Dr. Ralph Wachter  
Program Director  
Software Research Program, Code 311  
Mathematical, Computer and  
Information Science Division  
Office of Naval Research  
800 North Quincy Street  
Arlington, VA 22217-5660

Dear Dr. Wachter:

This is the final project report for the contract No. N00014-96-1-0709 that I was PI on. The contract was for support of the Twelfth Workshop on the Mathematical Foundations of Programming Semantics, which took place at the University of Colorado, Boulder from June 3 to June 5, 1996. The workshop featured invited addresses by six internationally recognized researchers, one special session, and forty talks contributed by participants. In all there were 69 participants from all over the world. The Proceedings of the meeting will comprise a special issue of the journal, Theoretical Computer Science, and it will be comprised of papers which are submitted by the participants and that will be refereed to the usual standards of TCS.

In addition to supporting MFPS 12, the funds in this grant also helped support a Workshop on Concurrency that took place at Tulane University, as well as a short workshop on Semantics and Security that also took place in New Orleans, in September of this year. The concurrency workshop consisted of visits by several researchers who collaborated with me on various aspects of my research program, and the workshop took place over a period of about two months. Details of those researchers who were supported by these funds, and about their visits to Tulane are presented in the attached report.

We wish to express once again our thanks to ONR for providing us with this much-needed support. ONR has been a continuing supporter of the MFPS series, and we believe has contributed greatly to the success and world-wide recognition it receives.

Best regards,

Michael Mislove  
Professor
Report on Conference Support Contract  
No. N00014-96-1-0709  
Michael Mislove, Principal Investigator  
Mathematics Department  
Tulane University

Summary of Completed Project

The funding from ONR was used to support the invited speakers at the twelfth workshop on the Mathematical Foundations of Programming Semantics, to help support participants in the special session held during the meeting, and to underwrite general conference support costs, including support of graduate students, women and members of minority groups to participate in the meeting. This annual series of meetings provides a venue for mathematicians and theoretical computer scientists to meet and discuss problems of mutual interest.

In addition to supporting MFPS 12, the funds from this grant were used to support visits to Tulane by several researchers who also work in the areas close to Professor Mislove's interests, and to support a small workshop on Semantics and Security that took place in New Orleans in September. Details of these activities are reported below.

Detailed Information

The Twelfth Workshop on the Mathematical Foundations of Programming Semantics took place on the campus of the University of Colorado, Boulder from June 3 to June 5, 1996, and featured invited addresses by six international researchers, one special session devoted to honoring Peter Freyd on his 60th birthday, and forty one talks contributed by participants in the meeting. The invited speakers at the meeting were

Peter Freyd (Penn),  
Mel Fitting (CUNY),  
Matthew Hennessy (Sussex),  
Gerard Huet (INRIA),  
Andre Scedrov (Penn),  
Jeannette Wing (CMU).

The conference attracted 69 participants from 11 countries, and the ONR grant helped provide support for the six invited speakers, for the participants in the special session, and for women and minority participants who participated in the meeting. The conference will
publish its *Proceedings* as a special issue of *Theoretical Computer Science*. This special issue will consist of journal-length papers submitted by the participants and refereed to TCS's usual standards.

In addition to supporting MFPS 12, the funds in this grant were used to support a Workshop on Concurrency that took place at Tulane University over a period of about two months, and which was comprised of visits to Tulane by several researchers who collaborated with Professor Mislove on parts of his research program. These researchers included Professor Giuseppe Rosolini (*University of Genoa*) and Dr. Paul Gastin (*LITP, Université Paris VII*). Dr. Gastin visited Tulane for a period of about a month, and during this time he and Professor Mislove embarked on a research program directed at their common interests - Dr. Gastin's well-known work on *true concurrency* and Professor Mislove’s work on domain theory and models for concurrency. The goal of the work is to find out if there is any advantage to using true concurrency in modeling concurrent languages, as oppose to the more traditional approach of resolving parallel composition by interleaving sequential compositions.

