I will address liberal arts colleges in general first, then turn my attention particularly to
Christian liberal arts colleges.

There have been several model curricula developed for computer science undergraduate
programs. The best known of these are the ACM's Curriculum 68 and Curriculum 78. (<3> and <4>)
Also the ACM has proposed a small college curriculum. (<1>) Recently, however, a model curriculum
has been proposed by a consortium of liberal arts colleges that is particularly well suited to the needs
of computer science programs in such schools. (<8>) It begins with the following definition of
computer science:

"Computer Science is the systematic study of algorithms and data structures, specifically
(1) their formal properties,
(2) their mechanical and linguistic realizations, and
(3) their applications.

The formal properties (1) of algorithms and data structures must be emphasized over their
specific machines and languages (2) as well as their applications (3) in order for a program to
be legitimately called computer science. If (2) takes precedence over (1), then the program
might be called computer engineering; if (3) takes precedence, the program might be called
information systems."

The structure of the curriculum itself is as follows:
There are several characteristics of this curriculum which make it particularly well suited for liberal arts colleges:

(1) The total number of computer science courses required is significantly less than in other model curricula. This is especially important since many liberal arts colleges restrict the number of courses that may be taken in a major program to 9 or 10.

(2) The program has a strong component of computer science theory. This is consistent with the liberal arts philosophy that students should master principles rather than techniques.

(3) It is not highly equipment dependent and thus can be offered in a college in which financial resources are limited.

(4) It can be taught by a faculty of three and is thus quite suitable for a small college.

While this is a strong, well-thought out, cohesive curriculum, it does share one weakness with the other model curricula mentioned earlier - it has not adequately addressed the role of mathematics in computer science education. The authors of the curriculum acknowledge this limitation. The role of mathematics in computer science is different from its role in any other science. In physics, for instance, mathematics is a tool for modeling physical entities and relationships. In even the most theoretical work, there is an underlying physical reality to which the mathematics refers. In computer science, mathematics is used for modeling (for instance, in the use of queueing theory in the study of operating systems) but it is also the object of study! For instance, binary trees are not studied as models of any physical reality, but the abstract, formal, properties of binary trees are studied and such study is viewed as intrinsic to computer science.

Thus computer science shares a much deeper relationship with mathematics than does any other science. Because of this relationship, the traditional notion of "mathematics cognates" cannot simply be carried over from other sciences to computer science. Mathematics must be fully integrated into the computer science courses as well. Thus formal definitions of concepts, proofs of theorems, and verification of algorithms should occur regularly in many computer science courses. At present, it is difficult to do this, especially with introductory courses, since beginning computer science textbooks typically avoid mathematics. However, this curriculum and others need to more fully come to grips with the role of mathematics in computer science.
In addressing the particular concerns of Christian liberal arts colleges, I see four points of contact between Christian faith and the discipline of computer science:

(1) ethical issues,
(2) technology in society,
(3) the nature of man,
(4) the nature of reason and the limits of algorithmic thinking.

There is a great need for a bibliography in each of these areas of contact that Christian schools could use. A few works are mentioned below. There are a few comments that can be made in each of these areas:

(1) The area of ethical issues is being well addressed. An outstanding work is Weizenbaum's *Computer Power and Human Reason*. (<11>) Deborah Johnson of Rensellaer Polytechnic Institute has published two excellent works (<9> and <10>). Also, an organization called Computer Professionals for Social Responsibility publishes newsletters, prepares video tapes, gives talks, etc. related to these issues.

(2) There are many good works on this subject both from secular and Christian perspectives. A work that is highly critical of the role of technology is <7>. Another perspective can be found in <2>.

(3) Weizenbaum's book is again the principal reference. <5> and <6> have also been recommended. Since this is a controversial and highly speculative area, there are many works of differing opinions. Almost any work by Marvin Minsky or Herbert Simon will present the view that computers have the potential of thinking like humans.

(4) The principal idea here is Church's thesis - that any algorithm can be carried out on a Turing machine and thus, at least in principle, can be executed on a computer. This provides both a statement of the breadth of capability of computers and a limit. For instance, the unsolvability of the halting problem provides one easily explainable intrinsic limit on the capability of computers. Weizenbaum is again the principal reference.

Much needs to be done, however, before an adequate Christian perspective on the discipline of computer science will have been attained.

References


