

Symbolic Systems Program Self-study

November 1, 2007

Section 1 – Introduction

The Symbolic Systems Program (SSP) focuses on the relationships between computation and intelligence in both artificial and natural systems that use symbols to represent information – hence the name “symbolic systems”. Examples of symbolic systems include computer programs, natural languages (e.g. English, Spanish), logic, human minds, the Internet, and mind-machine systems in which humans and computers interact. These different systems are related to each other through concepts that appear throughout our core curriculum, such as computation, representation, communication, learning, and intelligence.

There are three main ways in which computation and intelligence can be related to each other, which are reflected in three distinct areas of study for which the SSP core curriculum is good preparation:

- **cognitive science:** studying human intelligence, natural languages, and the brain as computational processes;
- **artificial intelligence:** endowing computers with human-like behavior and understanding; *and*
- **human-computer interaction:** designing computer software and interfaces that work well with human users.

SSP was formed as an outgrowth of the Center for the Study of Language and Information (CSLI), which was established in 1983 as a locus for interdisciplinary research in linguistics, philosophy, computer science, and psychology. In 1985, Tom Wasow, then Associate Director of CSLI, assembled a committee to develop an undergraduate program reflecting the research agenda of CSLI. The other members of the committee were Jon Barwise (Philosophy), Herb Clark (Psychology), John Etchemendy (Philosophy), Stuart Reges (Computer Science), and Ivan Sag (Linguistics). Out of this committee came SSP, which has been authorized to grant degrees since 1986. It has been reviewed three times, in 1990, 1997, and 2002. A master's program in SSP was approved by the Faculty Senate in 2001 and was reauthorized after a mini-review in 2005 (scheduled in anticipation of a synchronized review of the two degree programs in 2007-2008).

In the years since its inception, SSP has become a vibrant extended community of students, faculty, and alumni. The program attracts students with strong interdisciplinary skills and interests, and unusual drive. Our graduates typically do very well, whether they are applying to Ph.D. programs (in many different fields), starting companies, becoming engineers, going to professional schools, or pursuing careers that seem unrelated to their major.

Section 2 – Mission

2.1 Intellectual Rationale

Symbolic Systems' affiliated faculty come from several departments at Stanford, including Computer Science, Linguistics, Philosophy, Psychology, Communication, and Education. Our students are exposed to the tools of these disciplines -- formal methods, philosophical analysis, computer programming, and empirical research -- with the aim of being able to apply the appropriate tool(s) to a chosen concentration (area of specialization).

SSP provides a package of courses, faculty, and themes that is unusual among universities. This is not to say that the topics our students study, or even the courses they take, are not offered at many other highly selective universities and colleges. All of the core courses, and most of those that students take in their areas of concentration, are standardly offered at other universities, and almost all are drawn from departmental offerings that are also parts of other degree programs at Stanford. What is unusual about SSP, relative to other universities, is the joining of fields that relate computation and cognition in all of the three ways noted above. At other universities, with the possible exception of Indiana, students must generally choose a separate degree program, and at an earlier stage, in order to study at least one of the three main areas of intersection between cognition and computation.

2.2 The Name and Identity of the Program

With the exception of Arizona State University, which has a certificate program in Symbolic Systems within its Philosophy Department, the name “Symbolic Systems” is unique among degree programs at major universities. Having an unusual name has its advantages and disadvantages, both institutionally and for students. On the minus side, some alumni and students complain that it is difficult to explain to others, including potential employers, what their degree is about. The Director has taken to addressing this each year in his commencement speech, by explaining the focus of the major and its different branches, and we have made an effort to simplify the description on our website's homepage. We take comfort in the fact that the program's name seems to open more doors for our majors than it closes, and they get a lot of practice at explaining it. On the plus side, maintaining a unique name has allowed the program to define itself in a way that is less likely to get confused with other universities' programs in the still unsettled landscape of the cognitive and information sciences, and to maintain a curriculum that is well-suited to undergraduates and transitioning master's students.

Cognitive science, for example, has been instantiated quite differently at universities that have created departments with that name. Three of the top departments with “cognitive science” in their names are at MIT, UCSD, and Brown. At MIT, the Department of Brain and Cognitive Sciences has a clear emphasis on human cognition and neuroscience, with no faculty who do human-computer interaction (HCI). At UCSD, by contrast, the Cognitive Science Department includes a substantial fraction of faculty and students who do HCI, and computational neuroscience is a separate institute. At both universities, linguists (other than psycholinguists) generally work in departments different from cognitive science, but at Brown, cognition and linguistics are grouped together in the

Department of Cognitive and Linguistic Sciences. The fact that departments with “cognitive science” in their names often conjoin it with another word (e.g. “brain”, “linguistic”, “information” - see below) reflects the fact that this field comes in different flavors, as shown by the very different undergraduate curricula at UCSD, MIT, Brown, and Indiana, the last of which (a program, not a department) is the closest to SSP's.¹

The majority of SSP students actually focus on applied computing. In addition to HCI, this includes computational linguistics and artificial intelligence, both of which are sometimes included within broad definitions of cognitive science, but are not substantially represented in departments with that name and are usually found in other departments even at those universities (still the minority) which have a “cognitive science” department. So while the phrase “cognitive science” is more familiar than “symbolic systems”, describing SSP as “a cognitive science program” is misleading given the way our program has historically evolved. A more accurate statement is that Symbolic Systems provides students who want to specialize in fields relating computation and cognition, including cognitive science and neuroscience, a theoretical foundation for doing so. Other Stanford undergraduates who want to study cognitive science or neuroscience might be better served majoring in Biological Sciences, Human Biology, Psychology, or one of the engineering majors related to biology. Such students would acquire a foundation that is different from that of Symbolic Systems students. Separating the paths of preparation in this way allows students to choose the angle that best suits them. In SSP, we seek students who are inclined toward computational, mathematical, and philosophical analysis. This requires a background that would be difficult to combine with the chemistry and physics that is generally required for students of biology, for example. Hence our task when students who are interested in cognitive science enter the major is to make sure that Symbolic Systems is the right angle for them given their aptitudes and interests, and to discourage students who might major in Symbolic Systems merely because they see that cognitive science and neuroscience are concentration options within the major.

Other emerging interdisciplinary fields to which Symbolic Systems has many connections include “informatics” and “information science”. Stanford does not have a program or department in either of these areas exactly, although it does have a Biomedical Informatics Program in the Medical School, led by SSP-affiliated Professor Russ Altman. Faculty in HCI in particular are now often found in schools and departments of information at other universities, such as UC Berkeley, Michigan, and the University of Washington. Information schools have recently gotten together in conferences organized by the iSchool Project to further define this field, which increasingly overlaps with that of communication as well as HCI.² As mass media are giving way to the Internet, communication departments are putting more emphasis on HCI. While Stanford lacks an

¹ For Brown's Cognitive Science and Linguistics Department, see <http://www.cog.brown.edu/undergrad.html>; for Indiana's Cognitive Science Program, see <http://www.cogs.indiana.edu/underg/degree.html>; for MIT's Brain and Cognitive Sciences Department, see http://web.mit.edu/bcs/academics/undergrad_undergradrequirements.shtml; and for UCSD's Cognitive Sciences Department, see <http://www.cogsci.ucsd.edu/index.php?cat=undergrads&page=major>.

² See <http://www.ischools.org/oc/>.

“i-school”, our Communication Department is in the forefront of social science approaches to HCI, led by SSP-affiliated faculty Clifford Nass and Byron Reeves. SSP thus connects students with the fields of information and communication as they exist at Stanford, as well as with HCI researchers in CS (Terry Winograd and Scott Klemmer) and Management Science and Engineering (Pamela Hinds).

If we wanted to change the name of our program in a way that describes and maintains its current focus and attraction for students, two possibilities would be “Cognitive Informatics” or “Cognitive and Information Sciences”. Both of these phrases have appeared elsewhere and have been defined by some to be equivalent,³ but the latter phrase is more often used by people who have connections to our program.⁴ A name change might become necessary if and when “symbolic systems” no longer accurately describes the focus of the major. For now “symbolic systems” remains apt because it reflects the fact that our core curriculum is built around symbols and discrete mathematics. Focusing the core in this way is an efficient way to give our students an understanding of how philosophical problems can be analyzed and turned into mathematical, computational, and empirical questions. Once they have seen this, our students follow their own trajectories that emphasize one or more of these methodologies or that generalize their application, for example, to continuous state spaces. Although we think “symbolic systems” is still a good and descriptive name for our program, we plan to discuss the possibility of a name change with our faculty program committee, and may propose it if many faculty, students, and alumni, after some deliberation, think it is a good idea. In preliminary discussions with our undergraduate Advising Fellows, one point that was raised against a name change was that “symbolic systems” accurately connotes the mathematical and theoretical orientation of our program in a way that “cognitive and information sciences” might not.