Lastly, the funds were used to help support a small workshop on Semantics and Security that was held in New Orleans from September 15 to September 17, 1996. The goal of the workshop was to acquaint participants with potential applications of semantics to security. In addition to Professor Mislove, the participants were

- Steve Brookes (*CMU*),
- Connie Heitmeyer (*NRL*),
- Radha Jagadeesan (*Loyola, Chicago*),
- John McLean (*NRL*),
- G. M. Reed (*Oxford*), and
- A. W. Roscoe (*Oxford*).

The aim for the participants in this workshop is to find areas of collaboration in their research that will focus on using semantic techniques to attack problems involving security in areas ranging from homogeneous to heterogeneous computing systems.
Mathematical Foundations of Programming Semantics and Concurrency Workshop

ONR award number: N00014-96-1-0709
Total amount awarded: $15,000
Period of award: 3/1/96 - 9/30/96

Mathematical Foundations of Programming Semantics (MFPS XII 1996) - $12,000
University of Colorado at Boulder
Boulder, CO
June 3 - 5, 1996

Number of Participants: 69 total
   Faculty  59
   Students 10

Number of Countries represented: 11
   Canada
   Denmark
   France
   Germany
   Hungary
   Italy
   Japan
   Netherlands
   Portugal
   United States
   United Kingdom

Number of graduate students supported: 6
   Haack, C.
   Hu, H.
   Ibraheem, H.
   Kotov, S.
   Loughry, B.
   Resende, P.

Number of women supported: 2
   Finkelstein, S.
   Jourdan, S.
   Wing, J.

Faculty participants supported other than invited speakers:
   Fiore, M.
   Gastin, P.
   Oles, F.
   Rosolini, G.

Concurrency Workshop - $3,000
Tulane University
New Orleans, LA
May - August 1996

Supported professional visiting participants: Gastin, P.
   Rosolini, G.

Semantics workshop participants supported: Brookes, S.
   Jagadeesan, R.
   Reed, M.
   Roscoe, B.
Twelfth Conference on the
Mathematical Foundations of
Programming Semantics

University of Colorado
Boulder, CO USA
June 3 - 5, 1996

Partially Supported by the US Office of Naval Research

The Twelfth Workshop on the Mathematical Foundations of Programming Semantics will take place on the campus of the University of Colorado in Boulder, CO from June 3 to June 5, 1996. The invited speakers for the meeting are

Peter Freyd \hspace{1cm} Penn
Mel Fitting \hspace{1cm} CUNY
Matthew Hennessy \hspace{1cm} Sussex
Gerard Huet \hspace{1cm} Inria
Andre Scedrov \hspace{1cm} Penn
Jeannette Wing \hspace{1cm} Carnegie-Mellon

In addition to the invited talks, there will be one special session at the meeting, and the remainder of the program will consist of contributed talks by the participants. Time for the contributed talks will be allocated on a first-come, first-serve basis; parallel sessions may be used if there is a large number of requests that cannot be accommodated without them.

A Proceedings also is planned. As has been the case with previous MFPS Workshops, this will likely take the form of a special issue of the journal *Theoretical Computer Science*, devoted to journal-length papers on results related to those presented at the meeting. A Call for Papers for the special issue will be disseminated after the meeting.

In addition to supporting the workshop overall, the support being provided by the Office of Naval Research makes funds available to help offset expenses of graduate students. Women and minorities also are encouraged to inquire about possible support to attend the meeting.

Registration Information

Detailed information about registration and accommodations now is available. If you wish to register for the meeting, follow the link.

If you have questions about the meeting, send email to us at: mfps@math.tulane.edu.
List of Participants

David B. Benson (abstract p. 8)
School of Electrical Engineering and Computer Science
Washington State University
Pullman, WA 99164-2752
dbenson@eeecs.wsu.edu

Richard Blute
Mathematics Department
University of Ottawa
585 King Edward
Ottawa, Ontario K1N 6N5
CANADA
rblute@mathstat.uottawa.ca

Stephen Brookes (abstract p. 8 and 9)
School of Computer Science
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213
brookes@cs.cmu.edu

