This plan is excerpted from the “Self-Study Report” dated February 2, 1998, that the department produced as part of its program review. It has been slightly edited, mostly to remove references to other parts of the Self-Study Report.
Strategic Plan

(A more detailed version appears in Appendix B.)

Our environment

We operate in an environment where economic success increasingly depends on the contributions of software professionals and where priorities of funding agencies reflect the importance of computing research and education for the prosperity of the nation.¹

Recent enrollment data nationwide in computer science suggest a sharp upturn after several years of being flat.

Our opportunities

Fundamental changes within our own academic discipline, new opportunities for interaction with other fields, a thriving software economy, university and campus strategic plans that emphasize information technology — all of these circumstances add up to great opportunities for us. We will seek the necessary support to realize these opportunities, from within the university and from outside.

Curriculum content

We will make adjustments in our course offerings, both at the undergraduate and graduate level, to better reflect the changing needs for software professionals. We will do this after substantial consultation with practicing software professionals. We have started this process and will continue it during the Spring semester, resulting in curriculum changes that we will implement starting in Fall of 1998.

Such curriculum changes in our Bachelor’s and Master’s degree programs are motivated by changes in the nature of the software profession. We believe that we will serve our students better by introducing in our curricula a stronger emphasis on higher-level software issues such as architecture and design, without losing the necessary basis of strong programming skills.

While we have often adjusted our curriculum in the past, both by introducing new courses² and by making changes in the content of existing ones, those changes were mostly focused on individual courses. The adjustments we are planning at this time are broader and more ambitious.

In addition to serving our own students well, we intend to collaborate with other programs and departments of the university in efforts to offer an appropriate

¹ The Bureau of Labor expects a near doubling of programming and computer science jobs by the year 2006, on top of a doubling since 1983.
² on subjects including Object-Oriented Design, Software Engineering Methods and Tools, Networks
education in computing concepts to their students.

**Faculty growth and research areas**

We believe that our students are well served when most of our courses are taught by active researchers. This is the model we have been following. Faculty who conduct research funded at an average of over $200K per year cannot be expected to teach more than one course per semester — and any increase in teaching obligations would put us at a great disadvantage in recruiting new faculty (or retaining current faculty).

To teach more students, and to teach them well, we need more faculty. We also will explore ways in which our teaching as well as our research can benefit more from contributions of people other than regular faculty, e.g., practicing software professionals.

We have two faculty positions to be filled at this time, which we expect to fill in the general area of software and systems. These are vacancies created because two faculty left.

A significant number of new positions would allow us to teach an increased number of students and allow us to move into new research directions. One attractive area of expansion, loosely defined but of great potential, is at the intersection of some of the following: information technology, graphics, communication, networking, human and machine learning, film studies, fine arts, multimedia. We see such an expansion as an opportunity to create new areas of collaboration and to support university goals and initiatives such as TLE and ATLaS. The detailed Strategic Plan in Appendix B makes the case for six new rostered faculty, five of them over the next three years.

**Support personnel for teaching**

We will double the current default support level of roughly one Teaching Assistant for every 50 students. In addition we plan to add two people at the level of Teaching Assistants to support our instructional computing labs.

**Instructional labs**

Computing equipment gets outdated very quickly. Our instructional labs are quickly becoming out of date, in terms of both hardware and software. We will seek new donations from computer manufacturers and software vendors and well as support from NSF. This approach has worked well for us in the past when we were able to build up strong instructional facilities. We have had somewhat less success in the last few years, partly because we were competing with the College’s Integrated Teaching and Learning Lab.

We will broaden our approach to providing a state-of-the-art computing environment to our students by approaching more vendors, seeking funds again.

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3 Increased numbers of students and stable numbers of faculty have put this approach under some strain. This AY [meaning AY 97/98] five sections of courses, some of them large and central to our curriculum (two sections of CSCI 1300, Introduction to Computing, and one section each of CSCI 2270, Data Structures, and CSCI 3155, Programming Languages, and CSCI 4448, Object-Oriented Design), are being taught by PhD students or postdocs.