2.3 Goals for Undergraduate Majors

We have found, over the 21 years since the program began, that undergraduates who are declaring the Symbolic Systems major are often not yet able to specify which aspect of the mind-computation relationship interests them most, but that they generally know that symbolic systems represents the space of issues that interest them most. Indeed, many of our students maintain an interest in more than one of the three areas throughout their

³ See for example <http://csdl.computer.org/comp/proceedings/icci/2003/1986/00/19860114abs.htm> and <http://www.pnl.gov/cogInformatics/>.

⁴ “Cognitive and Information Sciences” appears in the title of two of the core courses in the Cognitive Science Program at Indiana University, whose curriculum is the probably the most SSP's. It is also the name of a department at Chiba University in Japan. In both the Indiana and the Chiba case, there are institutional connections. One of SSP's founding committee members, Jon Barwise, left Stanford for Indiana a few years after SSP was founded and, together with another former-SSP affiliate, Brian Cantwell Smith, had a large impact in defining the curriculum at Indiana. In fact, Barwise co-authored the proposal that led to the undergraduate degree in cognitive science at Indiana, and in that proposal it was recommended that the program be called “Cognitive and Information Sciences” (see <http://cognitn.psych.indiana.edu/rgoldsto/degree.html>). Two of the five primary faculty in Chiba's Department of Cognitive and Information Sciences have worked with SSP-affiliated researchers: Syun Tutiya and Makoto Kanazawa.

studies, doing, for example, an honors thesis studying human cognition experimentally, but then entering the workforce doing web programming or design.

In place of a curriculum that is specifically geared toward one of the three areas from the beginning, we provide a core of required courses the goals of which are (a) to provide a solid foundation for each of our concentration areas and (b) to help students decide on a concentration area. The criterion for inclusion in the core is that a course must be deemed useful preparation for later study in any of the concentrations. Other courses are generally placed in the lists of suggested concentrations. Students who graduate with a B.S. in Symbolic Systems should be:

- well prepared either for graduate study in one of several disciplines or for employment in an area related to humans and computers;
- endowed with skills from, and an appreciation for each of our core disciplines (computer science, philosophy, linguistics, psychology, and statistics), as well as with an ability to see connections between these methods and disciplines; and
- able to identify a good match between their personal talents and the many opportunities that graduates of our program have, in industry, academia, the professions, public service, and beyond, and to plan their future in an informed way.

The SSP curriculum (core plus a concentration) generally qualifies students for entry into several different graduate programs at both the Master's and Ph.D. levels. We have placed majors in graduate programs in Computer Science, Information Science, Informatics, Psychology, Communication, Cognitive Science, Management Science and Engineering, Education, Philosophy, Business, Linguistics, Statistics, Mathematics, Public Policy, and Neuroscience, to list the ones of which we are aware.

Almost all of the faculty in SSP were trained within the traditional disciplines, but have professional interests that spill over into neighboring fields. Most feel that their research agendas could be carried out better if they had had a more thoroughly interdisciplinary education. The hope is that, if students at the undergraduate level get the sort of preparation the faculty wished they themselves had, then the next generation of researchers will be able to accelerate the rate of progress in these developing areas.

We also recognize that most of our students will not go on to careers in basic research. Whether students go into the software/Internet industry (as many do) or end up doing something only tangentially related to the central subject matter of SSP, we believe that the variety of modes of inquiry included in the SSP core serves them well. Developing a broad range of problem-solving skills – from computer programming to philosophical discourse – gives our students an intellectual versatility that is very broadly applicable.

2.4 Goals for Master's Students

The master's program in SSP was created in 2001 in response to student lobbying for a coterminal option in Symbolic Systems. The program was initially restricted to current Stanford undergraduates and those with a completed B.S. in Symbolic Systems from Stanford. We have recently, with authorization from the Dean, opened admissions to students from outside Stanford, and our program committee approved a redesign of the

master's program to accommodate the needs of outside students. The program heavily emphasizes a research project requirement and a close working relationship between the student and his/her project advisor.

The master's program serves roughly two types of students: (a) those who seek deeper preparation than they received in their undergraduate program in order to apply to a Ph.D. program in an area related to SSP, and (b) those who seek the kind of credential needed to land technical, applied research, or design positions in industry related to SSP, but normally reserved for those with a graduate degree or experience beyond the bachelor's degree. For all master's students, an initial goal is to achieve competence in symbolic systems equivalent to our undergraduate core. Beyond that, students are expected (1) to complete an interdisciplinary course program bearing on their research project and chosen in consultation with their M.S. advisor, and (2) to complete the project working closely with their advisor. Master's students in our program sometimes acquire some teaching experience as well, generally through TA-ships.

2.5 Measuring the Success of Students

SSP alums are found in various occupations, including software design and applications, teaching and research, law, medicine, and public service. We measure our success by theirs, both before and after they graduate. The director and associate director keep in regular contact with our students and alumni through events such as post-forum dinners at Wilbur Hall (site of the Symbolic Systems and Related Majors focus house, Arroyo), twice-yearly barbecues, office visits, weekly meetings with our undergraduate advising fellows, and the interactive profile feature of our website. We ask each graduate to tell us what their post-commencement plans are, and the director reads these at the ceremony, giving us a sense of where our new graduates are headed each year.

As a measure of success while completing the undergraduate degree, Symbolic Systems B.S. graduates generally outpace the campus-wide 10% benchmark for election to Phi Beta Kappa. In the years since our last review (2002-2007), the percentage of PBK graduates in SSP was 14.8% (38 out of 256).⁵ Curricular changes made at around the time of our last undergraduate program review appear to have substantially reduced the number and percentage of our students who encounter serious academic difficulty. We believe this was accomplished by some tightening of the requirements. We enacted these curricular changes because we concluded that some students had been lured into a major that was not suited for them, perhaps by counting the number of difficult technical courses (especially in logic and computer programming), rather than by assessing the difficulty of the courses that were required. The change in requirements was not motivated purely or even primarily by a desire to weed out less technically inclined students, but it had that effect, and the students who have declared since that time have been more successful on average.

The undergraduate major reached a peak in popularity early in the present decade, in parallel with the nationwide surge in computer science majors during the "Internet

⁵ The figures for 2006-2007 were not included in the OVERVIEW provided by the Deanery for this review (Appendix 1). For 2006-2007, our records indicate that we had 46 B.S. graduates, of whom 11 were elected to Phi Beta Kappa.

bubble” that ended around 2001.⁶ SSP has fluctuated historically in popularity, reaching a low point prior to the bubble of 14 graduates in 1995. The recent numbers of B.S. recipients in SSP (31 in 2004-2005, 27 in 2005-2006, and 46 in 2006-2007) are in line with what we think of as our “steady state” - i.e. when most of the students who graduate in Symbolic Systems are well suited to the major.

A more long-term measure of success is what our alumni do after graduating from our program. Although we do not have exact statistics for comparison with other majors, and potential response biases make it hard to generalize statistically to our entire alumni population, our survey results (see Section 4) show what we believe to be an unusually high number of students enrolled who are enrolled in or have completed Ph.D. programs in a wide variety of fields.

Many of our alumni have gone into top programs in cognitive science, neuroscience, or psychology, for example. They and their faculty supervisors have often reported that the strong theoretical and programming background provided in the Symbolic Systems core has been crucial to the students' success as researchers in fields where others lack this background. Matt Kaufman (B.S. 2005) is currently a Ph.D. student in Neuroscience at Stanford. Matt's survey response reports that [SSP-affiliated Professor] “Bill Newsome (then-head of Neuro) told me on my grad school interview that he thought SymSys was the ideal preparation for neuro.” Bill repeated this assertion to us following a talk he gave in our weekly Symbolic Systems Forum series last spring, explaining that it is more valuable for students who want to study systems or computational neurobiology to get a solid mathematical and computing background as undergraduates than it is for them to focus on chemical and biological foundations, which can be studied once they get to graduate school. The many recent graduates we currently have in top Neuroscience, Cognitive Science, and Psychology Ph.D. programs (e.g. at MIT, Harvard, UCSD, Yale, Berkeley, Stanford, and Washington), as well as faculty placements at Princeton, Berkeley, Northwestern, and Colorado, provide a strong indication that our program works for students who want to study these fields.

SSP Alumni who go into computer science graduate programs also benefit from a core curriculum that gives them many fundamentals of an undergraduate degree in computer science, but with an emphasis on theory and its relationship to cognition and language. Because our undergraduate curriculum is generally sufficient preparation for entering a Ph.D. program in computer science, SSP majors who enter such programs are able to fill in the parts of computer science that are left out of the SSP core once they get to graduate school. Such students generally focus on artificial intelligence, natural language processing, or human-computer interaction as graduate students, and each of these areas is informed by courses in our core and concentration curricula that are not included in the Computer Science major, e.g. Introduction to Cognition and the Brain (Psych 55), Introduction to Syntax (Ling 120), and Computers and Interfaces (Comm 169). Again, since it is harder for a Ph.D. student to acquire a broad out-of-department background than it is for an

⁶ We had 54 graduates in 2001-2002, 57 in 2002-2003, and 41 in 2003-2004. We infer that the peak lagged the end of the Internet bubble because students commit to a major a few years before they graduate, and many students graduate one or more quarters later than their fourth undergraduate year.

undergraduate, students who desire this background appear to have been well served by majoring in SSP prior to specializing in graduate school. The testimonial of Michael Bernstein ('06) in his survey response illustrates this (see Appendix 4). Recent graduates have gone into Ph.D. programs in computer science at Berkeley, MIT, Stanford, and CMU.

