

FINAL REPORT

Workshop on Development and Learning

NSF/DARPA Grant: IIS # 9900498

Grantees: *John Weng and Ida Stockman*

1. Grant Objectives

This grant was awarded to plan and conduct a workshop on mental development and learning issues that are relevant to both biological and machine systems. The workshop was motivated, in particular, by the budding research area that is dedicated to the idea of building autonomous developmental robots; i.e., machines that develop mental skills through online, real time interactive experiences in the real physical environment. At the same time, recent developments in neuroscience reveal a need for changing traditional rigid views about the way the brain works.

The Workshop was intended to be a catalyst for forming a new alliance among the disciplines concerned with mental development. The Workshop aimed to offer an orientation to issues relevant to autonomous mental development at the same time that it provided a forum for articulating a new research direction and basis for scholarly collaboration across disciplines. This workshop is the first forum that is solely dedicated to the new direction: computational studies of mental development for both higher animals and for machines. It was the organizers' intention to use the Workshop to create the first research community for this new direction -- a community that is expected to participate in advancing this new endeavor in the future.

Details about the Workshop and its document outcomes appear in the appendices to this report. They include

- A. Workshop Proceedings
- B. Workshop Web Site Front Page
- C. Workshop Evening Program Advertisements
- D. MSU Lab Tour Handouts
- E. Workshop Evaluation Ratings
- F. A white paper titled "Computational Autonomous Mental Development" (intended for distribution to the scholarly community and research funding agencies)

These attachments will be sent through regular mail.

2. Workshop Planning and Organization

The Workshop involved 7 months of preparation. The planning activities required us to select and invite participants, solicit and review papers submitted for workshop presentation, specify

workshop activities, schedule and arrange for Workshop space and equipment, participant travel, hotel and food accommodations. To facilitate planning and communication about the workshop, a website (<http://www.cse.msu.edu/dl/>) was established early on. In the month preceding the conference (March, 2000), a pre-workshop email dedicated to the Workshop was created to stimulate discussion on the Workshop themes. This activity resulted in approximately 30 scholarly exchanges. These discussion items have been made publicly available under the “Email Forum” at the WDL web site: (<http://www.cse.msu.edu/dl/>). The Workshop proceedings were also prepared for distribution at the conference. See Appendix A.

All the participants attended by invitation only. Participants were targeted in multiple disciplines that included developmental and cognitive psychology, neuroscience, robotics and artificial intelligence. To select participants, we first identified a list of reputable scholars in multiple disciplines whose work was known to be very relevant to the Workshop’s focus. These potential participants were invited to submit a paper describing some aspect of their work. All of the submitted papers were reviewed by the organizing committee. The accepted submissions appeared in the WDL proceedings as “Related Working Papers.” A few papers were rejected after review, mainly for topic relevance reasons. However, a paper submission was not a requirement for attending the workshop and a few participants did not submit a paper.

3. Workshop Schedule

The workshop was convened April 5-7, 2000 at Michigan State University’s Kellogg Conference and Hotel Center. The participants included more than 30 scholars. Most resided in the U.S.; two were international. See the roster of participant names and affiliations in the Workshop Proceedings, pp. III – VI. The participants represented a variety of disciplines that included robotics, computer vision, machine learning, neuroscience, and developmental and cognitive psychology.

As planned, the first two days of the Workshop were devoted to focal scholarly exchanges in four designated research areas: developmental psychology, computational modeling, neuroscience, and robotics. The third and final day focused on future directions. See program in Workshop Proceedings, pp. 1-5.

Each morning and afternoon session on the first two days was structured to include (1) an overview talk that identified relevant major issues, in a field, (2) short respondent papers that addressed related themes and (3) an hour long spontaneous discussion period. On the third day, an hour-long discussion followed several short overview talks. The last session in the afternoon was devoted to open discussion from the floor.