4 "Networking" should be construed in a broad sense, including not just the technical aspects of computer networks but including issues such as the support for specific research and other communities and new ways of collaboration.

5 This level applies to courses that have a recitation, including most undergraduate courses. Courses without a recitation, which includes all graduate courses, get less support.
from NSF, and considering how we can make computers that our students own part of the solution.

Importantly, equipment and software alone does not yet guarantee a strong instructional environment. There needs to be appropriate personnel support. As mentioned above, we plan to add two people at the level of Teaching Assistants to support our instructional labs.

**Enrollment management?**

As mentioned earlier, there is strong evidence that after a period of decline and then leveling off, enrollments nationwide in computer science bachelor’s programs are rising again, and rising quickly. Our own B.S. program grew by 20% each of the last two years. Some surveys and anecdotal information pegs typical increases even higher.\(^6\)

Instituting substantial enrollment limitations has obvious drawbacks, going against our desire to serve our students and society at large. But to handle increases in enrollment there need to be procedures that allocate the necessary funds and faculty positions as well as support staff and computer labs. Some of these resources may be hard to add quickly enough to avoid enrollment restrictions in the short run. We are initiating discussions with the dean's office to explore implementation options.

**Diversity**

As stated in some detail earlier, we will make an intensive effort to address our most glaring case of lack of diversity, which is the small percentage of women in our undergraduate program. We will do this by trying to attract a group of female students to whom we provide special support, helping them to form a supportive community and become ambassadors for our programs in the future. We will seek NSF funding for this, but will not make this initiative entirely dependent on that funding coming through. In this effort we do have strong assets in the women on our faculty and in the college's *Women in Engineering Program*.

We will continue to seek out prospective graduate students at traditionally Black college and we will use personal contacts and networks to attract applicants to faculty positions and will provide appropriate mentoring after they join our department.

**Physical Space**

Our space is too small and too fragmented. We will pursue what limited options there exist in the Engineering Center as well as space in the next building that the college expects to build. None of those options will solve the fragmentation of our space. A solution will require a separate building for Computer Science, or a significant part of a new building shared with other units.

Current space is inadequate to an extent where this greatly interferes with the functioning of the department. We have become accustomed to what is a very detrimental situation. The department's space is fragmented in a way that isolates faculty from students. Our PhD students are located in the part of the “Classroom Wing” that has been renamed the “Computer Science Wing.”

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\(^6\) The Computing Research Association reports a one-year increase of 40% in the number of *new* Bachelor's degree students in PhD granting departments. (Computing Research News, March 1997, page 3.) One of the most stunning numbers comes from Purdue University, reporting a 261% increase in the size of its freshman computer science class over a three year period.
departmental faculty and staff offices are not in the “Computer Science Wing” — they are, with one exception, in the “Office Tower”, about as far away from the “Computer Science Wing” as one can get in the Engineering Center. While other departments in the college clearly do have their space problems, our situation is especially difficult. An inventory done by the dean's office shows us consistently at the bottom (or in some instances, second worst behind aerospace) in our space allocation. Assigned space is 849 sq.ft per faculty FTE, about the same as it was at the time of the last program review when that amount was described as “far below the national norms of 1200-1300 sq.ft.”

**Resources**

We will need more faculty to maintain the excellence of our research and teaching programs in light of enrollment increases. We need more support staff, including technical support for our instructional labs and teaching support. And our space situation needs to be accepted as being of the highest priority in the college's space allocation and planning processes. The strategic plan in Appendix B provides more details, asking for six new faculty positions to be added, as well as the staff, space, and computing resources to enable the current and new faculty be successful in their research and their teaching. We are ready to help in any way possible with efforts to find new resources outside the university. Still, much of the resources have to come from within.
Appendix B: Strategic Plan

Vision

Research
To carry out research that makes lasting contributions

- in selected areas of computer science as well as
- in areas of collaboration with other disciplines, not limited to
  traditional such collaborations.