While SSP sends its share of students to Ph.D. programs and, if anything, the percentage has increased in recent years, the largest grouping of SSP alumni still appears to consist of those who go into some aspect of the software industry, either directly or after a master's degree at Stanford or elsewhere. A substantial minority of these students do co-terminal master's programs in addition to completing our undergraduate degree. The master's degree, including SSP's own master's program, provides many of our majors with a chance to hone their skills in a way that makes them very competitive for industry positions such as product manager, interaction designer, and applied researcher. Such positions are difficult to land for students graduating with just a B.S. and little experience. But students who enter the workforce with just a B.S. in Symbolic Systems do quite well also. In general, our alumni who work in software and digital media industries report that the breadth of methods and styles of thinking to which they were exposed as undergraduates in Symbolic Systems has had durable benefit for them in their careers. Our core emphasizes knowledge that has withstood the test of time, and methods that are broadly applicable to the kinds of problems alumni encounter in industry, e.g. How can I design this interface so that people will find it easy to use?, How can I construct a scheme for the problem I am addressing that will be robust?, or How can I test the effects of my design on users?

We have an especially high percentage of graduates who have founded or been early employees of start-up companies, including half of the founders of Excite and very early employees at Yahoo! and Google in the 1990s, and more recently the founders of well-known startups Plaxo (Todd Masonis, '01), Meebo (Elaine Wherry, '01), iMeem (Dalton Caldwell, '03), and Powerset (Barney Pell, '89), and a very early employee of Facebook (Ezra Callahan '03).

Yet another substantial grouping of SSP alumni consists of those who go into a field other than one of our cognate disciplines. Each year we send students to professional schools such as Law, Medicine, Business, and Education. Law in particular has been popular among our recent grads. For these students, Symbolic Systems provides a solid analytical education that prepares them to think rigorously, empirically, practically, incisively, and with an appreciation for the humanistic angle on cognition and computation.

Our master's program alumni have also done quite well, and since there are far fewer of them, we have an easier time keeping track of each one after graduation. Of the 16 students who have graduated from our master's program since 2002, five are currently enrolled in Ph.D. programs (Jeff Cooper, MS '02, Stanford Psychology; David Danielson, MS '02, Stanford Communication; Alex Gruenstein, MS '03, MIT Computer Science; Heesoo Kim, MS '05, Berkeley Neuroscience; and Anna Rafferty, MS '07, CMU Human Computer Interaction Institute). Nine were working in industry when we last heard of or from them, including Kent Griffin (MS '03, user interface designer at Paypal), Raja Shah (MS '03, Product Manager at Google), Joseph Smarr (MS '03, Chief Platform Architect at

Plaxo), Andrew Waterman (MS '03, managing development of Emerginginvest.com), Sheba Najmi (MS '04, interaction designer at Yahoo!), Heather Pon-Barry (MS '04, researcher at Robert Bosch Research and Technology Center), Tanya Breshears (MS '06, Software Developer at Asurion Mobile Applications), Brendan O'Connor (MS '06, software developer at Powerset), Tony Tulathimutte (MS '06, User Experience Researcher at Bolt Peters). One is working in a university research laboratory (Dean Eckles, MS '07, Mobile Research Specialist at Stanford Persuasive Technology Lab). The remaining M.S. grad (Geoffrey Morris, MS '06) has not been heard from by our program since he graduated a year and a half ago. One student (Christopher Cox, BS '04) matriculated into the M.S. program but dropped out after one quarter to take a position at Facebook in October 2005.

We judge our master's alumni in general to have successfully applied their educations in our program because almost all of them are in positions, either in a university or in industry, that are fairly closely related to their graduate training in SSP. This trend was noted during our abbreviated M.S. program review in 2004-2005, and appears to be continuing with our recent graduates.

Section 3 Evaluation of Undergraduate and Graduate Programs

3.1 Intellectual Coherence of Curriculum

(a) Were changes made to the curriculum as a result of the last curriculum review?

There were two primary suggestions made by the Curriculum Committee during the 2001-2002 review. The first was the hope that we would “seriously consider making SSP 100 the required gateway course for all majors.” We discussed this for a long time with our Program Committee and the result was the replacement of the Interdisciplinary Cognitive Science requirement (either Symsys 100 or a higher level course bridging two departments chosen from a list of 4 or 5 courses) with the requirement that all majors take Symsys 100, beginning with this year's Bulletin. The requirement is being phased in, so that students who declare the major through Autumn of 2007 will be able to choose between the old and the new requirement. Changing this requirement was part of a larger overhaul in our undergraduate core approved by our program committee in the Spring of 2007 – the largest such overhaul since 2001. Requiring Symsys 100 has been challenging in part because we felt that many students and some faculty who take and teach (respectively) other courses that were alternatives to Symsys 100 were benefiting from the requirement as it existed before. We found a way to integrate most of those alternative courses, as new ways of satisfying the language/linguistics requirements of the revised core. Together with making Symsys 100 a requirement, we are beginning a process of redefining the course in response to criticisms that it is not providing the kind of interdisciplinary glue that it was created to be.

The second suggestion was the hope that “the program can work to create a course (even in more than one section) which provides a culminating experience for all its seniors.” We do require students to take an advanced small seminar. These courses are certified by the program each year as building on our core at a more advanced level, being small, and involving substantial student interaction with the instructor. We offer one or two such courses each year under the Symbolic Systems listing, and the rest are culled from

department offerings. Because our students specialize in different areas, by the end of their undergraduate careers they have developed quite distinct interests. It is our feeling that they benefit more from being able to choose an advanced seminar in their area of interest than from being in a course which every SSP major must take. With the new core requirements, to which we are transitioning, our plan is to ensure that each concentration will include one or more advanced small seminar options, displayed prominently within the list of requirements for each concentration. We will be working with faculty over the next two months to create these new lists.

(b) What is the underlying logic or intellectual coherence behind the organization and sequencing of courses in the curriculum? Do you have core and capstone courses that are taught on a regular basis?

The major is divided into a core, which all students must complete, and concentrations, from which each student must choose one. The core consists of courses that have been deemed important for students with any of the three main interest areas noted in Section 2: cognitive science, artificial intelligence, and human computer interaction. Courses that are important only for one or two of these areas are typically listed in the suggested concentrations.

The SSP core curriculum has several components. In the revised core, to which we are transitioning this year, and which appears in the 2007-2008 Bulletin, these components are as follows:

Cognitive Science

- Introduction to Cognitive Science (Symsys 100)

Computer Programming

- Programming Methodology (CS 106a) and Programming Abstractions (CS 106b); or Programming Methodology and Abstractions (Accelerated) (CS 106x); and
- Programming Paradigms (CS 107)

Logic

- (a) Basic Concepts in Mathematical Logic (Phil 150) (formerly Phil 159) *or* (b) Basic Concepts in Mathematical Logic (Phil 150X) (formerly Phil 159X) *and either* Discrete Mathematics for Computer Science (CS 103A) *or* Discrete Structures (Accelerated) (CS 103X); and
- First-Order Logic (Phil 151) (formerly Phil 160A)

Computational Theory

- Discrete Structures (CS 103B) or Discrete Structures (Accelerated) (CS 103X); and
- One of the following: Introduction to Automata and Complexity Theory (CS 154) or Computability and Logic (Phil 152) (formerly Phil 160B)

Probability

- One of the following: Probability, Induction, Statistics (Stat 121), Theory of Probability (Stat 116), Statistical Methods in Engineering and the Physical Sciences (Stat 110), Probabilistic Analysis (Management Science and Engineering 120), Introduction to Probability and Statistics (EE 178), Introduction to

Probability Theory (Math 151), or Introduction to Probability and Statistics for Engineers (CME 106/Engr 155C)

Philosophical Foundations

- An introductory course in Philosophy, to be taken prior to Phil 80, from among the following: God, Self, and World (Phil 10), Introduction to Moral Philosophy (Phil 20), Introduction to Political Philosophy (Phil 30), Introduction to Philosophy of Science (Phil 60), Modern Philosophy, Descartes to Kant (Phil 102), The Fate of Reason (IHum 23A and 23B -- *must complete both*)
- Mind, Matter and Meaning (Phil 80)

Cognitive Psychology

- Introduction to Cognition and the Brain (Psych 55) or Introduction to Cognitive Psychology (Psych 40)

Language and Mind

- One of the following: Introduction to Linguistics (Ling 1), Language Acquisition I (Ling 140), Language and Thought (Psych 131), Birds to Words: Cognition, Communication, and Language (Psych 137), or Philosophy of Language (Phil 181)

Linguistic Theory

- One of the following: Introduction to Syntax (Ling 120), Introduction to Linguistic Meaning (Ling 130A), Introduction to Computational Linguistics (Ling 180), or Introduction to Semantics and Pragmatics (Ling 230A)

Artificial Intelligence

- Introduction to Artificial Intelligence (CS 121) or Artificial Intelligence: Principles and Techniques (CS 221)

Advanced Small Seminar

(May be fulfilled by a course taken for another requirement in the major)

- an upper division, limited-enrollment seminar drawing on material from other courses in the core. Courses listed under Symbolic Systems Program offerings with numbers between SSP 201 and 210 are acceptable, as are other courses which will be announced at the beginning of each academic year.