Robin Cockett (abstract p. 10)
University of Calgary
Department of Computer Science
2500 University Drive NW
Calgary, Alberta T2N 1N4
CANADA
robin@cpsc.ucalgary.ca

John Cowles
Department of Computer Science
University of Wyoming
P. O. Box 3662
Laramie, WY 82071
cowles@meru.uwyo.edu

Denis Dancanet
Computer Science Department
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890
dancanet@cs.cmu.edu

Abbas Edalat (abstract p. 10)
Department of Computing
Imperial College
180 Queen’s Gate
London SW7 2BZ,
UNITED KINGDOM
ae@doc.ic.ac.uk

Zoltan Esik (abstract p. 10)
Department of Computer Science
Attila József University
P. O. Box 652
6701 Szeged
HUNGARY
esik@inf.u-szeged.hu

Stacy Finkelstein (abstract p. 12)
Mathematics Department
University of Ottawa
585 King Edward
Ottawa, Ontario K1N 6N5
CANADA
sfinkel@csi.uottawa.ca

Marcelo Fiore (abstract p. 12)
Department of Computer Science
King’s Buildings
Edinburgh EH9 3JZ
SCOTLAND
mf@dcs.ed.ac.uk

Melvin Fitting (abstract p. 12)
Mathematics and Computer Science Department
Herbert H. Lehman College CUNY
Bronx, NY 10468
mfitc@cunyvm.cuny.edu

Bob Flagg (abstract p. 13)
Department of Mathematics and Statistics
University of Southern Maine
96 Falmouth St.
Portland, ME 04103
flagg@usm.maine.edu

Peter Freyd (abstract p. 13)
University of Pennsylvania
Philadelphia, PA 19104-6389
pjf@saul.clis.upenn.ed

Paul Gastin (abstract p. 14)
LITP - IBP Universite Paris
7 2, place Jussieu
F-75251 Paris Cedex 05
FRANCE
Paul.Gastin@lip6.fr

Dan Ghica
Department of Computing and Information Science
Queen’s University
Kingston, Ontario, K7L 3N6
CANADA
gghica@qucis.queensu.ca

Christian Haack
Kansas State University
Department of Computer and Information Science
234 Nichols Hall
Manhattan, KS 66505-2302
haack@cl.cs.ksu.edu

Esfan Haghverdi
Department of Mathematics
University of Ottawa
585 King Edward
Ottawa, Ontario K1N 6N5
CANADA
ehaghver@csi.uottawa.ca
Michael Main  
Computer Science Department  
University of Colorado at Boulder  
Campus Box 430  
Boulder, CO 80309-0430  
main@colorado.edu  

Pasquale Malacaria (abstract p. 9)  
Imperial College  
Department of Computing  
180 Queen's Gate  
London SW7 1AZ  
UNITED KINGDOM  
pm5@doc.ic.ac.uk  

Austin Melton  
Department of Computer Science  
Michigan Technological University  
Houghton, MI 49931  
austin@mtu.edu  

Michael W. Mislove (abstract p. 18)  
Department of Mathematics  
Tulane University  
New Orleans, LA 70118  
mwm@math.tulane.edu  

Philip Mulry (abstract p. 19)  
Department of Computer Science  
Colgate University  
Hamilton, NY 13346  
phill@CS.COLGATE.EDU  

David Naumann (abstract p. 19)  
Department of Computer Science  
Southwestern University  
Georgetown, TX 78626  
naumann@cs.utexas.edu  

Cyrus F. Nourani (abstract p. 18)  
Computer Science Department, UCSB  
Santa Barbara, CA 93106  
73244.377@Compuserve.Com  

Susan Older  
Carnegie Mellon University  
Computer Science Department  
5000 Forbes Avenue  
Pittsburgh, PA 15213-3891  
sueo@cs.cmu.edu  

Frank Oles (abstract p. 19)  
IBM, T. J. Watson Research Center  
P. O. Box 218  
Yorktown Heights, NY 10598  
oles@watson.ibm.com  

Jim Otto (abstract p. 20)  
299 N. Dunton Avenue, Apt. 427  
Arlington Heights, IL 60004-5971  
otto@triples.math.mcgill.ca  