Teaching
To teach our students such that they become prepared for long and
productive careers by,

- in the Bachelor's degree program,
  - offering a wide range of courses, including courses in all
    the core areas of computer science;
  - emphasizing the teaching of fundamental concepts but
    doing so using material that is of special current
    relevance, including current research; and
  - enabling our students to complement their technical
    education with a generous amount of liberal arts and other
    courses that help prepare them for a career of leadership
    based on a broad education and an understanding of
    societal as well as technical issues;

- offering our Master's students courses that help them start or
  advance their careers in the computing field;

- preparing our PhD students for successful careers in research and
  teaching;

- collaborating with other programs and departments of the
  university in efforts to offer an appropriate education in computing
  concepts to their students.

- fostering the development of community ties among our students
  and between students and alumni, with the aims of enhancing what
  students learn from one another, meeting students’ needs for social
  as well as intellectual support, easing the transition from school to
  work, and encouraging alumni participation in our programs.
Strategic Directions

(Action items are in boldface.)

Adjusting the curriculum: Preparing competent software professionals

The software industry is changing. There is a growing need for software professionals who are not merely competent programmers — although they certainly need to be that — but who are also able to deal competently with the higher level issues of software design, architecture, and analysis, and who are knowledgeable about the tools and processes used in the software industry.

We acknowledge that no academic program by itself can produce such software professionals. It needs to be followed up by strong practical experience. In adjusting our curriculum our goal is to prepare our students as well as any academic program can for such a subsequent learning process. Specifically, we will review and adjust, with the help of practicing software professionals from industry, our coverage of

- Object-Oriented and other Design Methods
- Component-Based Development
- Architectural Styles and Patterns
- Human/Computer Interfaces
- Software Engineering Methods
- Development and Analysis Tools
- Software Project Management

both at the undergraduate and the graduate level. This review will include the first three computer science courses our majors take (CSCI 1300, Introduction to Computing; CSCI 2270, Data Structures; and CSCI 3155, Concepts of Programming Languages) and senior and graduate courses that touch on the topics listed above. We have addressed most of these subjects in various courses but we do not have a well-planned, integrated curriculum. This review will be conducted during the Spring of 1998 and produce a set of curriculum recommendations in a form suitable for adoption by other institutions as well.

We will develop a new course to teach computing concepts to students outside the department. Not merely a new version of a “computer literacy” course, this course will teach concepts of computing and give students an understanding of the technology.
We will pursue alliances with other units on campus who are interested in putting more computing content into their curricula. If ambitious in scope such changes would create a need for faculty positions. Such faculty who would implement such new courses could be rostered either in Computer Science or in the other units or hold joint appointments.

Improving the learning environment for our students

In addition to making changes in the content of our curriculum, we intend to improve the environment in which our students learn, by supplying adequate personnel support (especially teaching assistants), better hardware, better software, and more laboratory space.

Current personnel support levels provide a default of one Teaching Assistant for every 50 students, with each TA working 20 hours per week. Given the strong "hands-on" nature of learning computer science, our goal is to double the number of hours of support. This could be done by employing our best juniors and seniors (who are paid less than the traditional graduate student TAs, but can be equally effective, often more so) as assistants in freshman and sophomore courses, and by new support from industry in the form of Graduate Teaching Fellowships.

Our current instructional labs are quickly becoming outdated if indeed they aren’t so already. We have been running our own facilities, made possible by generous donations of equipment from industry, augmented with support from the university. We will seek donations of new equipment from industry, approaching prospective donors starting in Spring of 1998. Updated computer technology will make our curriculum more rewarding for our faculty and students.

We will be able to properly support all of our students, and not force them to wait for resources. Perhaps even more importantly, updated facilities will allow us to use modern industrial software in our curriculum; we will seek donations of appropriate software, including graphics software\(^7\), Javatest, and other packages.

In order to house these updated facilities, to properly support the technology watch and educational technology initiatives, and to provide our expanding student body with proper work space, we will seek additional space in the Engineering Center, both in existing space and in space that is in the planning stage at this time. Some amount of suitable and potentially available space exists now on the “Chemical Engineering Balcony” (certainly in ECCH 103, plus a possibility of shared use of ECCH 105 and 107, shared between general open lab use and occasionally reserved use for our work on the use of technology in teaching).