The components with more than one bullet point under them in the list above are vertically structured (that is, the first requirement must be completed before the second one is). The components are not intrinsically ordered with respect to each other, except in the case of the Artificial Intelligence component, which requires, at a minimum, CS 103B or X, and as a practical matter at least CS 106B or X, with CS 107 being highly recommended before a student takes CS 221. The Probability courses all require some calculus, at the level of Math 42 or higher. Calculus is not listed as an explicit requirement in the major because students acquire that background in different ways (often through AP credit in high school), but this is nonetheless an additional burden on some students.

Some courses that are listed as options within a component require other courses in the core. In particular:

- CS 106A or X is a corequisite for CS 103A in the Logic component.
- In the Computational Theory component, CS 106B or X is a corequisite for CS 103B, and CS 103X requires background in mathematical formalism and proof, so

in our core it should be taken only after one has completed Phil 150. Phil 152, which is an option for the second course in Computational Theory, requires that Phil 151 in the Logic sequence be taken first.

- Phil 181 in the Language and Mind component requires Phil 80 and a background in logic (i.e. Phil 150).
- In the Linguistic Theory component, Ling 130A and 230A each assume a background in logic such as Phil 151, and Ling 180 requires CS 106B or X.
- The Advanced Small Seminar component consists of course options which build on some part of the core, so the course taken for that requirement is generally taken following the course or courses on which it builds.

Since it was first taught in 2001, Symsys 100 has been the entry-point into the major for many students (although it was not strictly required until this year), but there are also freshman seminars, sophomore seminars, and sophomore college courses that provide a good first exposure to our program. Most majors begin the Computer Science requirements early, since they are more extensive than the requirements in other areas. Students tend to start their concentrations in their second year in the major, but some begin earlier. There is no expectation that the core will be completed before the concentration is begun.

Concentrations consist of six courses of three or more units each, and must be approved by the Director or Associate Director, either implicitly (by instantiating the requirements for one of our suggested concentrations) or explicitly (as approved modifications of the suggested concentrations or as individually designed concentrations). Some of the suggested concentrations have sequential requirements within them. The suggested concentrations are Applied Logic, Artificial Intelligence, Cognitive Science, Computer Music, Decision Making and Rationality, Human Computer Interaction, Learning, Natural Language, Neurosciences, and Philosophical Foundations. These concentrations were all designed by faculty in the relevant fields, and are periodically revised in consultation with one or more faculty members within each area. The course that we think of as our undergraduate capstone is the Advanced Small Seminar, which is chosen by each student from a menu of options listed on our website each year.

In general, the program requirements afford the students considerable flexibility to complete the core and concentration in a variety of ways and orders. Students seem to appreciate this, and the faculty seem to have no problem with it.

Our master's program is built around a research project which all M.S. recipients must complete. The curricular requirements consist of (a) demonstrating competence in the material of the undergraduate core, generally by completing the core requirements or their equivalent at another institution, with the exception of the Advanced Small Seminar requirement; (b) a small graduate core consisting of CS 108 ("Object Oriented Systems Design), an empirical methods course chosen from a menu of options, and the M.S. Program Seminar (Symsys 291); and (c) a specialization track chosen from among three options: Human-Computer Interaction, Natural Language Technology, or Individually Designed. All of the tracks include room for elective courses, chosen in consultation with the student's advisor, in support of the research project. Prior to embarking on the

master's project, as a new requirement this year, all students must submit a Qualifying Research Paper – a substantial piece of independent research that might be an honors thesis or a shorter paper, at the advisor's discretion. This is meant to ensure that students have some research experience prior to beginning the master's project.

(c) Does your program offer a Minor program of study? If so, how is it structured?

Students may minor in Symbolic Systems by completing either item 1 or item 2 below.

1. One course in each of the following core areas (please note that several of these courses have prerequisites):

a) Cognition: Symbolic Systems 100* or Psychology 55 (or 40)

b) Logic and Computation: Philosophy 150 (formerly 159) or 151 (formerly 160A), or Computer Science 103B, 103X, or 154

c) Computer Programming: Computer Science 106B, 106X, or 107

d) Philosophical Foundations: Symbolic Systems 100* or Philosophy 80

e) Formal Linguistics: Linguistics 120, 130A, or 130B

f) Artificial Intelligence: Computer Science 121 or 221

2. Symbolic Systems 100, plus an interdisciplinary SSP concentration listed on the Symsys website. To qualify, the selection of courses used for the minor must be interdisciplinary; i.e., it must either include courses from at least three departments, or include more than one course from each of two departments.

*Symsys 100 may not be counted for both areas a and d.

So the minor provides either a reduced version of the core of our major, or an interdisciplinary experience in one of the concentrations that is in the spirit of the major.

Minors in SSP are given full access to the resources of our program and are listed as students in our web database. One difference between minor and major declarations, however, is that majors are required to come in for an interview with either the Director, the Associate Director, or an Advising Fellow prior to approval of their declaration. This is not required for minor declarations.

(d) Describe your honors program and how the program provides support for the participants

SSP students may graduate with honors by completing an appropriate honors project. We allow considerable flexibility as to the nature of the project, and they have been extremely diverse, including such things as philosophical essays, mathematical proofs, computer programs of various sorts, multimedia presentations, psychological experiments, and neurobiological studies. In the six years since our last major review, 46 students (18%) have graduated in SSP with honors (out of 256 graduates).

We require that the student work closely with a faculty supervisor who approves the final project along with a second reader (who may be either faculty or another qualified researcher), and that a written document describing the project be turned in to the SSP office. Occasionally, honors projects are supervised by individuals who are not Academic Council faculty, and this requires approval of the Director or Associate Director. The requirement that each thesis be read and approved by a second reader has been added since our last review.

We encourage and provide support for strong students to undertake honors projects, in several ways. Our Summer Internship program provides many SSP students with early exposure to research, and a number of students have ended up doing honors projects based on their internships. At the last luncheon for our interns each summer, we encourage the students to apply for the Honors Program and (if they are accepted) to do a project that may be either a follow-up to their summer internship or a separate topic. We follow this up with an email to all SSP juniors late in the Autumn Quarter, advertising our Junior Honors Seminar (Symbsys 91), taught by Associate Director Todd Davies, and which directs students who are considering honors to the section on our program's website that details the requirements.⁷ This course, while not required, is designed to assist juniors considering honors in preparing and planning for doing a project during their senior year, including instruction on applying for VPUE funding, guidance on choosing an advisor and a topic, instruction in how to turn an idea into a thesis through research and reading, and information about the resources available at Stanford and elsewhere for honors students, e.g. honors writing assistance and writing guides.

All students who want to do honors must apply for acceptance into the SSP Honors Program. There are two deadlines: in May of the junior year and at the beginning of Autumn of the senior year. Acceptance is based on the following criteria: (a) good academic standing at the time of the application, (b) an academic record indicating that the student is worthy of honors -- generally at least a 3.0 GPA, and (c) submission of an acceptable project proposal. SSP participates in the Honors College every year (this year led by Prof. Lera Boroditsky in Psychology), and students must apply by the May deadline in order to be accepted into the Honors College. Todd Davies runs a Senior Honors Seminar (Symbsys 191) for seniors working on honors projects in the Autumn Quarter. Each year students doing honors pick and choose which of the support activities (honors seminars and the honors college) they wish to participate in. We do not require any of them, but rather try to help each student decide which ones will most benefit them.

We reconvene all of the graduating honors students late in the spring for our annual Honors Presentations at the weekly Symbolic Systems Forum (Symbsys 10) speaker series, which is followed by a dinner for the honorees.

(e) Are there opportunities for independent research outside of the honors program?

Yes. Many of our students do non-honors or pre-honors research during the academic year on projects that are supervised by faculty or graduate students. Our website facilitates this through a listing service for research opportunities during the academic year. Each year an email message is sent to all of our affiliated faculty encouraging them to list positions in this database/email list. But many students and faculty in our program arrange research assistantships or independent study research on their own, under faculty grants or independent study courses (e.g. Symbsys 196). SSP students are often prized as research assistants because of the range of their technical and analytical skills.

(f) Are there opportunities for internships in your program?

