

**02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and  
co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS**

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Submit only ONE copy of this form for each PI/PD and co-PI/PD identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. **DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.**

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**PI/PD Name:** Alan H Bond

**Gender:**  Male  Female  
**Ethnicity:** (Choose one response)  Hispanic or Latino  Not Hispanic or Latino

**Race:**  
(Select one or more)  
 American Indian or Alaska Native  
 Asian  
 Black or African American  
 Native Hawaiian or Other Pacific Islander  
 White

**Disability Status:**  
(Select one or more)  
 Hearing Impairment  
 Visual Impairment  
 Mobility/Orthopedic Impairment  
 Other  
 None

**Citizenship:** (Choose one)  U.S. Citizen  Permanent Resident  Other non-U.S. Citizen

**Check here if you do not wish to provide any or all of the above information (excluding PI/PD name):**

**REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project**

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**Ethnicity Definition:**

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

**Race Definitions:**

**American Indian or Alaska Native.** A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.

**Asian.** A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.

**Black or African American.** A person having origins in any of the black racial groups of Africa.

**Native Hawaiian or Other Pacific Islander.** A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.

**White.** A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

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**WHY THIS INFORMATION IS BEING REQUESTED:**

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information received from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational opportunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

## List of Suggested Reviewers or Reviewers Not To Include (optional)

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### **SUGGESTED REVIEWERS:**

Not Listed

### **REVIEWERS NOT TO INCLUDE:**

Not Listed

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# CERTIFICATION PAGE

## Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

### Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

### Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

### Debarment and Suspension Certification

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

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?

Yes

No

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

### Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding \$100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding \$150,000.

### Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

- (1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

### Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

### Certification Regarding Flood Hazard Insurance

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

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

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

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

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE		DATE	
NAME					
TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS			FAX NUMBER	

\*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

## Project summary

This project will develop a computer system which will solve problems creatively and will be based on the extension, abstraction and generalization of the cognitive processes that people use. By building and experimenting with such a system, original insights will be gained into the nature of creativity, which will help improve the development of creativity in our schools and workplaces. In order to develop such a system, it will be necessary to understand the different cognitive processes involved in creativity and how they can cooperate.

The model will be developed by extending an existing computational model which has been developed over the past several years by the principal investigator. This model already exists as a computer program for simple knowledge-based problem solving. It has a highly parallel architecture with components for processing goals, plans, memory and perception. In order to extend this model it will be necessary to extend its various components to incorporate new types of knowledge that are to be used creatively. It will be necessary to introduce new mechanisms for conceptual representations and their manipulation. This will need a method of representing knowledge allowing it to be flexibly abstracted or constrained as required to discover new problem solutions. The highly parallel nature of the existing model will allow many different kinds of knowledge to be activated together concurrently thereby allowing a large set of potential solutions to be considered, but it will also allow a large set of constraints to be applied together concurrently to find the best solutions.

The **intellectual merit** of the project will be in advancing our understanding of the important area of creativity by showing how different knowledge-based processes work together to creatively solve problems. Its **broader impact** will be in showing how to develop systems which support and enhance human creativity in the design of commercial products, in artistic and cultural activities, in understanding the development of creativity in our children, in educating our students to be more creative, and to have marketable creative skills.

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

	Total No. of Pages	Page No.* (Optional)*
Cover Sheet for Proposal to the National Science Foundation		
Project Summary (not to exceed 1 page)	1	_____
Table of Contents	1	_____
Project Description (Including Results from Prior NSF Support) (not to exceed 15 pages) <b>(Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</b>	5	_____
References Cited	2	_____
Biographical Sketches (Not to exceed 2 pages each)	2	_____
Budget (Plus up to 3 pages of budget justification)	3	_____
Current and Pending Support	1	_____
Facilities, Equipment and Other Resources	1	_____
Special Information/Supplementary Documentation	0	_____
Appendix (List below. ) <b>(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)</b>	_____	_____
Appendix Items:		

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

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## Project description

### Objectives

The main objective of the project is to develop a new computational model of creative problem-solving which has integrated planning, perception and memory aspects, and is highly parallel, and is inspired by human cognition and brain architecture.

