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Carol Tenopir

University of Tennessee - Knoxville, ctenopir@utk.edu

Peter B. Boyce

Maria Mitchell Association and American Astronomical Society

Donald W. King

University of Pittsburgh

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NOT ALL USERS ARE ALIKE: HOW DO AGE AND PRODUCTIVITY AFFECT USER BEHAVIOR?

*Peter B. Boyce, Maria Mitchell Association and American Astronomical Society
Carol Tenopir, University of Tennessee
Donald W. King, University of Pittsburgh*

Abstract

A survey of the usage patterns of astronomers shows large differences in behavior between the productive and not-so-productive cohorts. The productive half of the user community accounts for 80% of the publications, exhibits no dependence of usage upon the age of the user, and is willing to master difficult procedures to use online services. The less productive set of users show usage decreasing with age. The entire cohort overwhelmingly prefers the journals over the e-print servers as a source of definitive information. Within the astronomical community the e-print servers are used as a tool for keeping aware of recent developments but not as a substitute for the journals.

In 2002 the authors conducted a survey of the membership of the American Astronomical Society (AAS) to assess the usage patterns of astronomers with regard to the electronic information services available to the astronomical community.¹

Astronomy makes a perfect test bed for studies of this sort because it is a small discipline with a limited number of core journals. Gomez shows that 90% of the cited articles are published in 11 journals.² In addition, astronomers have had electronic journals since 1995³ and a well-linked electronic information system since 1997.

The astronomical community has a well-established and comprehensive set of information resources consisting of feature-rich electronic journals, a searchable abstract database, an archive of full text backfiles for all the core astronomical journals, and several international databases holding tabular data and catalogs of information. All the services are interlinked and interoperable, providing an integrated resource for most of the usual information needs of the users. This system has been available in its current form since 1997.

The Astrophysics Data System (ADS) is a NASA-supported service set up for the astronomical community (<http://adswww.harvard.edu>).⁴ The central component of the ADS is a searchable database of abstracts of the astronomical literature deep linked (one click) to full text of the articles. The coverage is virtually complete for the core literature in astronomy. The second component of the ADS is a store of full text, page-image scans of nearly all the important astronomical literature, complete from page 1 of volume 1. As well as being linked to the full text, the ADS abstracts are linked to data tables, reference lists, future citations back to the article, abstracts of similar articles, etc. As will be seen, this is a powerful system for the users.

This chapter focuses on the behavior patterns of the more productive users. We measure productivity by the number of papers submitted to refereed journals. In our survey, we asked how many papers they had submitted to a peer-reviewed journal during the previous two years. According to our survey, the average astronomer submits 2.8 articles per year. This is

not a true measure, since many of these articles have multiple authors. Abt has done several analyses of published astronomical literature.⁵ Making appropriate corrections for multiple authors, percentage of astronomers in graduate school, etc., our results are consistent with Abt's earlier results—a publication rate of somewhat more than one-half refereed paper per year per astronomer.

We divided our survey responses into three productivity classes, as shown in Table 1. The characteristics of these three productivity classes are shown in Figure 1. The productive astronomers make up 46% of our sample but produce 78% of the published literature and account for 61% of the reading. The productive astronomers read twice as many articles per month as the cohort of astronomers we have labeled nonproductive.

Table 1. Definition of Productivity Classes.

Label	Definition
Non-Productive	< 1 refereed articles per year
Average	1–2 refereed articles per year
Productive	>2 refereed articles per year

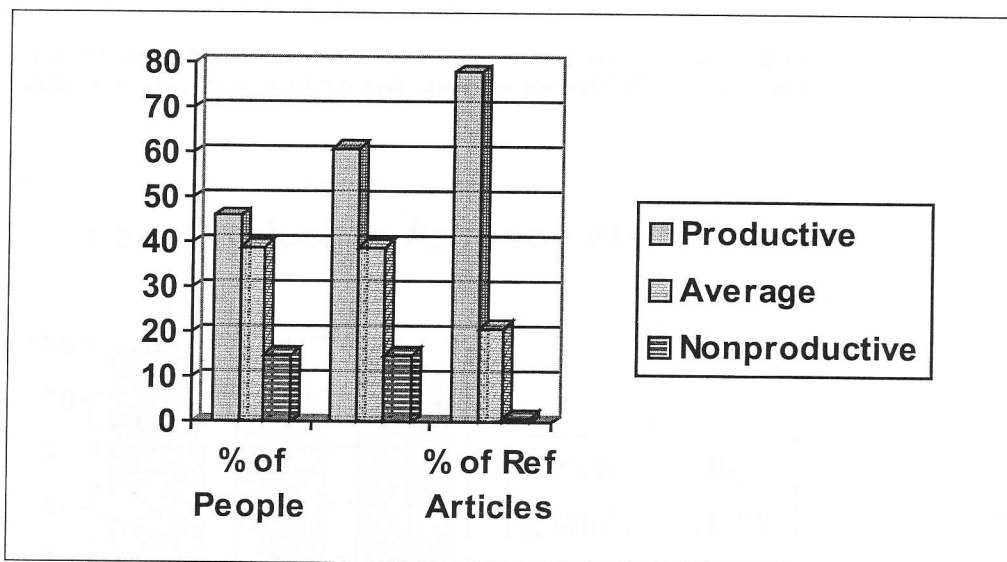


Figure 1. Characteristics of Productivity Classes Showing the Percent of the Population, the Percent of the Total Usage of the ADS, and the Percent of Refereed Articles Contributed by Each Class.