⁷ See http://symsys.stanford.edu/ssp_static?page=honors-guidelines.html

Yes. We have a Summer Internship Program each year, funded with a combination of VPUE Departmental Grant money for which we apply annually, and individual faculty grants. Faculty are asked to provide half of a student's summer stipend, but we try to put together whatever money is required from our Departmental Grant and our own gift funds to pay the matching portion for faculty who cannot afford the matching contribution. Opportunities are posted by faculty, and students submit their resumes and transcripts, through a special section of our website each February. Faculty and students then have the responsibility to contact each other for interviews, and we leave it to them to do the matching through agreements between each student and supervisor. In the six summers since our last review, our students have completed 111 internships through this program (an average of 18.5 each summer).

(g) What activities does the program provide to create intellectual community for majors and other undergraduates?

Several, including:

- Our weekly Symbolic Systems Forum series (Symbsys 10). This takes place each quarter. A different researcher presents their research each week. A majority of the talks are by SSP-affiliated faculty members, and speakers are asked to present their talks at a level that sophomores with little or no background in our major could understand. Students get credit (1 unit, S/NC) for attendance, and are encouraged to take the course at least once early in their careers as majors. But many of the students in attendance each week are not taking the course for credit. Faculty often attend, and we have refreshments and discussion afterward. Most speakers also have dinner with students afterward in Wilbur, the dining hall for Arroyo House (the Symbolic Systems and Related Majors focus house -- see below). Forum speakers are generally invited and hosted by individual undergraduate Advising Fellows.
- Our annual Distinguished Speaker lecture series, generally held once a year and honoring a famed researcher or contributor to a symbolic systems related field, chosen by our Advising Fellows. These events generally feature a catered dinner afterward to which all students and faculty are invited.
- Semiannual barbecue parties for alumni, students, and faculty. Held during Homecoming/Reunion weekend and again in the late spring, these events help us to stay in touch with our alumni and help students and alumni to talk to each other.
- Arroyo – the Symbolic Systems and Related Majors focus house. This is a dormitory in Wilbur Hall where students get priority based on participating in an SSP-related event the previous spring. All majors are encouraged to spend at least a year living in Arroyo, and about a dozen per year do so. Arroyo hosts many events of special interest to SSP students, in addition to the forum speaker dinners on Thursday nights. Focus events include Philoso-teas (philosophical discussions over tea, often with a faculty guest), Topic Tables (dinner tables designated for a given topic), and a residential seminar for credit, organized by the two student Focus Assistants in the house. The focus house idea originated with former SSP-

affiliated Prof. David Beaver (now at UT Austin), who was the Resident Fellow in Arroyo until 2006. This is the second year for the focus house. The Resident Fellow of Arroyo is Todd Davies, Associate Director of SSP.

- Field trips. Each year the Advising Fellows organize one or two field trips to locations of interest to SSP students. Themes have included “Online Social Network companies”, “Designing the Future in San Francisco”, and “Hopkins Marine Station”.
- “From Symbols to Reality” events. These are generally talks or panels featuring SSP alumni, organized around thematic career areas. Themes have included “Getting a Ph.D.”, “Start-ups and Entrepreneurship”, and “Professional Schools”.
- Social events. Generally organized by the student Advising Fellows, these events include games nights in Arroyo, “CoHo Nights” (now at the Axe and Palm), and other events such as beach trips. We also have a welcoming party each fall for students and faculty, and a graduation lunch for graduating B.S. and M.S. students right before commencement.
- Special advising events. Events where students meet each other and prospective students, sometimes with faculty: e.g. majors nights in dormitories, open house during New Student Orientation, and open house during Admit Weekend.
- Symposiums on Symbolic Systems and Society. Also generally held once a year, these are public events that focus on the wider social implications of the topics that students study in our program.

3.2 Teaching

(a) What is the involvement of Academic Council faculty in creation and oversight of the curricular offerings?

The original undergraduate curriculum was designed by a committee consisting almost entirely of Academic Council faculty members (all but one member) in the mid-1980s. Since then, all major changes have been approved by our faculty Program Committee, most of whose members are on the Academic Council. The Program Director and the Program Committee oversee both our undergraduate program and our master's program. The Director generally proposes curricular changes before they are put to the committee for approval, but ideas for curricular reform often bubble up from committee meetings.

The first Director of SSP was the late Jon Barwise (then a member of the Stanford Philosophy Department), who served in this capacity from 1986 to 1989. Jim Greeno (Education) succeeded him, and served from 1989 to 1992. Tom Wasow (Linguistics and Philosophy) served as Director from 1992 to 2000, and from 2001-2005. Ivan Sag (Linguistics) is the current Director (2005-present), and also served as Director in 2000-2001 when Tom Wasow was on leave.

The Graduate Studies Director position was created in 2001 when the master's program was authorized. From 2001-2005, the position was held by Ivan Sag (Linguistics). Since 2005, it has been held by Chris Manning (Linguistics and Computer Science).

All administrative and curricular issues that might substantively affect the program are discussed with the Program Committee, which oversees both the undergraduate and master's degree programs. Principal among these issues are changes in the core requirements, addition or dropping of concentration options (specialization track options in the case of the master's program), and the addition of new faculty, especially consulting faculty appointments in SSP. The role of the committee is advisory, but discussions have always arrived at a consensus, so the views of the committee have determined the shape of the program.

The Program Committee is a faculty steering committee, with one faculty member from each of the contributing departments, plus one consulting professor. The SSP Director, Associate Director, Graduate Studies Director, and the Director of the Center for the Study of Language and Information sit on the committee as ex officio members. The composition of the committee in the years since the last review has been as follows (with Academic Council members denoted by an asterisk):

2002-2003: Todd Davies, Jim Greeno*, Daphne Koller*, John Perry*, Byron Reeves*, Ivan Sag*, Paul Skokowski, Barbara Tversky*, Tom Wasow*

2003-2004: Todd Davies, Daphne Koller*, John Perry*, Byron Reeves*, Ivan Sag*, Paul Skokowski, Barbara Tversky*, Tom Wasow*

2004-2005: Lera Boroditsky*, Todd Davies, Daphne Koller*, Krista Lawlor*, Byron Reeves*, Ivan Sag*, Paul Skokowski, Tom Wasow*

2005-2006: Lera Boroditsky*, Todd Davies, Chris Manning*, Byron Reeves*, Eric Roberts*, Ivan Sag*, Paul Skokowski, Ken Taylor*, Tom Wasow*

2006-2007: Lera Boroditsky*, Todd Davies, Chris Manning*, Byron Reeves*, Eric Roberts*, Ivan Sag*, Paul Skokowski, Ken Taylor*, Tom Wasow*

2007-2008: Lera Boroditsky*, Todd Davies, Scott Klemmer*, Chris Manning*, Byron Reeves*, Eric Roberts*, Ivan Sag*, Paul Skokowski, Ken Taylor*, Tom Wasow*

Most of our courses are drawn from department offerings, taught by Academic Council faculty. Our major required course offered under an SSP listing is Symbsys 100 ("Introduction to Cognitive Science"). This course was staffed by at least one Academic Council member each year from when it was first taught in 2001 through 2007. For the coming year, we were unable to identify an Academic Council member to lead the course, but we secured funding from the Deanery to entice regular faculty to participate in restructuring the course and in identifying faculty willing to take responsibility for the course or to help teach it as a team. The difficulties this year have been due to the lateness with which the Directorship was settled upon for the present year and a set of commitments that have tied up faculty whom we hope will be able to teach the course in future years. Our Associate Director, Todd Davies, is taking responsibility for leading the course this coming Spring, with a substantial number of lectures to be given by other faculty in their areas of expertise. Both Todd and Ivan will be involved in convening the faculty panel to design the course for the future.

In 2004 we were given special funds by the Dean's office to develop a new course for our program. We convinced Persi Diaconis to create a new course in Statistics, Stat 121 on probability, induction, and statistics, which was taught the following year (2005) and was

an option for our Probability requirement. Unfortunately, Persi's duties in the last few years have prevented him from teaching this course again, although he has expressed an interest in doing so. We would very much like this to happen, since the course is of special relevance to our students interested in the philosophical foundations of probability and Bayesian statistics.

(b) What role do non-Academic Council members play?

The Director is assisted in reviewing the curriculum and proposing changes by the Associate Director (called the "Coordinator" prior to 2005). Since 2000, this position has been held by Todd Davies, an Academic Research and Program Officer and a Lecturer. Todd has a Ph.D. in cognitive psychology from Stanford (1995) with a background as a computer scientist in the Artificial Intelligence Center at SRI International (1985-1991) and as an Assistant Professor of Psychology at Koc University in Istanbul (1996-1999). Having also been an undergraduate at Stanford (B.S. & M.S., Statistics, 1985), and a resident fellow in two undergraduate dormitories (1988-'92 in Naranja and 2006-present in Arroyo), Todd has a great deal of experience with undergraduate education. He also served as Coordinator of the program for two years (1994-1996) while transitioning from graduate school to his position in Turkey, so he now has 9 years of experience working in Symbolic Systems.