The overall purpose of the project is to try to understand the properties of creativity in general as an abstraction, extension, and generalization of human creativity.

*Human creativity.* It seems that human creativity is not a special ability but is achieved using common cognitive abilities. At the cognitive level of analysis, there are many issues and phenomena that we need to understand. Creativity is goal directed [17], and involves dynamic goal-setting and goal-changing. There is a need for unconstrained generation of alternatives and efficient search of large sets of possibilities. Memory and knowledge are very important [22] [13], although their effects can be both positive and negative. Visual imagery is important, including the construction of images, structured imagination and creative invention [1] [14]. Perception can be creative. Analogy and metaphor are important mechanisms in generating and assessing creative results [15]. Creativity involves synthesis and construction. The abstraction, combination and merging of concepts can be useful and may be necessary. Creativity involves the revision, re-representation and reconstrual of the problem. Evaluation of possibilities is important and needs high standards. The role of routinization, overlearning and incubation has been emphasized by a number of researchers, however there is some contrary opinion, see for example Hayes [17]. There are many types of obstacles and traps in creative thought [23]. Metacognition can be useful in the conscious control and management of the creative process [2]. There are neuroscience data [18] [3], and theories such as cortical arousal and focus of attention [19]. There are methods for improving creativity [26] [21], and there are methods for measuring creativity [24] [16].

The development of a general computational model of creativity will produce much-needed insights into many of these key issues and phenomena. Such insights will allow the better assessment of creativity and the development of methods for increasing and optimizing creativity.

*Expected significance.* The research will provide an understanding of creativity in general and a basis for improving creativity at work, and improving the development of creativity in children and students.

*Relation to long-term goals of the principal investigator.* The research develops the basic problem-solving/perception/memory mechanisms of the model to incorporate more extensive memory and to allow the representation of wider classes of cognition and behavior.

*Relation to the present state of knowledge of the field.* The proposed model will be more comprehensive than previous models of creativity, and based on parallel processing, human cognition and brain architecture, unlike most previous models.

*Relation to the work in progress by the principal investigator under other support.* The current other funding is mainly related to logical representations of knowledge in engineering and neuroscience. Thus the relation between the projects is at a theoretical and methodological level. He is however collaborating with the design process group at NIST whose main focus is on engineering design.

*Relation to work in progress elsewhere.* The proposed work will provide a more comprehensive model for comparison with work on the psychology and neuropsychology of creativity.

## **General plan of the work**

*The architecture of the proposed system.* The model will be developed by extending an existing cognitive model [7] [6]; an outline architectural diagram of the proposed computational system is given in Figure 1. The proposed system uses a modeling approach of a modular

distributed computational architecture, with an abstract logical description of data and control, which has a correspondence to the cortex. In the last few years, we have conducted a series of studies and models concerning cognitive mechanisms, including problem solving [5], episodic memory [9], and spatial working memory [10].