In order to meet the demands of a rapidly-growing high tech industry in the Boulder/Denver area, we will introduce a professional certificate program. This will consist of three graduate courses and a capstone series of half-day seminars, and will start in Fall of 1998.

\(^7\) Photoshop, Macromedia Freehand, Adobe Illustrator, Macromedia Director, various 3D graphics tools etc.
We will recruit a small number of undergraduates into a prototype **Undergraduate Research Apprenticeships** in AY 98/99. Such research apprentices are undergraduate students who join a research group as sophomores, allowing them to become part of the professional community very early in their career. They will work closely with a mentor and will be engaged in all aspects of a research project, including the development of prototype systems but also more scholarly and theoretical aspects of the research projects.

**Research directions**

In research, our goal is exceptional strength in a limited number of areas. **When there is a small number of openings we will add to existing strengths,** which lie in *artificial intelligence*, *database systems*, *human-computer interaction*, *neural nets*, *numerical computation*, *parallel processing*, *programming languages*, *software engineering*, *systems*, and *theory*. When resources are scarce we will prefer hiring new faculty in those areas while remaining open to hiring candidates in any area and favoring candidates who show promise to be able to move into new research areas over time. With larger numbers of openings, we will be able to add new research areas. **One attractive area of expansion, loosely defined, is at the intersection of some of the following: information technology, graphics, communication, networking**, *human and machine learning*, *film studies*, *fine arts*, *multimedia*. We see such an expansion as an opportunity to create new areas of collaboration and to support university goals and initiatives such as TLE and ATLaS.

**Growth in numbers of faculty**

The growth of Computer Science on the Boulder campus can follow different scenarios, ranging from modest growth and little expansion in teaching and research to substantial growth that our larger environment seems to demand.

One option is “to close the doors”, i.e., not to allocate new resources and not to let the number of students grow. At the opposite end of the spectrum is the option of “opening the doors wide”, i.e., admitting all qualified students and allocating resources (faculty positions, staff support, office and computing lab space) proportionately.

**We advocate an approach that combines new resource allocations with some amount of enrollment control.** We advocate enrollment restrictions in the **short term**, since necessary additional faculty and other resources will not become available quickly enough, certainly not by Fall of this year. For subsequent years, we advocate increases in the number of regular faculty as well as increased use of adjunct and teaching faculty, increased staff support and lab space, in order to accommodate increased numbers of students without compromising the quality of our program.

Specifically, we advocate the **addition of six new rostered faculty**, five of them in the next three years. **Three of the six positions will be used to establish a strong new presence in the multimedia / networking / communication area**, the other three will be used to complement strength already present in the department, in **software engineering**, in **human and machine learning**, and in **systems**. We will strongly favor applicants who can build bridges between several such areas and who promise to be strong contributors to campus and

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8 Again, "Networking" should be construed in a broad sense, not just the technical aspects of computer networks but including issues such as the support for specific research and other communities and new ways of collaboration.
initiatives such as TLE and ATLaS.

We will make every effort to work with development staff to try to secure support for at least one of the six positions from outside the university.

Diversity

Our most prominent diversity problem is the small number of women among our undergraduate majors. We will seek funds from NSF for a prototype program where a sizable cohort of women undergraduates are recruited and receive special support while in the program. (The deadline for this proposal is October 1, 1998.) This support includes an undergraduate and a graduate student acting as group mentors, individual mentors from among practicing software professionals, a retreat each semester, and scholarship support. In this effort it is a great advantage that the college has an outstanding Women in Engineering and Minority Engineering programs.

We have diversity challenges in other areas. Neither African-Americans nor native Americans are represented in our programs in the numbers they should be. If successful we hope that our approach to increasing the presence of women could be applied to such minorities as well. In addition, we will join college and university efforts to bring the numbers up.

In our recruiting of faculty we will use existing networks and personal contacts to try to encourage women and members of minorities to apply and to provide the mentoring and other support to help them be successful once they are here.