Among other duties, Todd supervises our six undergraduate Advising Fellows each year, does extensive general advising of our students, runs our weekly speaker series (the Forum), our honors seminars (Symbsys 91 and 191), and our master's seminar (Symbsys 291), and teaches one or two other courses each year, including one of our advanced small seminars. He also plays a central role in helping the Director propose new policies and curricular changes. This year, for the first time, he is also taking responsibility for Symbsys 100, but our long-term plan is to secure commitments from Academic Council faculty to take responsibility for the majority of the lectures in that course. Todd's background makes him a versatile stand-in when regular faculty are unavailable to teach a course in a given year. For example, he taught one of our core courses for the Psychology Department, Psych 40 (Introduction to Cognitive Psychology) in 2004-2005 for the Psychology Department after Barbara Tversky had left, but before Lera Boroditsky had developed her course, Psych 55 (Introduction to Cognition and the Brain), which has since replaced Psych 40.

Other Lecturers and Consulting faculty teach some courses. These are largely in the areas of human-computer interaction and natural language technologies, the two principal foci of the new master's program. The curriculum provided by these individuals is a welcome addition to the offerings for undergraduates, but it is not essential to the undergraduate program. The only component of the core that includes courses taught by these instructors is the Advanced Small Seminar requirement, which includes a minority of courses each year taught by non-Academic Council faculty.

As long as it is Stanford's policy that all Academic Council appointments must be in departments, at least some IDPs will need to rely on other teaching resources for portions of their curriculum. SSP is less disadvantaged by this policy than most IDPs, because Stanford is so strong in the departments that provide the core curriculum. For the core,

all that the program really needs to contribute is coordination, plus a course to help students see the connections across the disciplines, a role filled by Symsys 100.

Other needs, such as service courses geared specifically toward SSP students, including the honors seminars, as well as interdisciplinary courses used for concentrations or master's tracks (e.g. Symsys 145, Cognition in Interaction Design), would be extremely difficult to meet without adjunct faculty. Consulting faculty and lecturers sometimes teach courses, e.g. in the Computer Science and Linguistics Departments, which our students take for their concentrations. These instructors generally bring valuable applied experience that would be unusual to find among regular faculty, and which our students value as they move toward a career.

- (c) What is the program's policy on team teaching (that is, under what circumstances do faculty receive full course credit for team teaching)?

We do not have control over this. Symsys 100 has often been team-taught, but it is up to the faculty involved to work out credit with their departments.

- (d) Besides the mandatory end-quarter student evaluations of teaching, what other methods, for example, peer evaluation, does your program use to secure feedback on teaching effectiveness?

Since we offer relatively few courses of our own and do not have regular faculty of our own, peer evaluation would be difficult for us to implement at the program level. The primary way that we learn about the quality of teaching is by talking to students during Advising Fellow meetings and advising sessions. We choose good students to be Advising Fellows, and we take their perspective seriously, especially when advising students about which courses to take when they have options. Students are also usually present at Program Committee meetings, represented by one or more Advising Fellows.

The main policy decisions that are affected by knowledge of teaching effectiveness are decisions about whether to include or exclude courses in lists of requirements and options. Many of our students help us with this, but we are careful not to rely on the opinions of one or a few when making major decisions. Student opinions are usually combined with those of faculty in the relevant departments, who have their own sources of information on teaching effectiveness. For example, in making a decision about whether to include a course in the list of options for our Probability core requirement, the Program Committee consulted with a professor in Statistics who could give an independent judgment of the course's relevance and quality.

- (e) If graduate students teach in your program on a regular basis, is there faculty oversight of TAs? Does the program provide TA training?

Many courses SSP students use for the major involve TAs, including most of the core courses. In general, these are the responsibility of the departments offering the courses. SSP plays no role in their selection, supervision, or compensation. The only course for which SSP *does* regularly play a role in TA support is Symsys 100.

Symsys 100 generally has 2-3 TAs. For the last few years, these positions have been filled by one graduate student paid for by a TAship from the Linguistics Department, and two paid by SSP. The SSP-funded TAs have included Linguistics Ph.D. students and

SSP Master's students. The instructors have provided the oversight for all the TAs in this course. SSP does not have its own program of TA training, but we have been given access to the TA training materials developed by the Linguistics Department for use by our own Master's students when they help staff the course. We will be using these materials this year for the first time.

(f) How do you balance graduate and undergraduate teaching needs?

The only course that is offered by SSP specifically for our master's students is Symsys 291, our Master's Program seminar. This course consists of monthly lunch meetings attended by the Program Director, Director of Graduate Study, and Associate Director (who officially staffs the course) along with all of our active master's students, plus student presentations in the Symbolic Systems Forum, and practice talks for those. Each Master's student must attend three full quarters of the monthly meetings and student Forum talks, and give a full lecture at the Forum before they graduate. The lunch meetings consist of informal presentations by students of their ongoing project work, with feedback provided by the Director, Graduate Studies Director, Associate Director, and fellow master's students. The course does not require a lot of faculty time beyond what is required to attend meetings, but is quite valuable for our master's students, as it gives them lots of practice in presenting their research and critiquing that of others.

Last January, our Program Committee approved a plan for opening admissions to our master's program to applicants from outside the Stanford undergraduate and SSP alumni populations. Until now, all of our master's students have been SSP undergrads prior to studying for the master's degree. The opening of admissions to outsiders necessitated developing a plan to ensure that all students in the master's program are given general training in doing independent research equivalent to what our undergraduate honors students receive, prior to embarking on the master's project. The solution arrived at by the Program Committee was to replace the current Junior Honors Seminar (Symsys 91) with a course that could include first year master's students who need this training along with juniors considering honors, beginning in 2008-2009 when we anticipate the first outside master's applicants will matriculate. Since this course already exists, we can leverage the time that is being spent on it for this purpose, but there will be some additional work required in offering it to more students, and in redesigning it so it is appropriate for both the undergraduate and graduate populations.

The rest of the courses taken by our master's students are from department offerings or courses that are available to both undergraduate and master's students in SSP and other degree programs. So it is hard to assign these to one program over the other. Having a population of master's students in some cases makes it easier to populate courses that are useful to upper division undergraduates and Ph.D. students, which is one motivation for expanding the master's program beyond its current 2-3 graduates per year up to around a projected 10 per year. The same can be said for our undergraduates -- that their availability for graduate courses helps to justify and populate department offerings. We do not see evidence that this interferes with undergraduate teaching in our program.

(g) Are there problems or obstacles to effective teaching that the school should be aware of?

The main challenge we face is the staffing of Symsys 100. Although prior to this year, the Director has always succeeded in securing a commitment from at least one Academic Council faculty member to teach this course, these commitments have been short-lived. Some of those who have taught or co-taught the course in the past (David Beaver, Jim Greeno, Daniel Richardson) have left Stanford. Others (Ken Taylor, Tom Wasow, Dan Jurafsky, Johan van Benthem, and Joan Bresnan) have had other commitments that have precluded them from continuing to teach the course. In addition, the high turnover rate has produced problems of reliability in the content of the course, and discussions with students, alumni, and those who have TA'd it indicate that the course, while often interesting and well taught, is failing to provide the glue for the major that we hoped it would provide when the course was created.

The Director and Associate Director have taken a close look at the course and will soon be convening faculty to restructure the course and to put it on a sounder footing for future years. But the departmental incentive system remains as a large obstacle to securing long-term faculty commitment to this course. The model we are currently working with is based on supplemental teaching funds that we intend to pay to faculty in exchange for involvement with this course. We have high hopes for this approach, but it remains to be seen whether or not it will be effective.

3.3 Advising

(a) How do your students obtain their advisors?

Upon declaring, SSP undergraduate majors are encouraged to begin looking for appropriate faculty advisors in their concentrations. Asking a professor to serve as the advisor is the student's responsibility. A substantial number of SSP students find an advisor in this way, but many of these relationships are not formally recorded in Axess.

In our meetings with undergraduates when they declare and afterward, we tell students that they should seek advice from more than one person, and that different types of advice and assistance can best come from different faculty or academic staff, as well as peer advisors. Much of the time, for example, what students need is someone who can be represented officially as their advisor on a form, petition, or letter certifying their satisfactory progress, e.g. to the Registrar, the U.S. Government, or a potential employer. For this reason, we designate the Associate Director as one of each undergraduate's advisors, because Todd is the person they are most likely to go to and who is most likely to be able to help in this situation. Todd and Ivan both provide general advice to majors on how to get through the curriculum. Again, this requires knowledge of the SSP core and concentration requirements specifically, and is difficult for faculty advisors to provide.

Students who get involved in some sort of research (internship, honors, research assistantship, or independent study) form relationships with their research supervisors and get advice from them pertaining not just to research but more area-specific curricular and career issues. We believe that roughly half of our students form some sort of relationship with a faculty member on this basis, and generally get good advice as a result.