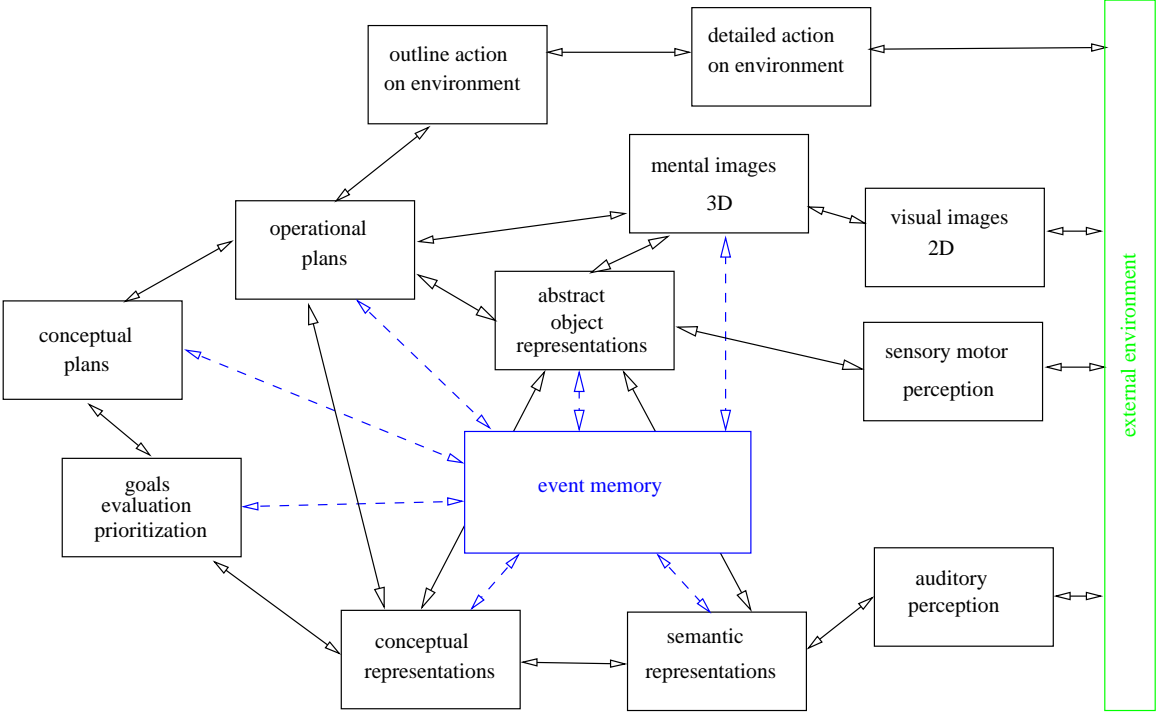


Figure 1: The architecture of proposed system

In the current approach to brain-based cognitive modeling of problem solving, the action of the system, like the brain, involves the continuous parallel action of all processing modules, and each module is specialized for processing and storage of particular types of data.

The continuous action of the system creates goals, selects a goal, retrieves a plan and executes a plan step. Plan execution uses working goals in the plan execution module and also constructions and percepts that it receives from the perception hierarchies, in order to search different possible states and to construct new possible states. Goal selection, plan selection and plan step selection are reconsidered every processing cycle, and plan steps at different

levels of abstraction run concurrently. Feedback, to these goal and planning modules from the constructed states, which are distributed over the modules of the perception hierarchies, can change their selections.

*The proposed creative problem solving dynamics.* In extending our model, our approach to creative problem-solving is informed by the work of DeGroot [12] and Newell and Simon [20] who give a clear description of the problem-solving cycle with a succession of narrow beam searches each ending in an evaluation. After each search, the subject reconsiders the position in the light of this evidence, possibly reformulates, reconceives and rerepresents the problem, generates a conceptual or logical goal, then an operational goal, and then makes another search. We give an outline diagram in Figure 2, indicating the sequence of searches and the operations in the problem solving cycle.

