the University of Chicago on "The University of the Twenty-First Century." (A shorter version of this paper will be published in the summer 1992 issue of *Minerva: A Review of Science, Policy, and Learning*.) Shapiro's focus on increasing per capita student and faculty costs and on problems of productivity are particularly relevant to the situation of an academic librarian. That he invokes research libraries as a model for industry-wide institutional interdependence is both provocative and disturbing. Shapiro's comments underscore not only how far academic libraries still have to go, but also how little the institutions we serve understand the complexity and economic uncertainty of the tasks before us all. At the most fundamental level, one might indeed wonder whether colleges and universities can carve out a cooperative, interdependent niche for themselves, or for just some parts of their operations, in an otherwise competitive marketplace. The Anti-Trust Division of the Justice Department has opposed such behavior in the administration of student aid, for instance. Are there in fact any models that indicate whether such exceptional economic behavior can succeed, and do we know what its public policy consequences, both positive and negative, might be?—*Scott Bennett, Johns Hopkins University, Baltimore, Maryland.*

Blum, Rudolf. *Kallimachos: The Alexandrian Library and the Origins of Bibliography.* Trans. by Hans H. Wellisch. Madison, Wis.: Univ. of Wisconsin Pr., 1991, 282p. $37.50 (ISBN 0-299-13170). LC 91-28997.

Rudolf Blum's study was originally published in Germany in 1977 as a monograph and in an issue of *Archiv für Geschichte des Buchwesenss.* It presents the argument that Kallimachos (perhaps more familiar in the Latinized form Callimachus) invented the library catalog and bibliography. Kallimachos may be best known as a learned court poet of the Hellenistic period, famous for his remark that a "big book is a big evil," and especially influential with Roman poets like Catullus. Kallimachos was also a

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scholar and librarian. Blum believes that he was the second to hold the position of chief librarian of the great library at Alexandria. His *Pinakes* (or *Lists*), in Blum's view the first bio-bibliography, was a massive work in 120 books, now known only through later references, and a major source for information about authors and their works in antiquity.

Founded in the early third century B.C. by Ptolemy I, one of Alexander's successors, the Alexandrian library quickly grew in size so that by the time of Kallimachos it must have held a significant portion of extant Greek literature. Blum concludes from the fragmentary and scattered evidence available that Kallimachos had inherited a collection that was organized and inventoried, but that he was the first to catalog its contents. Such an undertaking demanded a critical understanding of Greek language and literature, since many works were known under a variety of titles or were falsely ascribed or attributed to several authors. With a few exceptions, such as a now-lost work of Aristotle on Athenian playwrights, no reference tools existed to help determine authenticity. Kallimachos was forced to rely to a great degree on internal evidence in the works themselves and on his knowledge of linguistic and historical context. Thus, the task of cataloging went far beyond bibliographic description and became a combination of literary history and textual criticism. Blum believes that Kallimachos included in this catalog not only bibliographic information about the works but also biographical information about authors accumulated in the course of his research.

This unpublished catalog served chiefly as an internal document describing all copies of the works then held in the library. The *Pinakes* formed a natural adaptation of this catalog and described not copies, but works. Because it included most extant Greek literature, the library at Alexandria served as a *de facto* national library and the *Pinakes* became a kind of national bio-bibliography for its day. Published by Kallimachos or his literary heirs, the *Pinakes* came to be a standard reference work and for many years was used and cited as an authoritative source for Greek literary history. The format adopted by Kallimachos presented the name of the author, some formulaic biographical data, the title, the size of the text and sometimes the first words (in medieval terms, the *incipit*). Although the *Pinakes* has not survived, and its accuracy and thoroughness must remain uncertain, it decisively influenced the format and content of bibliographic work through antiquity and into Byzantine times.

Because neither the *Pinakes* themselves, nor the works based on them have survived, Blum had to examine scraps of evidence from the fifth century B.C. to the Byzantine era. His reconstructions often depend on a series of inferences from this evidence with varying degrees of certainty, and at times the foundation seems too flimsy to support the conclusions. Nevertheless, his analysis and bibliography show familiarity with both the ancient evidence and previous scholarship on the subject. The English version follows the German in translating all the ancient source material so that the reader without Latin or Greek can readily follow the arguments.