John Power  
Department of Computer Science  
King's Buildings  
Edinburgh EH9 3JZ  
SCOTLAND  
apj@dcs.ed.ac.uk  

Vaughan Pratt (abstract p. 20)  
Department of Computer Science  
Gates 4B  
Stanford, CA 94305-9045  
pratt@cs.stanford.edu  

Lutz Priese (abstract p. 20)  
University Koblenz  
Rheinaul D-56075  
Koblenz  
GERMANY  
priese@uni-koblenz.de  

Pedro Resende (abstract p. 21)  
IST - Department of Mathematics  
Av Rovisco Pais 1000  
Lisboa  
PORTUGAL  
pmr@math.ist.utl.pt  

John Reynolds  
Computer Science Department  
Carnegie Mellon University  
Pittsburgh, PA 15213  
John.Reynolds@cs.cmu.edu  

Kim Ritter Wagner (abstract p. 13 and 16)  
University of Cambridge Computer Laboratory New  
Museums Site  
Pembroke Street  
Cambridge CB2 3QG  
UNITED KINGDOM  
Kim.Wagner@dcam.ac.uk  

Edmund P. Robinson (abstract p. 22)  
Department of Computer Science  
Queen Mary and Westfield College  
Mile End Road London E1 4NS  
UNITED KINGDOM  
edmundr@dcs.qmw.ac.uk  

Giuseppe Rosolini (abstract p. 22)  
DIMA/DISI via Dodecaneso 35  
16146 Genova  
ITALY  
rosolini@disi.unige.it
MFPS
Schedule of Presentations and Workshop Events
Monday, June 3, 1996

8:00 AM  UMC  Aspen Rooms
          CONTINENTAL BREAKFAST

8:25 AM  UMC 157  WELCOME

8:30 AM  UMC 157  Stephen Brookes, Carnegie Mellon University
                 Parallel Algol: Combining Procedures with Parallelism
                 (abstract on p. 8)

9:00 AM  UMC 157  Hans Hüttel, Aalborg University
                 Objects as Mobile Processes (abstract on p. 15)

9:30 AM  UMC 157  Zoltan Ésik, Atilla József University
                 Independence of the Group Axioms for Iteration
                 (abstract on p. 10)

10:00 AM UMC  Aspen Rooms
          BREAK

10:30 AM Sibell Wolle  Fine Arts N141  INVITED ADDRESS
          Gerard Huet, INRIA Rocquencourt
          Regular Bohm Trees (abstract on p. 15)

11:30 AM Sibell Wolle  Fine Arts N141  Abbas Edalat, Imperial College
          A Computational Model for Metric Spaces
          (abstract on p. 10)

12:00 NOON  UMC  Aspen Rooms
            LUNCH

1:20 PM  Sibell Wolle  Fine Arts N141  INVITED ADDRESS
           Mel Fitting, City University of New York
           Logic Programming Semantics (abstract on p. 12)

2:30 PM  UMC 157  OR  UMC 158
           Pasquale Malacaria, Imperial College
           Relative Definability of Boolean Functions via Hypergraphs
           (abstract on p. 9)

           Philip Mulry, Colgate University
           A CCC Construction for Categories of Partial Maps
           (abstract on p. 19)

(MONDAY SCHEDULE CONTINUED ON NEXT PAGE)
Monday, June 3, 1996 (continued)

3:00 PM     UMC  Aspen Rooms  **BREAK**

3:30 PM     UMC 157
            **David Naumann**, Southwestern University
            *A Rational Imperative Language* (abstract on p. 19)

            OR     UMC 158
            **Robin Cockett**, University of Calgary
            *Shape Rings* (abstract on p. 10)

4:00 PM     UMC 157
            **Denis Dancanet**, Carnegie Mellon University
            *Programming Language Expressiveness and Circuit Complexity* (abstract on p. 9)

            OR     UMC 158
            **Glen Whitney**, University of Michigan
            *Extensional Non-deterministic Recursion* (abstract on p. 25)

4:30 PM     UMC 157
            **Yoshiki Kinoshita**, Electrotechnical Laboratory, Japan
            *Data Refinement and Algebraic Structure* (abstract on p. 17)