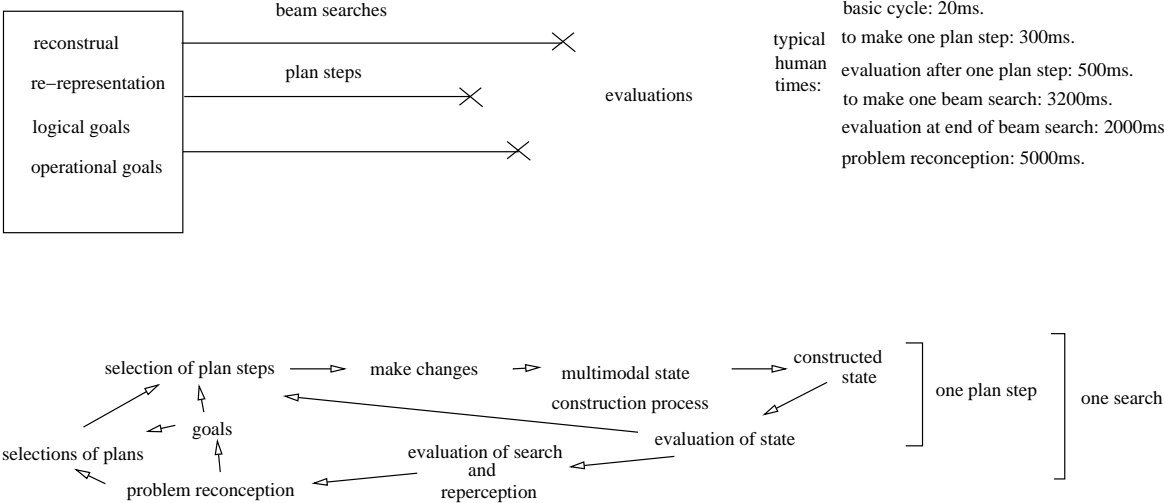


Figure 2: The proposed cycle of creative problem-solving dynamics

To achieve this approach to creative problem solving, we will need to extend the use of memory in all modules so that each module has many alternate methods for representing its state. Memories are formed by the episodic memory module, which builds in associations among co-occurring memory items in different modules, which later will aid in creativity by

providing multiple perspectives, multimodal representations and inter-modular constraints. We will need to develop and implement new functionalities: (a) for (re)perception of the problem at each step, (b) for greater constructional ability, in mental imagery and conceptual combination, (c) for memory-based plan elaboration: (i) several different plans at different abstraction levels, (ii) several arguments for each plan step from associated memories, and (iii) the action of plan steps associating with memories to form the new constructed state, and (d) for evaluation of the current constructed state. The use of concurrent plan steps and concurrent plan constraints will allow the construction of a large space of possible states, and also will facilitate the filtering, evaluation and recombination of state elements to form more optimal and novel constructions.

*The research plan.* There will be a sequence of stages, each lasting about 3 months: (i) development of a conceptual representation, (ii) development of mechanisms of problem perception, (iii) extension of plan representations to include constraints, and (iv) development of the narrow beam elaboration process. Throughout, the research will involve the development of different cognitive model mechanisms and testing with creative problem-solving tasks. The choice of which problem-solving tasks to study is itself part of the research. There are some classic problems such as Duncker's radiation problem. Even the task of learning to solve the Tower of Hanoi problem involves discovering new strategies by making creative associations, for example, seeing the problem in terms of pyramids of disks, or realizing that parity can be used in constructing a strategy.

*Documentation and sharing.* The documentable results of the project will be papers and programs which will be sharable with other researchers in the field.

*Broader impacts.* The project will integrate research and education by advancing our understanding of creative thought and how it can be improved and measured. Potential benefits to society at large will flow from the new insights and understanding of creativity which is a key issue in science, technology and the arts.