The remaining students face more of a challenge in getting involved with faculty one-on-one. The main place where students who do not do research form a relationship with faculty is in the Advanced Small Seminars and other small courses, usually taken for a

student's concentration. Again, these relationships are often not codified in Axess, but they are the basis for many letters of recommendation and much informal advice in specific concentrations.

Although we urge students to let our Student Services Officer know who their advisor is, only a minority do so. We do not require them to do this, for a couple of reasons. For one, it is not obvious to us, much less to students, that there is much advantage to a student in having their advisor listed as such in Axess. The main consequence of such a link appears to be that the advisor then has direct access to the student's grades. But checking grades on Axess is so cumbersome that few faculty do it regularly for their advisees, instead relying on occasions when there is a need to do so, such as when a student needs a letter of recommendation or, more rarely, is flagged for academic trouble. In those instances, it is not usually hard to obtain a copy of the transcript. Students generally provide these when asked, and Student Services Staff are available to obtain them in other cases. A second reason why we do not require students to formalize their relationship with an advisor is that we fear this will place additional burdens on faculty, and we have not worked out a way to distribute this equitably. Forcing a student who is not otherwise motivated to declare their advisor would result in many additional communications between students and faculty that would, in the present environment, have a forced bureaucratic feel. Students are likely to overburden the most popular faculty members, who have the least time for this additional communication anyway, and the resulting interactions might leave both students and faculty disillusioned. Despite all of this, we would like to increase substantially the number of our majors who have declared advisors. We believe we can do this through a bigger push on students who effectively have advisors to get these relationships formalized. We also plan to take up with our program committee and in our next annual faculty meeting how we can get faculty involved in advising more undergraduates.

It is clear from our surveys that not all students have gotten the advice they need over the years. Much of what is missing we think could be provided by our advising fellows, the Director and Associate Director, alumni, and more student knowledge of resources and individual initiative. In the coming year we will be placing more emphasis on communications with students about the resources available to them and the importance of utilizing these, and also to utilize new technology planned for our future website, which is currently in development. The new site should make it easier for advice to be shared with everyone who could benefit from it, and to direct questions to those most able to answer.

For our master's students, the advising relationship is much more solidly determined. Each student must submit a Project Area Statement, endorsed with a commitment from the student's prospective project advisor no later than May 1 of the academic year prior to the expected graduation year. In the past this has always occurred as part of the application process, because all admitted students have so far been undergraduates in Symbolic Systems who can complete the master's program in one year. Because the master's program requires demonstrating competence in the undergraduate core requirements, however, students entering from outside SSP will in most cases need more than one year to complete the degree and will have no relationship with an advisor coming in, so they will be admitted prior to submitting a Project Area Statement and will need to

find an advisor to endorse the statement prior to moving on to the project phase of the program. In any case, every student will get an advisor before moving into the last 12 months of their program.

(b) Please provide a list of advisors with the number of current undergraduate advisees.

Each of the following faculty (with Academic Council members starred) are registered in Axess as advisors of one of our undergraduates, unless another number is specified in parentheses: Jonathan Berger*, Christopher Chafe*, Todd Davies (76), John Etchemendy*, Michael Genesereth*, Daniel Jurafsky*, Lauri Karttunen*, Scott Klemmer* (3), Marc Levoy*, James McClelland* (2), Tirin Moore*, Marc Pauly*, John Perry*, Stanley Peters*, Eric Roberts*, Baba Shiv*, Jeff Shrager, and Terry Winograd*

As stated above, this list is misleading regarding actual advising, because most students who have an advising relationship with a faculty member do not get it registered in Axess, and all students are listed as having our Associate Director Todd Davies as an advisor whether or not they have another registered advisor. We have other measures of advising, most notably the number of students doing research with faculty. Roughly half of our students fall into this category before they graduate. We do not have data to determine how many of those who do not do research are getting advice from faculty not listed as their advisors, but we do know that some have not been getting the advice they feel they need, based on our alumni survey data (see Section 4). See our response to question 3.3(a) above on how we plan to address this in the future.

We have three active master's students presently. Their advisors are Christopher Manning (for Gorkem Ozbek), Stanley Peters (for Itamar Rosenn, although Axess inaccurately lists his advisor as Chris Manning) and Baba Shiv (for Aurelie Beaumel).

(c) What role does the staff or non-Academic Council faculty have in advising students?

Todd Davies, Associate Director and Lecturer, is listed as an advisor for every undergraduate in Symbolic Systems for the reasons stated in answer to question 3.3(a) above. The number of undergraduates who do not have an advisor recorded in Axess other than Todd is 58. Thus, 18 out of 76 students have such an advisor. Of these 18, one has an advisor (Jeff Shrager) who is a consulting professor. All of the rest of those listed as advisors are on the Academic Council. Three students have more than one advisor listed in Axess in addition to Todd. Todd has extensive office hours and spends a good deal of time advising students, both face-to-face and via e-mail. Even for students with other faculty advisors, he does a good deal of advising.

For master's students, our admissions committee⁸ and the directors enforce a strict rule that each master's project must have an Academic Council faculty member either as the primary advisor or as the second reader. Of our 16 master's graduates so far, 13 had primary advisors on the Academic Council, and 3 had non-Academic Council faculty as advisors. The three who did not were advised by B.J. Fogg (for Dean Eckles in 2007),

⁸ Members of the Master's Program Admissions Committee are Ivan Sag*, Todd Davies, Chris Manning*, Terry Winograd*, and Cliff Nass*.

Todd Davies (for Raja Shah in 2003), and Henry Lowood (for Tony Tulathimutte in 2006), and all had Academic Council members as second readers. Of our three current master's students, none have primary advisors who are non-Academic Council members.

(d) Do students receive career advising? If so, describe.

In addition to verbal advice from the Director, Graduate Director, Associate Director, and faculty, which is hard to measure, we provide several resources on our website for career advice.⁹ Students also get advice from alumni at events such as “From Symbols to Reality” (which is often videotaped and made available online), field trips, and our semiannual alumni-student-faculty barbecues.

(e) Does your program make use of peer advising? If so, please describe.

Yes. We have six advanced students in the program (mostly seniors) who serve as “Advising Fellows”. These students are paid to hold office hours (typically four hours per week), during which they are available for consultation about anything related to the major. They also answer questions via e-mail, and organize a variety of activities (intellectual and social) for SSP undergraduates and prospective students.

We do not have a formal program of peer advising for master's students, but the monthly luncheons and the requirement that each master's student attend all the student forums (in particular, presentations by fellow students) results in a good deal of cross-fertilization between master's students. Master's students are integrated into the undergraduate life too, so they often provide advice, and they are sometimes appointed as Advising Fellows in their coterminal year.

(f) What mechanisms do you use to inform students of major events and other relevant information?

Our primary remote communication tools are our program website (<http://symsys.stanford.edu>) and our student email lists, although we do occasionally send announcements through the mail, such as for graduation and the annual graduation lunch. Face to face promotion occurs at our weekly Forum speaker series, in announcements before Symsys 100 class sessions, during private meetings with Advising Fellows, the Director and Associate Director, and all the other events mentioned in answer to 3.1(g) above. We also list our public events on the Events.stanford.edu website, and they appear in the CSLI Calendar of Events and are sent to a wider ssp-events email list. Occasionally we have purchased advertisements in the Stanford Daily, but have not done so recently. We have also occasionally (more recently) publicized events on Facebook.com, both buying ads and creating groups of interested students on that website. And we distribute flyers and posters for our annual Distinguished Speaker lecture and events such as the Symposiums on Symbolic Systems and Society (SSSS).

(g) What mechanisms do you have in place to attract new students to the major?

Our Advising Fellows, the Director, and Associate Director all put in time talking to prospective majors at events such as Majors Nights in dormitories, open houses during New Student Orientation and Admit Weekend, and our welcoming party each fall, to

⁹ See http://symsys.stanford.edu/ssp_static?page=jobs.html.

which prospective students are actively invited. Prospective students are signed up on our ssp-others email list as soon as we know about them, and that list gets all the announcements sent to our declared majors with the exception of ones that only apply to declared majors (such as information about how to apply for the honors program or how to submit graduation planners). The Symbolic Systems Forum (Symbsys 10) is a great recruiting tool. Many prospective majors take that course for one quarter before declaring, and they thereby also get on ssp-others if they are not already declared. Events in Arroyo, the Symbolic Systems and Related Majors focus house, also attract prospective majors, and the house has an associates list for nonresidents who want to be informed of events there.

(h) Does your program work with Undergraduate Advising Programs? If so, please describe the nature and quality of the interactions.

