Final Assessment Report of the Review of the Cognitive Science Program (Option) July 2013

Review Process

This is the second program review of the Cognitive Science Option. The Cognitive Science Program was last reviewed in 2005. The self-study discussed future plans concerning improved organizational and financial support, a possible new undergraduate degree, changes to the Option, marketing improvements, and increased research activities. The review report did not make specific recommendations, but commented that: (a) adding a major did not seem likely; (b) the program should be housed in Arts; (c) the enrollment numbers are small but the program does well with respect to quality; (d) questions about compensation for the Director needed to be addressed; (e) the University should encourage a sense of belonging to the program and interdisciplinary studies in general.

The two-year progress report indicated that the transfer of the program to the Faculty of Arts along with other university-wide interdisciplinary programs worked well. The Cognitive Science Program began new ways to support interdisciplinary research activities. It has worked closely with the new Centre for Theoretical Neuroscience initiating Waterloo Brain Day.

This self-study was completed by the following process. In July, 2011, the Cognitive Science Program Advisory Board met to discuss the current state of the Program and possible future directions. In April, 2012, all current students in the Program were contacted by email with questions about its strengths and weaknesses and asked for suggestions about improvements. Additional feedback came from former students contacted by email. A draft of the self-study was written by the Director in April, 2012, and then discussed by the Advisory Board at a meeting in May, 2012. A final draft of the study was submitted to the Associate Vice President Academic and Strategic Initiatives on June, 2012, with a copy sent to the Dean of Arts.

The site visit of the review team occurred on September 27, 2012; the review team's report was received January 17, 2013; and the Director's and Dean's response together with an implementation plan, was submitted June 28, 2013.

Historical Overview

The Cognitive Science (COGSCI) Program at the University of Waterloo (UW) began in 1995, with the approval of the Cognitive Science Option, which is like a smaller version of an undergraduate Minor taken by students along with their regular Major. It was expanded in 2001 with the addition of a Graduate Diploma that can be taken by graduate students in conjunction with their Master or Doctoral degrees. In 2011, the University approved conversion of the Option into a Minor, to take effect in September, 2012.

At the University of Waterloo, the main Departments involved in the Program are currently Philosophy, Psychology, English Language and Literature, Computer Science, Systems Design Engineering, Electrical and Computer Engineering, and Biology. There are four main Cognitive Science programs in Ontario: Carleton University, Queen's University, University of Toronto at Scarborough, and York University. The University of Waterloo's program is weaker than these in that it does not offer a degree in Cognitive Science. But a case could be made that UW is stronger than all of them based on the academic quality of the participating faculty members and Departments. Outside Ontario, the main Canadian Cognitive Science Programs are at Simon Fraser University, McGill University, and the Université de Québec á Montréal. The review team acknowledged that UW's cognitive research strength is in the top one-third of universities in Canada.

Currently the Minor in Cognitive Science has no space of its own; has almost no budget; and the program is not an administrative unit, no budget lines for faculty positions, no power to hire faculty members for the program, and so on.

Program Objectives

The primary goal of the Cognitive Science Program is to foster teaching and research in Cognitive Science, which is the interdisciplinary study of mind and intelligence. The aim of the Cognitive Science Option is that undergraduates who complete it will be able to recognize, distinguish, and critique the concepts and methods used by different disciplines to understand how the mind works. The main desired learning outcomes concern: cognitive concepts, cognitive methods, interdisciplinary connections, and practical applications. The new Minor has the same desired outcomes.

Cognitive Concepts
By the end of the Option, students will:
- grasp fundamental concepts such as mental representation and processing;
- understand computational and neural mechanisms that underlie thinking;
- demonstrate ability to assess the strengths and weaknesses of different theories of mind.

Cognitive Methods
By the end of the Option, students will:
- recognize and distinguish experimental methods in Psychology, Neuroscience, Linguistics, and Psychology;
- understand how computational models contribute to cognitive theorizing;
- be able to analyze and evaluate philosophical arguments concerning theories of mind.

Interdisciplinary Connections
By the end of the Option, students will:
- compare and contrast the cognitive concepts and methods from different disciplines;
- grasp the advantages of taking an interdisciplinary approach to the study of mind;
- be able to analyze and evaluate interdisciplinary ideas.

Practical Applications
By the end of the Option, students will:

- identify the practical areas in which cognitive science has applications, including education, management, robotics, and mental health;
- grasp the advantages of pursuing applications using interdisciplinary concepts and methods.

Academic Programs Offered

The Cognitive Science Program at UW includes:
- Cognitive Science Option (until August 31, 2012): four required plus three optional courses;
- Cognitive Science Minor (after September 1, 2012): four required plus four optional courses;
- Cognitive Science Graduate Diploma: four courses including COGSCI 600.