## References

- [1] Rita E. Anderson and Tore Helstrup. Visual discovery in mind and on paper. *Memory and Cognition*, 21:283–293, 1993.
- [2] Bonnie B. Armbruster. Metacognition in creativity. In John A. Glover, Royce R. Ronning, and Cecil R. Reynolds, editors, *Handbook of creativity*, pages 177–182. Plenum Press, New York, 1989.
- [3] N. P. Bechtereva, A. D. Korotkov, S. V. Pakhomov, M. S. Roudas, M. G. Starchenko, and S. V. Medvedev. PET study of brain maintenance of verbal creative activity. *International Journal of Psychophysiology*, 53:11–20, 2004.
- [4] Alan H. Bond. Modeling social relationship: An agent architecture for voluntary mutual control. In Kerstin Dautenhahn, Alan H. Bond, Dolores Canamero, and Bruce Edmonds, editors, *Socially Intelligent Agents: Creating relationships with computers and robots*, pages 29–36. Kluwer Academic Publishers, Norwell, Massachusetts, 2002.
- [5] Alan H. Bond. Problem-solving behavior in a system model of the primate neocortex. *Neurocomputing*, 44-46C:735–742, 2002.
- [6] Alan H. Bond. A Computational Model for the Primate Neocortex based on its Functional Architecture. *Journal of Theoretical Biology*, 227:81–102, 2004.
- [7] Alan H. Bond. An Information-processing Analysis of the Functional Architecture of the Primate Neocortex. *Journal of Theoretical Biology*, 227:51–79, 2004.
- [8] Alan H. Bond. A psycholinguistically and neurolinguistically plausible system-level model of natural-language syntax processing. *Neurocomputing*, 65-66:833–841, 2005.
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- [10] Alan H. Bond. A System-level Brain Model of Spatial working Memory. In *Proceedings of the 28th Annual Conference of the Cognitive Science Society, Vancouver, August*, pages 1026–1031, 2006.
- [11] Alan H. Bond. Brain mechanisms for interleaving routine and creative action. *Neurocomputing*, 69:1348–1353, 2006.
- [12] Adriaan D. de Groot. *Het Denken van den Schaker*. North Holland, Amsterdam, 1946. Translation into English and published as *Thought and Choice in Chess*, Mouton, 1965.
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- [15] Mary L. Gick and Keith J. Holyoak. Analogical problem solving. *Cognitive Psychology*, 12:306–355, 1980.
- [16] J. P. Guilford. *The Nature of Human Intelligence*. McGraw-Hill, New York, 1967.
- [17] John R. Hayes. Cognitive processes in creativity. In John A. Glover, Royce R. Ronning, and Cecil R. Reynolds, editors, *Handbook of creativity*, pages 135–145. Plenum Press, New York, 1989.
- [18] Markus Knauff, Thomas Mulack, Jan Kassubek, Helmut R. Sali, and Mark W. Greenlee. Spatial imagery in deductive reasoning: a functional MRI study. *Brain Research. Cognitive Brain Research*, 13:203–212, 2002.
- [19] Colin Martindale. Creative imagination and neural activity. In Robert G. Kunzendorf and Anees A. Sheikh, editors, *The psychophysiology of mental imagery*, pages 89–108. Baywood, Amityville, New York, 1990.
- [20] Allen Newell and Herbert Simon. *Human problem solving*. Prentice Hall, Englewood Cliffs, New Jersey, 1972.
- [21] Ginamarie Scott, Lyle E. Leritz, and Michael D. Mumford. Types of creativity training: approaches and their effectiveness. *Journal of Creative Behavior*, 38:149–179, 2004.
- [22] Barry S. Stein. Memory and creativity. In John A. Glover, Royce R. Ronning, and Cecil R. Reynolds, editors, *Handbook of creativity*, pages 163–176. Plenum Press, New York, 1989.
- [23] Melvin Tumin. Obstacles to creativity. In Sidney J. Parnes and Harold F. Harding, editors, *A sourcebook for creative thinking*, pages 105–114. Scribner, New York, 1962.
- [24] Klaus K. Urban. Assessing Creativity: The test for creative thinking - drawing production (TCT-DP): the concept, application, evaluation, and international studies. *Psychology Science*, 46:387–397, 2004.
- [25] Robert W. Weisberg. *Creativity : understanding innovation in problem solving, science, invention, and the arts*. John Wiley, Hoboken, New Jersey, 2006.
- [26] Charles S. Whiting. *Creative thinking*. Reinhold, New York, 1958.

## Biographical Sketch: Alan Bond

### a. Professional preparation

Magdalen College, Oxford University, Physics B.A. (First class honours), 1961

Magdalen College, Oxford University, Physics M.A., 1966

Imperial College of Science and Technology, London Univ., Theoretical Physics Ph.D. 1966

### b. Appointments

(2005 - present) Research Psychologist, Semel Institute for Neuroscience and Human Behavior, Geffen School of Medicine, University of California at Los Angeles, Los Angeles, California

(2005 - present) Visiting professor, National Institute of Standards and Technology, Gaithersburg, Maryland

(Sept 1998 - 2004) Lecturer in Computer Science, California Institute of Technology, Pasadena, California.

(Sept 1996 - 2004) Senior Scientist, Departments of Electrical Engineering and Computer Science, California Institute of Technology, Pasadena, California.

(Sept 1995 - June 1996) Instructor, Department of Computer Science, University of California, Los Angeles.

(Feb 1994 - Dec 1994) Visiting Researcher, Division of Neurosurgery, School of Medicine, and Computer Science Department, University of California, Los Angeles

(Sept 1991-Jan 1994) Member of Technical Staff, Computer Systems Research Department, The Aerospace Corporation, Los Angeles

(Feb-Aug 1992) Sony Sabbatical Chair, Sony Computer Science Research Laboratory, Tokyo

(1985-1991) Principal Development Engineer, University of California, Los Angeles

(1969 - 1984) Lecturer (Corresponds to Assistant and Associate Professor) in Computer Science, Queen Mary College, London University (tenured from 1973)