This work, first published in 1977, is undoubtedly useful for its close examination of the evidence and its articulation of Kallimachos' contribution to scholarship and bibliography. Its methodology—the unavoidable scrutiny of fragmentary and ambiguous information, and the rehearsal of previous scholarly interpretation—makes it rather difficult to read, and the translation does not help. In general the translation seems to be accurate, though constrained by the content and structure of the original. But the style is often pedestrian and awkward, and occasionally nonidiomatic, if not incorrect (e.g., "Certainly the Alexandrian grammarians found in these works many useful informations.").

Although Blum's conclusions may deserve wider recognition in the English-speaking world—it attracted little attention from reviewers in the English-speaking world when it was originally published—it is not clear that a transla-

tion is really needed. To analyze Blum's arguments would require someone well-grounded in classical studies, who would necessarily have to be able to read the original German. The general picture of the Alexandrian library, and the methods and achievements of Kallimachos—subjects which might have attracted the interest of readers without backgrounds in classical studies and innocent of German—remain entangled in the unfriendly prose and dense arguments of the text.—*Edward Shreeves, University of Iowa, Iowa City.*

Gelernter, David. *Mirror Worlds: Or the Day Software Puts the Universe in a Shoe Box . . . How It Will Happen and What It Will Mean.* New York: Oxford Univ. Pr., 1991. 237 p. acid-free, $24.95 (ISBN 0-19-506812-2). LC 91-19178.

In *Mirror Worlds* David Gelernter joins the ranks of computer scientists who have attempted to provide the nontechnical reader with a glimpse of the future of information technology. Gelernter teaches computer science at Yale and specializes in programming languages for what is known as massively parallel computation. His book is both an explication of the software architecture for parallel programming and a vision of the potential applications of this technology.

A *mirror world* is a software model of reality, fed and constantly updated by rivers of data pouring in from remote sensors and databases. For the user, the intricate complexity of a city, corporation, hospital, or any other institution is collapsed into a single, recognizable but constantly changing image on a computer screen. The user can zoom in on the intimate details, or zoom out for a global picture, open up television pictures of actual events taking place at that moment, or move back in time, delving into the historical record.

To support these mirror worlds, vast computer power is needed, much more than can be reasonably expected from single programs on single machines. Gelernter proposes as an alternative "asynchronous software ensembles," myriads of separate programs, running on separate machines but cooperating, communicating, and coordinating with each other over high-speed networks. Some of these ensembles take the form of personal "agents" that act as information gatherers for the individual user; others are more like general-purpose utilities, floating in some computational hyperspace, available for anyone to use. Gelernter likens these to piranhas waiting for a meal to present itself. As a task "floats by," the programs "attack" it and solve whatever parts they can. The remaining parts float on until the entire task is solved, and the results are gathered up by those agents "interested" in them.

Supporting the mirror worlds is a vast "Tuplesphere" of information and programs distributed via a global network from countless machines and databases. "While we're at it," Gelernter writes, "we might as well take the world's libraries, digitize them and dump them into the Tuplesphere as well," with the all-too-common computer science insouciance for the time, cost, and legal issues involved in such an action.

Gelernter describes at some length how programs work and how his "Linda" system coordinates the actions of many simultaneous programs. He manages through analogy and metaphor to convey a sense of what is really going on in massively parallel computation (at least for the Linda model) in terms that should be understandable to the intelligent layperson. For readers with a technical background, there are a few references to his textbook on parallel programming.

Gelernter's writing style ranges from the folksy to occasional bursts of visionary lyricism. One passage, describing a program he calls an "infomachine" is reminiscent of the science fiction writing of William Gibson: "An infomachine bursting forth into the emptiness of computer-science is a fireworks chrysanthemum—intricate tracery drawn carefully on nothing, hanging in a void, ungraspable, unfolding automatically—but real, vivid and striking. It burns fast and bright, transforms galaxies of com-