Instructional technology and technology exploration lab

We will seek support for a program and a facility that lets us and our students explore state-of-the-art hardware and software. This will give our students experience in learning about and assessing new technologies and will support efforts in introducing technology in our own teaching, including web-based delivery and distance learning.

Visibility, alumni relations, industry relations, etc

We will develop new printed and web-based materials, participate in university events such as the “CU Before The Game” presentations and other suitable events, and initiate an annual one-day “Open House” for industry to be held for the first time during AY 1998/99.

We will actively seek input from partners in industry, making the strongest possible use of our Advisory Boards and other partners.

Support we will seek from outside the university

Faculty
New and upgraded faculty positions

We will approach supporters in industry for endowed faculty positions.

Teaching Professorships

We will seek partial or full support packages for faculty who devote more than the standard portion of their time and effort to teaching.

Students and postdocs

Graduate and Postdoctoral Research Fellowships

We will seek support for graduate students and postdoc in all of our research areas.

Graduate Teaching Fellowships

The holder of a Graduate Teaching Fellowship is assigned to assist with the teaching and/or development a course. This assignment is in addition to the default level of support. The holder of the fellowship gets support for attending conferences and other expenses related to her or his academic work. Gaining such a Fellowship is regarded as an honor that Courses that are strong initial candidates for such support include

- CSCI 3308, Software Engineering Methods and Tools
- CSCI 3287, Database and Information Systems
- CSCI 4273, Network Systems
- CSCI 6838, User-Interface Design
- CSCI 4448/6448, Object-oriented Programming and Design
- CSCI 4308+4318, Senior Software Engineering Project
- CSCI 4229/5229, Computer Graphics
- CSCI 5828, Foundations of Software Engineering.

Undergraduate System Administration Apprenticeships

These are scholarships for students who get practical experience in system administration both with our instructional lab and our research network.

Scholarships for undergraduate women

Such scholarships will be part of a new initiative to attract more women into our Bachelor's degree program.

Industrial Affiliates

Formal affiliation with the department will bring the following benefits to a company: (1) invitation to an event involving our students during the Fall semester, (2) invitation to an event focusing on research and new developments in the Spring semester, and (3) invitation to submit project ideas to our senior software engineering course.

The membership fee in this program will be pegged to the size of the company. A trial membership with all the above benefits will be free for one year. Sponsorship of a Graduate Teaching Fellowship carries with it the benefits of industrial affiliate status.

Funds raised from such affiliations will be spent at the discretion of the
Personnel support from industry

Advisory functions: Practicing software professionals can help us in the review of our curriculum. Such an advisory role is a central part of our curriculum review plan.

Professionals “on loan”: Software professionals can be “on loan” for a semester or year, teaching or team-teaching a course and being a member of a research group, akin to colleagues who visit us during their sabbaticals.

Software Engineering Projects Coaches: Our very successful Senior Software Engineering Projects course provides a special challenge and opportunity. The current model of one instructor closely supervising all individual projects will not work for higher enrollments.

A new model will leave the overall responsibility for the course in the hands of the one instructor (Bruce Sanders, who has a lot of experience in teaching this very successful course) but will add several “Software Engineering Projects Coaches.” These are practicing software professionals spending the equivalent of one half or one full day per week supervising and coaching six project groups. Adding two such coaches, each spending one full day per week, plus one Graduate Teaching Fellow to the course will support an increased enrollment of up to 72 students. (There are four students per group.) Adding another coach and teaching fellow would support up to 106 students. These coaches may also play the role of guest lecturers on topics in which they have special interest and expertise.

Instructional computing environment

Equipment: Our instructional computing environment is far from state-of-the-art anymore. We will seek equipment donations from equipment vendors.

Sponsorship of an instructional technology lab: We will seek equipment donations and grants and personnel support for such a lab. Specifically, we will seek a Graduate Fellowship for Instructional Technology, similar to the Graduate Teaching Fellowships described above but dedicated to the support of work in instructional technology.