(1968-9) Acting Assistant Professor, Engineering Department, UCLA, Los Angeles

(1967-8) Visiting Assistant Professor, Computer Science Department, Carnegie-Mellon University, Pittsburgh

(1966-7) Research Scientist, Computer Science Department, Carnegie Institute of Technology, Pittsburgh

(1966) Research Assistant in Computing Methods, Mathematics Department, Royal Holloway College, London University

Visiting Posts:

(1991) Esprit DAI project IMAGINE. Logic Programming Group, Imperial College, London

(1983-5) Senior Research Scientist, Electrical Engineering Systems Department, University of Southern California, Los Angeles

(1982) Visiting Research Professor, Image Processing Institute, University of Southern California, Los Angeles

(Summer 1981) Engineer, Naval Ocean Systems Center, San Diego

(Summer 1980) Visiting Researcher, Computer Science Department, Carnegie-Mellon

University, Pittsburgh

(Summer 1973) Visiting Lecturer, Makerere University, Kampala, Uganda

**c. Five publications relevant to the proposed project**

Alan H. Bond. A Computational Model for the Primate Brain based on its Functional Architecture, *Journal of Theoretical Biology*, vol 227, pp. 81-102, 2004.

Alan H. Bond. Representing episodic memory in a system-level model of the brain, *Neurocomputing*, vol 65-66, pp. 261-273, 2005

Alan H. Bond. A System-level Brain Model of Spatial working Memory , *Proceedings of the 28th Annual Conference of the Cognitive Science Society*, pp. 1026-1031, 2006.

Alan H. Bond and Basuki Soetarman. Integrating Prolog and CADAM to produce an Intelligent CAD System. *Software Practice and Experience*, 20:1049-1076, 1990.

Alan H. Bond and Richard Ricci. Cooperation in aircraft design. *Research in Engineering Design*, 4, 115-130, 1992.

**d. Synergistic activities**

**Innovations in teaching:** Developed ten undergraduate courses in computer science and developed master's program in computer science, at Queen Mary College, University of London. Developed advanced level computer courses at California Institute of Technology. Tutor on university teaching methods for the University Teaching Methods Research Unit, London University.

**Development of research tools:** The CADLOG system at UCLA, and the BAD system.

**Development of computation methodologies:** Predicate logic approach to CAD/CAM. Logic programming approach to Brain Science.

**e. Collaborators and other affiliations**

**Collaborators and co-editors:** Professor Les Gasser, University of Illinois at Champaign.

**Graduate advisor:** Professor Raymond Streeter, University of London.

**Thesis advisor:** No graduate students within the last five years.

# SUMMARY PROPOSAL BUDGET YEAR 1

ORGANIZATION <b>University of California-Los Angeles</b>				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Alan H Bond</b>				AWARD NO.	Proposed	Granted	
				A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)			
	CAL	ACAD	SUMR				
1. <b>Alan H Bond - Research Psychologist</b>	6.00	0.00	0.00	\$ 42,000			
2.							
3.							
4.							
5.							
6. ( 0 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0			
7. ( 1 ) TOTAL SENIOR PERSONNEL (1 - 6)	6.00	0.00	0.00	42,000			
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0			
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0			
3. ( 0 ) GRADUATE STUDENTS				0			
4. ( 0 ) UNDERGRADUATE STUDENTS				0			
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0			
6. ( 0 ) OTHER				0			
TOTAL SALARIES AND WAGES (A + B)				42,000			
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				10,286			
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				52,286			
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT				0			
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				3,000			
2. FOREIGN				1,500			
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ _____				0			
2. TRAVEL _____				0			
3. SUBSISTENCE _____				0			
4. OTHER _____				0			
TOTAL NUMBER OF PARTICIPANTS ( 0 ) TOTAL PARTICIPANT COSTS				0			
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES				300			
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0			
3. CONSULTANT SERVICES				0			
4. COMPUTER SERVICES				0			
5. SUBAWARDS				0			
6. OTHER				2,324			
TOTAL OTHER DIRECT COSTS				2,624			
H. TOTAL DIRECT COSTS (A THROUGH G)				59,410			
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>Overhead (Rate: 54.0000, Base: 59410)</b>							
TOTAL INDIRECT COSTS (F&A)				32,081			
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				91,491			
K. RESIDUAL FUNDS				0			
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				\$ 91,491			
M. COST SHARING PROPOSED LEVEL \$ 0				AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME <b>Alan H Bond</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