            OR     UMC 158
            **Cyrus Nourani**, METAII
            *The Tree Amplification Principle* (abstract on p. 19)

5:00 PM     UMC 157
            **Dieter Spreen**, Universitaet Siegen
            *Finitely Generated Rank-Ordered Sets are a Model of Type:Type* (abstract on p. 25)

            OR     UMC 158
            **Vaughan Pratt**, Stanford University
            *Stochastic Manifolds* (abstract on p. 20)

6:00 PM     **RECEPTION HONORING PETER FREYD**

Old Main
Heritage Center

Tuesday, June 4, 1996

8:00 AM     UMC  Aspen Rooms  **CONTINENTAL BREAKFAST**

8:30 AM     **INVITED ADDRESS**
            **Sibell Wolle**
            *Fine Arts N141*
            **Andre Scedrov**, University of Pennsylvania
            *Linear Logic Proof Games and Optimization* (abstract on p. 24)

9:30 AM     **Stacy Finkelstein**, McGill University
            *Fine Arts N141*
            **Applications of Tau Categories** (abstract on p. 12)

10:00 AM    **BREAK**

(Tuesday schedule continued on next page)
Tuesday, June 4, 1996 (continued)

10:30 AM  Sibell Wolle  
Fine Arts N141  
**Edmund Robinson**, Queen Mary and Westfield College  
*Enriched Categories and Algebraic Compactness*  
(abstract on p. 22)

11:00 AM  Sibell Wolle  
Fine Arts N141  
**Marcelo Fiore**, University of Edinburgh  
*Enrichment and Representation Theorems for Categories of Domains and Continuous Functions*  
(abstract on p. 12)

11:30 AM  Sibell Wolle  
Fine Arts N141  
**Guiseppe Rosolini**, Universita di Genoa  
*Models of Synthetic Domain Theory*  
(abstract on p. 22)

12:00 NOON  UMC  
Aspen Rooms  
**LUNCH**

1:20 PM  Sibell Wolle  
Fine Arts N141  
**INVITED ADDRESS**  
**Jeanette Wing**, Carnegie Mellon University  
*Mathematics for Software Engineering*  
(abstract on p. 26)

2:30 PM  UMC 157  
**Bob Flagg**, University of Southern Maine  
*A Logical Approach to Quantitative Domain Theory*  
(abstract on p. 13)

2:30 PM  OR  UMC 158  
**Richard Kieburztz**, NSF and Oregon Graduate Center  
*Encapsulated Effects*  
(abstract on p. 17)

3:00 PM  UMC  
Aspen Rooms  
**BREAK**

3:30 PM  UMC 157  
**Michael Mislove**, Tulane University  
*A New Theorem on Adjunctions with an Old Application*  
(abstract on p. 18)

3:30 PM  OR  UMC 158  
**Ed Brinksma and Joost-Pieter Katoen**, Universite Twente  
*(Paper presented by R. Langerak)*  
*Disjunctive Causality*  
(abstract on p. 8)

4:00 PM  UMC 157  
**Philipp Sunderhauff**, University of Southern Maine  
*Representation of Quantitative Domains*  
(abstract on p. 13)

4:00 PM  OR  UMC 158  
**Krzysztof Worytkiewicz**, EPFL, Lausanne  
*Abstract Interpretation of Polymorphically Typed Languages*  
(abstract on p. 26)

4:30 PM  UMC 157  
**Mathias Kegelmann**, University of Birmingham  
*Factorization Systems on Domains*  
(abstract on p. 17)

4:30 PM  OR  UMC 158  
**Dennis Volpano**, Naval Postgraduate School  
*Towards Type Systems for Secure Remote Evaluation*  
(abstract on p. 25)

(TUESDAY SCHEDULE CONTINUED ON NEXT PAGE)
Tuesday, June 4, 1996 (continued)

5:00 PM  UMC 157  Pedro Resende, Instituto Superior Tecnico, Portugal
Quantales, Finite Observations and Strong Bisimulation
(abstract on p. 21)