The two special courses for the Option are PHIL/PSYCH 256 and PHIL/PSYCH 447. PHIL/PSYCH 256 reflects the current state of Cognitive Science by providing a broad overview of how Psychology, Neuroscience, Linguistics, Anthropology, Artificial Intelligence, and Philosophy interact to increase understanding of mental processes. PHIL/PSYCH 447 is a much smaller seminar on a special topic each year that leads students in a state-of-the-art investigation of a cognitive topic of current interest, such as consciousness or creativity.

Students

From 1995 to 2012, 166 students had enrolled for the Cognitive Science Option, with 86 since 2005. Annually, from 2005 to 2011 inclusive, an average of 11 students had enrolled in the Option, from a high in 2005 of 16 students to a low of seven in 2007. These data are based on applications to the Director. Of the 79 students enrolled in the program, between 2005 and 2011 inclusive, 21 came from Computer Science, 17 from Software Engineering, 11 from Psychology, and 10 from Systems Design Engineering. Five of the six Faculties at UW have students enrolled in the Option.

With the exception of some of the Psychology students and the dozen or so students just mentioned, all the students in the Option have strong computational and mathematical backgrounds. This has two implications: firstly, students in the program are mostly very strong in general; and secondly, this very strength has probably played a role in the program not growing faster; it is an intimidating program for students without such a background.

Between 2005 and 2011 inclusive, 78 students graduated with the Cognitive Science Option – an annual average of 11. The largest number of graduates was 19 in 2005, and the least was six in 2010. Approximately 18% of these students graduated on their Dean's Honours Lists. Of the 53 students enrolled in the Option, from 2005 to 2009 inclusive, 46 graduated for a completion rate of 86%.

Students of Cognitive Science viewed the strengths and weaknesses of the Option as follows:

Strengths:

- Gave a good integration with technical fields such as Computer Science and Engineering;
- Provided a good interdisciplinary view of Cognitive Science;
- Allowed students the opportunity to learn about others points of view and the different approaches people use in problem solving.

Weaknesses:

- Choice of courses was limited by Major and co-op;
- The Option could benefit from more applications of the lecture material;
- The lack of a suitable accessible machine intelligence course. All courses in the list from which students can select as possible machine intelligence courses have prerequisities indicating that they are either only available to Computer Science or Engineering students. This makes them inaccessible to students in other Departments.

Improvements suggested by students were:

- Offer courses more frequently;
- Offer another required discussion-based course to emphasize the cross disciplinary nature of the Option;
- Make the different disciplines' subject matter more related to the Option so that the "bigger picture" can be seen;
- Foster a student community.

Faculty

The Cognitive Science has a Director who is a Professor of Philosophy, and an Advisory Board of five faculty members from five different Departments from three different Faculties. The Program has no support staff but currently is serviced by staff members in Women's Studies and the Department of Philosophy. In addition, there is no dedicated financial support. The Faculty of Arts has generously provided support for "Waterloo Brain Day" and "Waterloo Ignorance Day". The reviewers noted that the "programme is remarkably starved for resources."

Of the faculty members most involved with Cognitive Science, one comes from Philosophy, one from Psychology/ Systems Design Engineering, one from English Language and Literature, and the fourth from Electrical and Computer Engineering.

Collectively they have published three books; 11 edited books; 22 book chapters; 156 refereed journal articles; 183 refereed conference proceedings; over 60 conference proceeding, and many other publications/ workshops/ invited talks etc. In total, they are editors, associate editors, or on the editorial boards of at least 20 academic journals. They are also sought as reviewers for many different academic journals, university presses, and granting agencies. In addition they have had many honours: Canada Research Chair, University Chair (UW); Fellow of the Cognitive Science Society; Canada Council for the Arts, Molson Prize for Social Sciences and Humanities; Fellow of the Association for Psychological Science; Fellow of the Canadian Academy of Engineering; Fellow of the Engineering Institute of Canada; and Fellow of the International Association of Pattern Recognition.

Issues and Opportunities for Improvement

Cognitive Science faces a variety of issues over the next five years. The self-study made several recommendations, which the review team endorses:

Recommendation 1: that the new Cognitive Science Minor be closely monitored to determine whether it is sufficiently accessible and doable.

Recommendation 2: that the Cognitive Science Advisory Board begin to discuss a post-2014 transition to a new Director together with arrangements for teaching core Cognitive Science courses since the present Director's term finishes in 2014.

Recommendation 3: that the Dean of Arts be requested to provide a dedicated faculty position for Cognitive Science, in either of the Philosophy or Psychology Departments, effective September 1, 2015. [This particular recommendation was especially strongly endorsed by the review team].

The following additional recommendations were made by the review team:

Recommendation 4: The review team noted that Cognitive Science gives Arts students (especially those in Psychology and Philosophy) access to the Cognitive Science area, which they could apply to a great many areas of specialization. At the same time, a Cognitive Science Minor gives Engineering and Computer Science students a unique perspective on the areas of Psychology and Philosophy. Because of these reasons, a Minor should continue to be offered.