# SUMMARY PROPOSAL BUDGET Cumulative

ORGANIZATION <b>University of California-Los Angeles</b>				FOR NSF USE ONLY		
				PROPOSAL NO.	DURATION (months)	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>Alan H Bond</b>				AWARD NO.	Proposed	Granted
				NSF Funded Person-months		
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				CAL	ACAD	SUMR
1. <b>Alan H Bond - Research Psychologist</b>				6.00	0.00	0.00
2.						
3.						
4.						
5.						
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	0.00
7. ( <b>1</b> ) TOTAL SENIOR PERSONNEL (1 - 6)				6.00	0.00	0.00
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00
2. ( <b>0</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00
3. ( <b>0</b> ) GRADUATE STUDENTS						0
4. ( <b>0</b> ) UNDERGRADUATE STUDENTS						0
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						0
6. ( <b>0</b> ) OTHER						0
TOTAL SALARIES AND WAGES (A + B)						42,000
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						10,286
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						52,286
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)						
TOTAL EQUIPMENT						0
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)						3,000
2. FOREIGN						1,500
F. PARTICIPANT SUPPORT COSTS						
1. STIPENDS \$ _____				0		
2. TRAVEL _____				0		
3. SUBSISTENCE _____				0		
4. OTHER _____				0		
TOTAL NUMBER OF PARTICIPANTS ( <b>0</b> ) TOTAL PARTICIPANT COSTS						0
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES						300
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						0
3. CONSULTANT SERVICES						0
4. COMPUTER SERVICES						0
5. SUBAWARDS						0
6. OTHER						2,324
TOTAL OTHER DIRECT COSTS						2,624
H. TOTAL DIRECT COSTS (A THROUGH G)						59,410
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)						
TOTAL INDIRECT COSTS (F&A)						32,081
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						91,491
K. RESIDUAL FUNDS						0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)						\$ 91,491 \$
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$		
PI/PI NAME <b>Alan H Bond</b>				FOR NSF USE ONLY		
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION		
				Date Checked	Date Of Rate Sheet	Initials - ORG

C \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

## Budget Justification

Senior Personnel Salaries(A): 50% salary for Dr. Alan Bond who will carry out all the work, including theory, design and implementation of the model.

Fringe benefits(C): The fringe benefit rate of 24.49% is assessed on salaries.

Travel

(E1): Domestic travel is requested to present results at conferences and for collaboration.

(E2): Foreign travel is for international conferences and for discussions with international collaborators.

Other direct costs (G) Other (6): We will require a software license for a Sicstus Prolog System, which costs 1560 euros for the first year, which we have converted at the rate of 1.34 to give \$2090. UCLA also has an administration charge of \$39 per month for fulltime, so for 50% for 12 months this is \$234.

Indirect costs(I): F and A charges are 54.0% of all direct costs.

## Current and Pending Support

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

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: <b>Alan Bond</b>	Other agencies (including NSF) to which this proposal has been/will be submitted.
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: <b>NIST IPA</b>	
Source of Support: <b>National Institute of Standards and Technology</b> Total Award Amount: \$ <b>228,000</b> Total Award Period Covered: <b>12/15/05 - 05/31/08</b> Location of Project: <b>Gaithersburg, Maryland and UCLA</b> Person-Months Per Year Committed to the Project.    Cal: <b>6.00</b> Acad: <b>0.00</b> Sumr: <b>0.00</b>	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project.    Cal:              Acad:              Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project.    Cal:              Acad:              Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project.    Cal:              Acad:              Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project.    Cal:              Acad:              Summ:	

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

## FACILITIES, EQUIPMENT & OTHER RESOURCES

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

**Laboratory:** **UCLA has a very large brain imaging center with an international reputation.**

**Clinical:**

**Animal:**

**Computer:** **UCLA medical school has an impressive network of computers for research.**

**Office:**

**Other:** **UCLA's comprehensive library system, with six million books, and a specialized biomedical library, is second in the nation (after Johns Hopkins).**

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

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

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