OR  UMC 158  Robert Kim Yates, Lawrence Livermore National Lab
Causal Continuity of Non-monotonic Processes
(abstract on p. 26)

7:00 PM  The Broker Inn  CASH BAR (7 PM)
CONFERENCE BANQUET (7:30 PM)

Wednesday, June 5, 1996

8:00 AM  UMC Aspen Rooms  CONTINENTAL BREAKFAST

8:30 AM  UMC 157  Paul Gastin, LIITP, Paris
Resource Traces: A Domain for Processes Sharing Exclusive Resources
(abstract on p. 14)

9:00 AM  UMC 157  Kim Ritter Wagner, Cambridge University
Variations on Fixed-Point Theorems for Semantics
(abstract on p. 16)

9:30 AM  UMC 157  Vijay Saraswat, Xerox Parc
Truly Concurrent Constraint Programming
(abstract on p. 23)

10:00 AM  UMC Aspen Rooms  BREAK

10:30 AM  Sibell Wolle Fine Arts N141  INVITED ADDRESS
Matthew Hennessy, University of Sussex
A Fully Abstract Denotational Model for the Pi-Calculus
(abstract on p. 14)

11:30 AM  Sibell Wolle Fine Arts N141  Alan Jeffrey, University of Sussex
Linear Types for Higher-order Processes with Unique Name Generation
(abstract on p. 16)

12:00 NOON  UMC Aspen Rooms  LUNCH

(WEDNESDAY SCHEDULE CONTINUED ON NEXT PAGE)
Wednesday, June 5, 1996 (continued)

1:20 PM   Sibell Wolle
           *INVITED ADDRESS*
           *Fine Arts N141*
           Peter Freyd, University of Pennsylvania
           *Paracategories, Paramathematics* (abstract on p. 13)

2:30 PM   UMC 157
           Frank Oles, IBM Thomas J. Watson Research Center
           *An Application of Lattice Theory to Knowledge*
           *Representation* (abstract on p. 19)

2:30 PM   OR UMC 158
           Katherine St. John, University of Pennsylvania
           *Recursion on Finitely Generated Structures*  
           (abstract on p. 22)

3:00 PM   UMC
           Aspen Rooms
           *BREAK*

3:30 PM   UMC 157
           Marta Kwiatkowska, University of Birmingham
           *Fair Recursion in Synchronous CCS* (abstract on p. 16)

3:30 PM   OR UMC 158
           Peter Selinger, University of Pennsylvania
           *Henkin Representations and Polymorphism*  
           (abstract on p. 24)

4:00 PM   UMC 157
           Eiichi Horita, NTT Communications Science Laboratories
           *Self-Interpretation in an Extension of CCS with Parametric*
           *Channels* (abstract on p. 15)

4:00 PM   OR UMC 158
           James Otto, McGill University
           *Bicategories for Logic Programming* (abstract on p. 20)

4:30 PM   UMC 157
           Claudio Hermida, McGill University
           *Simulations as Modules* (abstract on p. 15)

4:30 PM   OR UMC 158
           Hongde Hu, Université de Québec
           *Sofiness, Coherence Spaces and Free, Bicomplete*
           *Categories* (abstract on p. 15)

5:00 PM   UMC 157
           Lutz Priese, Universitäts Koblenz
           *Compositional Petri Net Semantics* (abstract on p. 20)

5:00 PM   OR UMC 158
           David Benson, Washington State University
           *Stone Duality between Queries and Data* (abstract on p. 8)

END OF PROGRAM
Funds under this grant were used to support three principal activities. The first was the Twelfth Workshop on the Mathematical Foundations of Programming Semantics, which took place on the campus of the University of Colorado, Boulder from June 3 to June 5, 1996. The second was a series of visits by researchers to Tulane University during the two-month period June - July, 1996, to collaborate with the Principal Investigator on topics of common research interest. These visits formed the bulk of the Workshop on Concurrency listed in the title of the grant. Lastly, funds were used to help support participants in a small workshop in New Orleans from September 15 to September 17, 1996 which focused on applications of semantic techniques to problems in security of distributed computing systems.