Beyond keeping our information current, the Director and Associate Director (Ivan and Todd) did meet with Lorraine Sterritt in H&S last year to talk about advising resources that could be provided centrally. Since meeting with her, we have had some further thoughts on the challenges of advising. We appreciate the work of UAR, but a continuing source of frustration in advising is the lack of good technology and information flow related to student academic performance. Hard copy notices of academic probation or suspension are sent sporadically and usually too late to affect the quarter when we receive them. Accessing student grades in Axess is a real chore, requiring multiple clicks for each advisee even after one is in the system and on the advisees page. We tell students that it is their responsibility to come to us, for example, if they get a grade below a C- in a core course, so that we can talk with them about whether they should continue in the program. If we could be notified more easily of such cases, this would help us to reach these students. It would be even better if they could be notified automatically based on some criterion.

One interaction we had with UAR that was less than ideal was a request for the list of incoming frosh who had expressed an interest in SSP. We asked for this last year, but never received it. We did get a response from UAR, which was that it would be difficult to put together.

3.4 Extra-departmental Programs

(a) What is the relationship of your program to other departments, centers, or interdisciplinary programs on campus? Do you depend on such programs or centers for any part of your major requirements?

SSP's curriculum draws most heavily from the departments of Computer Science, Philosophy, Linguistics, and Psychology, with multiple core courses coming from each of these departments. Our core also includes courses from several other departments, mostly as options for our Probability requirement and the Advanced Small Seminar requirement. Departments that offer courses frequented by SSP students include Communication, Economics, Education, Management Science and Engineering, Mathematics, Mechanical Engineering, Music, Neurobiology, and Statistics.

A few courses owe the majority of their enrollments to SSP requirements. In particular, Linguistics 120, 130A, & 130B and Philosophy 80, 150, & 151 draw current and prospective SSP majors in larger numbers than any other group of students. The size of the other core courses also tends to be significantly increased by SSP enrollments.

SSP shares staff and some office equipment with the Linguistics Department. This arrangement has proved to be both pleasant and efficient for us.

SSP has a distinct focus among interdepartmental programs at Stanford. Occasionally, a student interested in neuroscience finds it difficult to decide between Human Biology and SSP. A few other students express uncertainty about whether to major in SSP or Science, Technology, and Society (STS). However, although SSP and STS both appeal to students who want to bridge the divide between C.P. Snow's "two cultures", they are quite different in how they do it. STS's focus is on how science and technology influence (and are influenced by) the wider society; SSP's is on areas of inquiry – information, intelligence, and language – that have been studied from both scientific and humanistic perspectives. For example, while an STS student might investigate the social impact of advances in speech understanding technology, an SSP student would be studying how the technology actually works and how it relates to what humans do in understanding speech. In short, the content of SSP is quite distinct from STS – and even more so from other IDPs.

SSP has a longstanding historical relationship to the Center for the Study of Language and Information (CSLI), having grown out of CSLI in the mid-1980s. In some cases, researchers at CSLI have taught crucial courses. For example, in the past, logic courses have been taught by CSLI researcher Dave Barker-Plummer because of staff shortages in Philosophy. CSLI researchers have also taught courses in areas important for our Natural Language undergraduate concentration and master's track.

(b) What impact (if any) do the demands of extra-departmental courses on students (GERs, IHUM, PWR) have in creating and maintaining a coherent curriculum for your majors?

When courses in our major are listed as fulfilling General Education Requirements, that may increase the teaching burden on faculty, but this is a consequence for all departments and programs that teach such courses, and GER students can add value to the course as

well. The Introduction to the Humanities philosophy sequence (IHUM 23A and 23B) actually count as an option (if both taken) for the Philosophical Foundations component of our undergraduate core. It might be helpful if incoming frosh were notified of this, since we have no way of identifying most incoming students who are interested in Symbolic Systems. Although it may not be fair to expect it from the Program on Writing and Rhetoric, skills that students often lack after completing the PWR sequence include the ability to contribute usefully to a discussion seminar and to comment critically about a piece of writing. Undergraduates often seem to feel that reacting to a serious article should be a matter of their feelings or opinions. The need to invoke sound arguments and evidence escapes many of them even into their senior year. Instructors in Advanced Small Seminars must either accept this or engage in remedial instruction in how to contribute meaningfully.

(c) What impact (if any) do the demands for extra-departmental teaching on your faculty (IHUM, IDPs, SIS) have in creating and maintaining a coherent curriculum for your major?

We *are* an IDP, so for the most part we are on the other side of this. However, the Stanford Introductory Seminars program in particular could be better integrated with our major. Frosh and sophomores often seem to worry that they are wasting a course if they take an SIS course, because, as we understand it, such courses do not typically count for major credit. We would like to consider ways of incentivizing students who are interested in SSP to take an SIS course with one of our affiliated faculty, because that is an excellent way to get a taste of at least one part of our major. But this would probably need to be done in conjunction with SIS, because the SIS booklet would need to indicate potential applications of a course to a major.

Section 4 Student and Alumni Survey

Letters were sent via both U.S. Mail and email by Gretchen Lantz, Student Services Officer for SSP, to all SSP alumni and current students for whom we had contact information on August 7, 2007, requesting feedback for the SSP self-study. The letter was signed by Todd Davies, Associate Director, and Ivan Sag, Director. Copies of the letters appear in Appendix 3. A follow-up, with the same content, was sent out by email on September 11, and a “last call” on October 26. The raw responses are included as Appendix 4, organized alphabetically within each class year, followed by M.S. alumni and current students.

The response rates are summarized in the table below, with the number of alumni in each class reflecting class year data for each student in our database, rather than the official graduation year.

<i>Class</i>	<i>Total Majors</i>	<i>Responses</i>
1987	8	1
1988	10	2
1989	17	3
1990	16	0

<i>Class</i>	<i>Total Majors</i>	<i>Responses</i>
1991	32	4
1992	29	7
1993	26	4
1994	19	4
1995	17	0
1996	16	7
1997	36	7
1998	21	3
1999	34	3 (+1 minor)
2000	49	15
2001	63	10
2002	53	16
2003	64	15
2004	46	14
2005	33	5
2006	21	5
2007	34	4 (+1 minor)
M.S. Alumni	16	7
Current Students	76	10

So for the period since the last review (2002-2007), we received 59 responses from 251 total undergraduate major alumni¹⁰, a 23.5% response rate. The response rate for M.S. alumni was 43.8% (7 out of 16), and for current students it was 13.2% (10 out of 76).

The raw responses provide a rich sampling of our alumni going back to the beginning of the program. Reviewing the comments with special attention to the period since the last review, we find the following recurring themes:

- Alumni and current students are generally very enthusiastic and positive about SSP. As in previous surveys, they tend to report that it meets their educational needs well, through its inter-disciplinarity and the thinking skills it imparts. Many give concrete examples of how their education in SSP has been put to use during their time since graduating, and we see this across a broad range of careers.

¹⁰ The number of total majors for this period is slightly different from that reported in section 2 because these data are based on class year instead of graduation year.

- Many alumni clearly appreciate the flexibility that the program offers in allowing students to choose courses that meet their needs within the broad framework of symbolic systems.
- Alumni and students are somewhat divided on whether the curriculum offers the right mix of breadth and depth. Many feel that the core requirements hang together well and provide students with a solid set of skills. But some feel that their education did not give them enough depth, e.g. as training for a career or an academic field. We think that we hear the latter type of comment less often from those who majored in SSP after the tightening of requirements went into effect for all new majors in 2002. A number of students have told us that the major since then has gotten more rigorous, with the inclusion of CS 107 being an important step in that direction, along with deeper concentrations (six courses instead of five). The revised core that goes into effect this year should help even more.
- A common sentiment among many students from the beginning of the program through to recent graduates is that they could use more advice. We were disturbed to find that some alumni and current students appear not to know about all the resources that are available for advising. Most show an understanding that success in finding the right path in SSP (indeed, in any major) requires a good deal of student initiative.
- A number of respondents mention that the name of the program can present problems when trying to explain their major. This sentiment ran particularly high early in the present decade, before we made an effort to clarify the relationship between SSP and cognitive science in particular.
- Symbolic Systems 100 receives mixed reviews, getting positive comments from some students, but also being seen as not sufficiently integrative across different fields within the major.

After thinking about all the surveys, we are inclined to pursue the following directions, and will be discussing these with our Program Committee.

- Proceeding with a restructuring of Symsys 100 so that it develops interdisciplinary themes and supplements our core rather than providing a sample or tour of the fields within it.
- More systematic communication with students about the philosophy underlying the program and resources available to students, including stronger messages urging students to seek advice and advisors.
- Implementing new web tools to strengthen advising, e.g. by giving more students access to the responses to particular queries and enabling questions to get routed to those most appropriate for answering them, including alumni and faculty.
- Increasing the guidance we give to students who want and have time to go into more depth in an area than is strictly required for graduation. Our most eager students sometimes finish the major early and can be at a loss for how to spend their time after that. We could suggest supplementary courses, for example for those planning to go to graduate school in neuroscience or computer science.

- Talking seriously with our faculty, students, and alumni about whether the name of the program should be changed, and investigating how this would be done institutionally at Stanford.

*For a copy of the attachments
to this document contact*

*Priscilla Johnson
Academic Secretary's Office
650-723-1747*

priscilla.johnson@stanford.edu