To structure the Workshop’s content, we identified a specific set of questions/issues that was supposed to guide participant contributions to each session as shown in the Proceedings, pp.6-14. Participants on the program were encouraged to relate their comments and existing research to the questions posed for each session.

An evening program was planned for the first two days. See Appendix B. On the evening of April 5th, Gerald Edelman, Ph.D., M.D. of the Neurosciences Institute (San Diego, CA) delivered a keynote lecture, which was open to the MSU community. On evening of April 6th, Alex Pentland, Ph.D. (M.I.T. Media Laboratory) and Michael Merzenich, Ph.D. (University of California, San Francisco) delivered separate lectures to different audiences. These lectures were followed by visits to several related research laboratories on the MSU campus. See Appendices B and C.

4. Future Action Steps

An open discussion among participants resulted in the following recommendations:

1. Create a website as a repository of development and learning.

Such a repository allows researchers to get and share up-to-date information about new information related to computational studies of mental development. The existing website address at Michigan State University should be maintained for this purpose.

2. Preparation and publication of a “White Paper.”

This suggestion reflected group consensus that the Workshop had called attention to a new research agenda: computational studies of mental development. This white paper will be submitted to NSF, NIH and DARPA. See appendix E. Two magazines have received a draft copy of this white paper:

- a) The *Science* magazine
- b) The *AI* magazine

After initial evaluation, the *Science* magazine expressed interest in publishing this material. The *AI* magazine also expressed interest in publishing an article about the Workshop with material tuned to the AI community.

3. Establishing a regular conference series. The next one is planned in two years, i.e., summer of 2002. Possible conference sites: MIT, Carnegie Mellon University; and Indiana University.

This suggestion reflected group consensus that the Workshop had tapped scholars with enough shared interests and focus to form a community; however solidifying that community requires repeated opportunities to come together to share and clarify common interests. The series of workshop can help the growth of this new research community and promote the advance of this new research area.

5. Workshop Evaluation

Participants provided anonymous feedback about the conference using a standard rating form. See Appendix D. Participants used a 1 to 5 point rating scale to evaluate the adequacy of the workshop for stimulating research ideas, professional collaboration, and expanding perspectives on development and learning. They also rated the adequacy of the scientific/technical sessions, conference schedule and conference facilities. Appendix B shows the rating for each area of evaluation as averaged across 24 of the participants. The ratings ranged from 3.8 to 4.3 and averaged 4.05 (5 = maximum positive rating).

The rating was above average overall and in every category evaluated. The evaluation also summarizes what participants liked most and least about the Workshop. A recurring theme among participants' positive comments was their satisfaction with the opportunity to interact with scholars from multiple disciplines. The most persistent negative comment seemed to be that the conference schedule was filled with too many activities in the short amount of time scheduled for the Workshop. Nonetheless, the generally positive ratings were consistent with many positive informal comments offered by participants following the conference.

In our judgment, the Workshop overall was successful in achieving its immediate goals of stimulating scholarly debate and exchange of ideas about the implication of computational studies of mental development. The Workshop also was successful at seeding a new community of scholars. We were particularly pleased that the Workshop attracted such an elite group of scholars.

6. Budget Report

The projected grant budget allowed us to comfortably meet Workshop expenses, as itemized below. We request that the remaining balance be used for (1) establishing the website on development and learning and (2) making additional copies of the proceedings available free of charge to the research community. We plan to use the remaining fund of about \$1,200 for the creation of the web repository for development and learning as a part of responsibility of the workshop.

Direct Costs

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| Participant Transportation | \$13,200 |
| Participant Lodging | 6,411 |
| Conference Facilities and Equipment | 6,471 |
| Preparation of Proceedings | 1,300 |
| Miscellaneous Supplies and local transportation | 1,000 |
| Paper and Supplies (for conference) | |
| Bus Rental | |
| Postage (mailing proceedings and programs) | |
| Total Direct Costs | 28,468 |

Indirect Costs: 309

\$28,777