to be a mentor? Was it adequate?
 3. What is most difficult about being a peer mentor?
 4. What is most rewarding about being a peer mentor?
15. What, if anything, has been surprising to you about SOARS?
 16. If you could go back in time to the point right when you became involved with SOARS, knowing everything you know now, is there anything you would do differently? Anything you would make a point of doing again, the same way?
 17. What advice would you like to give re the SOARS program? Any advice for other organizations planning a similar initiative?
 18. How has SOARS changed since you have been involved with the program?
 19. What, if anything, has been surprising to you about SOARS?
 20. If you could go back in time to the point right when you became involved with SOARS, knowing everything you know now, is there anything you would do differently? Anything you would make a point of doing again, the same way?
 21. How has SOARS changed since you have been involved with the program?
 22. What advice would you like to give re the SOARS program? Any advice for other organizations planning a similar initiative?

For Mentors

1. What is your area of expertise and years of experience in the field?
2. How did you hear about the SOARS program?
3. What led you to become a mentor?
4. How many summers have you been a mentor?
5. What do you see are the goals of the SOARS program?
6. Is the process for selecting protégés effective? How could it be improved?
7. Is the process for matching protégés and mentors effective? How could it be improved?
8. For research mentors: How do you select an appropriate project for your protégés?
9. What benefits do you want your protégés to gain from working with you?
10. What have you found is the most effective way to mentor the protégés to accomplish these goals?
11. What have you found most rewarding about being a mentor? What is the most challenging? What is the most frustrating?
12. To what extent do people you work with, or for, support the SOARS program?
13. What qualities in a protégé are most likely to lead to their having a successful experience?
14. What do you believe are the most beneficial aspects of the SOARS program for the protégés?

15. Which protégés do you have an on-going relationship with after they have left for the summer or permanently?
16. In what ways could the SOARS program be improved for the protégés?
17. In what ways could the SOARS program be improved for the mentors?
18. Were you/are you mentored, yourself? How has this informed your own mentoring?
19. What are the costs of being a mentor? (lack of support from work group/supervisors; time constraints; energy expended; stress)
20. What are the “lessons learned” since the beginning of the program/of your involvement with SOARS?
21. What, if anything, has been surprising to you about SOARS?
22. If you could go back in time to the point right when you became involved with SOARS, knowing everything you know now, is there anything you would do differently? Anything you would make a point of doing again, the same way?
23. How has SOARS changed since you have been involved with the program?
24. What advice would you like to give re the SOARS program? Any advice for other organizations planning a similar initiative?

For SOARS Staff (Focus group)

1. Go around the room: Please describe how and why you became a member of the SOARS staff, and what your current role is on the SOARS team.
2. What do you see are the goals of the SOARS program?
3. For whom is the SOARS program beneficial?
4. How has the SOARS program evolved since it first began in 1996 and why?
5. From your perspective, what criteria determine the success of the SOARS program?
6. What are the costs of running the SOARS program?
7. Is the process for selecting protégés effective? How could it be improved?
8. Is the process for matching protégés and mentors effective? How could it be improved?
9. Is the process for selecting a research project effective? How could it be improved?
10. How would you describe the cultural environment and values held by the SOARS team? How are these values similar to or different than the cultural values of the UCAR work environment in general?
11. What do you believe are the most beneficial aspects of the SOARS program for protégés?
12. What difficulties and challenges do protégés face at UCAR?
13. In what ways could the SOARS program be improved for the protégés?
14. In what ways could the SOARS program be improved for the mentors?
15. What, if anything, has been surprising to you about SOARS?
16. If you could go back in time to the point right when you became involved with SOARS, knowing everything you know now, is there anything you would do differently? Anything you would make a point of doing again, the same way?
17. How has SOARS changed since you have been involved with the program?
18. What advice would you like to give re the SOARS program? Any advice for other organizations planning a similar initiative?

For SOARS Administrators (Focus group)

1. Go around the room: Please describe your current role at UCAR

2. Go around the room: Please describe how and why you became involved with the SOARS program.
3. What do you see are the goals of the SOARS program?
4. For whom is the SOARS program beneficial?
5. From your perspective, what criteria determine the success of the SOARS program?
6. What are the costs of running the SOARS program?
7. How would you describe the values held by the SOARS team? How are these values similar to or different than the cultural values held by UCAR employees?
8. Is the process for selecting protégés effective? How could it be improved?
9. Is the process for matching protégés and mentors effective? How could it be improved?
10. What do you believe are the most beneficial aspects of the SOARS program for protégés?
11. In what ways could the SOARS program be improved?
12. What, if anything, has been surprising to you about SOARS?
13. If you could go back in time to the point right when you became involved with SOARS, knowing everything you know now, is there anything you would do differently? Anything you would make a point of doing again, the same way?
14. How has SOARS changed since you have been involved with the program?
15. What advice would you like to give re the SOARS program? Any advice for other organizations planning a similar initiative?

Protocol For New Protégés

19. What is your major or area of expertise? What year are you in school?
20. How did you learn about SOARS? Why did you choose to apply?
 - a. How did the application process go (was it fair/difficult, etc.)?
21. What do you see are the goals of the SOARS program?
22. What aspects of the SOARS program do you think will be the most beneficial for your career?
23. What aspects of the SOARS program help create an environment conducive to learning and personal growth?
24. What do you think will be the most rewarding about your research project? What will be the most challenging? What will be the most frustrating?
25. What do you like about the writing and presentation assignments? What don't you like about them?
26. What is the work environment at UCAR like for you to work in?
27. Is the process for matching protégés and mentors effective? How could it be improved?
28. What is your relationship like with your research mentor? Writing mentor? Community mentor? Peer mentor? SOARS staff? (what do you find most valuable about the relationship and what was the least valuable, where do you click and where not and why)
29. What aspects of being a protégé in the SOARS program do you think you will like the most?
30. How do you think being in the SOARS program will change you personally and professionally?
31. In what ways could the SOARS program be improved for the protégés?
32. What, if anything, has been surprising to you about SOARS? Pleasant surprises? Disappointments?
33. If you could go back in time to the point right when you became involved with SOARS, knowing everything you know now, is there anything you would do differently? Anything you would make a point of doing again, the same way?
34. What advice would you like to give re the SOARS program? Any advice for other organizations planning a similar initiative?