Recommendation 5: that steps be taken immediately to begin to build a Cognitive Science community in the University.

Recommendation 6: that the teaching of PHIL/PSYCH 256 and PSYCH 447 be continued.

Recommendation 7: that UW develops a machine intelligence course for a non-technical audience.

Recommendation 8: that the problem be rectified that students with little computational background cannot do any of the courses in the fourth group of the "three of the following" section of the requirements for the Minor.

Recommendation 9: that the University establishes a task force charged with planning a proper Cognitive Science degree program.

Program Response
The Program response focused on the six questions raised by the review team, which relate to varying degrees to the recommendations listed above.

1. Strengthening the Cognitive Science Minor (Recommendations 1, 4, 5, 6, 7, 8)
The program recognizes that the Cognitive Science Minor has to be a doable, attractive option to invite enrollment by suitably qualified students.

a) Better publicizing of the Minor will be achieved by (i) annual meetings of the Director with undergraduate organizations in the departments that have provided most students to the minor and the previous option. (ii) Students taking PHIL/PSYCH 256 by Extended Learning will be directly informed of the existence of the Cognitive Science Minor.

➔Implementation: The Director will engage student groups as required, beginning in fall 2013. This will be ongoing.

b) In order to make it easier for students to satisfy the Minor requirements, the range of courses should be expanded to include additional courses such as the following: BIOL 377 (Systems neuroscience: from neurons to behavior); INTEG 251 (Nature of scientific knowledge); SYDE 433 (Conflict resolution). These courses are already on the books.

➔Implementation: The Director will submit a revision of the Minor requirements to UGAG in fall 2013.

c) Another way of making it easier for students to satisfy the requirements would be the addition of a non-technical course on machine intelligence to provide another way of satisfying the "three of" section of the requirements for the Cognitive Science Minor. The course on human and machine intelligence discussed under question 3 below would fill this role.

➔Implementation: In fall, 2013, the Director will discuss the feasibility of this new course with the Cognitive Science Advisory Board and relevant department chairs.

d) In order to raise the visibility of the Cognitive Science Program beyond Waterloo Brain Day and Waterloo Ignorance Day, we should arrange to have 2 Cognitive Science speakers per year, one in each of the fall and winter terms. Initially, this could be done in coordination with relevant departments and the Centre for Theoretical Neuroscience. Funds should be sought from the Dean and/or Provost.

➔Implementation: The Director will initiate discussion with the Dean of Arts and/or Provost in fall 2013.

2. Additional resources for the Cognitive Science program (Recommendations 3, 5)
 A faculty position should be requested from the Dean of Arts and/or Provost for a specific appointment in Cognitive Science, joint with a relevant department. To attract an outstanding candidate, a Canada Research Chair would be ideal.

➔ Implementation: The Director will initiate discussion with the Dean of Arts and/or Provost in fall 2013.

3. Introduction of a course in machine intelligence accessible to non-technical students (Recommendation 7)
A non-technical course on machine intelligence does not seem feasible because training in that field requires programming experience beyond the reach of most students in arts and sciences. However, there is a great opportunity for a new interdisciplinary course that discusses similarities and differences in intelligent processes found in people, nonhuman animals, and computers. Topics will include problem solving, learning, language, and consciousness.

➔Implementation: In fall 2013, the Director will discuss the feasibility of this new course with the Cognitive Science Advisory Board and relevant department chairs.

4. Connection with Knowledge Integration Program (Recommendation 5)

There are clear overlaps between Knowledge Integration's ambitions and the interdisciplinary field of cognitive science.

➜ Implementation: The Directors of the two programs will meet in fall 2013 to discuss possible cooperation between the programs.

5. Creation of a task force to discuss establishment of a Cognitive Science degree program (Recommendations 5, 9)

Eventually, we would like to see the Cognitive Science Program expanded to offer a Major in Cognitive Science in addition to the Minor. This aim is complicated by the fact that a large proportion of the students taking the Minor come from Engineering and Mathematics, whereas a Major in cognitive science would most naturally be organized in the Faculty of Arts.

➜ Implementation: The Director will spend the next two years focusing on increasing enrollment in the Minor. Once this occurs, he will strike a task force concerned with establishing a Major.

6. Long term management of the Cognitive Science Program (Recommendation 2)

This issue will become acute when Paul Thagard ends his 20-year stint as Director at the end of 2014. A search for a new director will begin in September, 2014, initially by emailing all 40 faculty associated with the program to invite them to apply. The search committee will be the Cognitive Science Program Advisory Board. Once a new director is selected, negotiations will be required with relevant departments to ensure continued teaching of cognitive science courses, including PHIL/PSYCH 256, PHIL/PSYCH 447, COGSCI 600, and – if it has been developed – COGSCI 300.

➜ Implementation: The Cognitive Science Program Advisory Board will start the selection process in September, 2014.