Sponsorship of a “Technology Exploration” group and lab: This is envisioned as a group of students who evaluate new software and advice faculty and other students (and maybe sponsors) on the suitability of new software for specific tasks. This can include software to be used in teaching, such as development platforms. The need is for the donation (and occasional purchase) of equipment and software and for attendance of tutorials and workshops, plus financial support for the students and summer support for one faculty member.
Distinguished Speakers Colloquium Series

Colloquium Series  We have some funds (established by Mervyn Young) for a colloquium series. We need more in order to attract a good number of top speakers.

Physical space

Remodeling of Computer Science Wing  Computer Science has been given additional space in the Engineering Center, completing our occupancy of two floors in what is now called the “Engineering Center Computer Science (ECCS)” wing. This presents an opportunity to create a coherent and highly functional space for computer science research, as well as a space that lends itself to interactions with visiting groups, providing a setting both for demos and for discussions.

Remodeling of Graduate Lab  This facility serves mostly our Master’s students. It is not an inviting space, is likely to move to a different (not necessarily better) location and needs a make-over to turn it into an attractive space.

Remodeling of Computer Science seminar rooms  Two adjacent rooms on the top floor of the Engineering Center Office Tower have a great view (and patio) but are in great need of some interior remodeling. If done well, these spaces can greatly facilitate the spontaneous discussions that are important in the climate of an academic department.

Consolidated physical space  Our space is limited and fragmented, and the expansion and consolidation needed to support our ambitions is not possible within the existing Engineering Center. We will work towards the goal of a new building by increasing the visibility of the department and the awareness of our needs and of our contributions both within the university and in our larger community.

Support we will seek from the university

Faculty positions  The current two openings, to be filled in 1998, are replacements for people who have left. We intend to use the two openings in ways that build on existing research strength, in the general area of software and systems. In 1999 we hope to have one new position available funded by the university. Over the next three years we are asking for six new faculty positions and will try to get at least one funded through outside sources.

Space  Space in the Engineering Center is at a premium. Still, some opportunities exist. Realizing our short-term ambitions will be helped by allowing us to use space on the “ChemE Balcony”. ECCH 103 has been requested for us by the dean’s office in a memo to the chancellor. A decision is pending. Our request to get at least

9 This label is very misleading since all faculty offices (with a single exception) are located elsewhere, on the top floors of the “Office Tower,” which is about as far away from the “Computer Science Wing” as one can get without leaving the Engineering Center.
shared use of ECCH 105 and 107 has so far not found support in the college.

In the longer term, any significant increase in the size of the department will require substantial new space. We will seek college and university support for major new construction.

**Budget processes**

Existing budget formulas do not support our potential for expansion and improvement. Even at current levels our Bachelor’s degree program is the largest degree program in the college\(^\text{10}\) and is putting a strain on the college’s budget allocation formulas. We will argue for budget formulas that are pegged to our actual enrollment even when those enrollments are increasing rapidly.

**Enrollment management**

Planning for the existing Bachelor’s degree program had been predicated on the assumption that our number of majors would level off at 200. It now stands at 357, plus 99 minors, and is increasing rapidly. For the coming Fall semester we will ask for enrollment restrictions to be put in place, hoping that such restrictions can be lifted in the future as increased resources become available.

**A BS in Computer Science in the College of Arts and Sciences?**

We are open to considering a BS degree program in Computer Science in the College of Arts and Sciences, if this can be done in a way that provides adequate budget support and faculty positions. Academically, there is no compelling reason why all our programs would need to be in the College of Engineering and Applied Science. In fact, the existence of a Computer Science major in A+S would alleviate some persistent problems with intra-university transfer requirements. (It is true that A+S resisted a similar idea after our previous program review. It is unclear whether the same arguments would prevail at this time.)

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\(^\text{11}\) such as Photoshop, Macromedia Freehand, Adobe Illustrator, Macromedia Director, various 3D graphics tools

\(^\text{10}\) Electrical and Computer Engineering has two degree programs. The combined enrollment of those two degree programs exceeds ours.