In the AAS survey we asked about awareness and usage of various electronic information services. The central role played by the ADS's abstract database is apparent from Figure 2. Every productive user knows about and uses the ADS, the searchable abstract database. One of the surprising results of our survey was the high use of electronic resources by older astronomers. Figure 2 demonstrates this for usage of the ADS. In particular, productive astronomers of all ages use the online abstract database. Even for the less productive (and less active) users

there is very little falloff of usage with age. The left-hand set of bars shows the percentage of respondents who are aware of the service, and the middle set shows the percentage of respondents who use the service. The right-hand set of bars in Figures 2a and 2b shows the percentage of those astronomers aware of the service who actually use it.

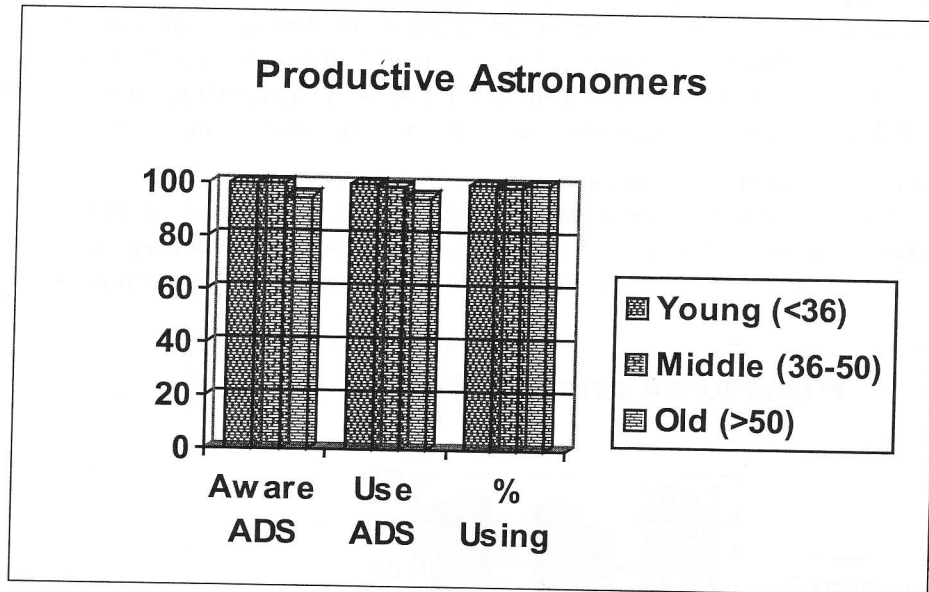


Figure 2a. Percent of Productive Astronomers Aware of and Using the ADS. The right-hand set of bars shows the percentage of astronomers aware of the ADS who actually use it.

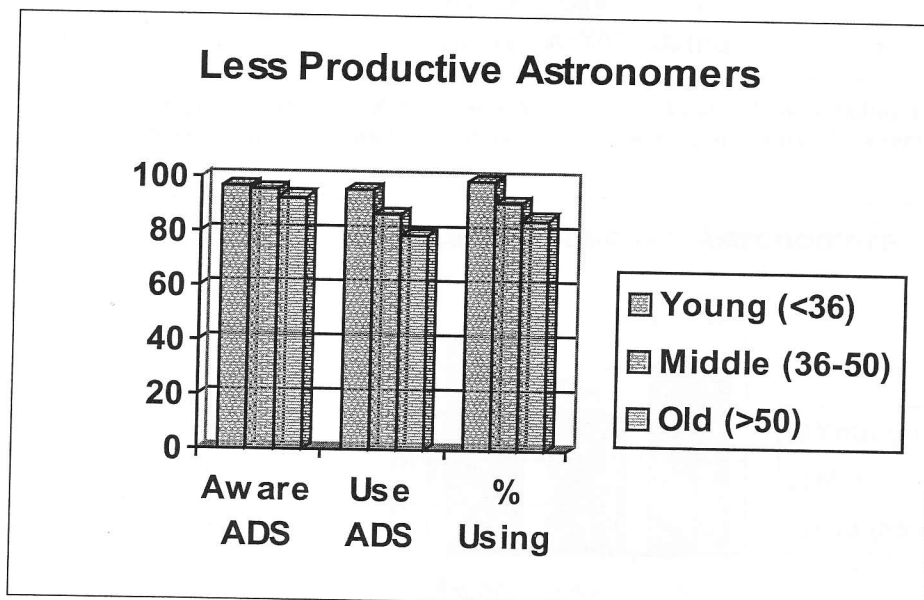


Figure 2b. Nonproductive and Average Astronomers Aware of and Using the ADS. Note the small decline in awareness and usage with age among the less productive astronomers.

Note that all the productive users both know about and use the ADS regardless of the age of the user. Among the less productive astronomers, the older users are slightly less likely than their younger colleagues to use the ADS. However, the fact that 80% of the oldest and least productive astronomers use the ADS confirms the importance of the ADS to the astronomical community.

The astronomical community has a long tradition of using paper abstracts, and in today's electronic environment, much of the community has turned to using the ArXiv e-print server (<http://arxiv.org>). Since the manuscripts remain on the ArXiv server after they are published, we adopt the term *e-print* to refer to the electronic manuscript both before and after publication. Figure 3 shows the percentage of astronomers who have used the ArXiv in the past year.

While there are other e-print services available, astronomers almost exclusively use the ArXiv server. Other services used in astronomy tend to be selective services limited to small subspecialties. Non-ArXiv usage is less than a few percent, so we take the ArXiv usage as representative of astronomers' work patterns.

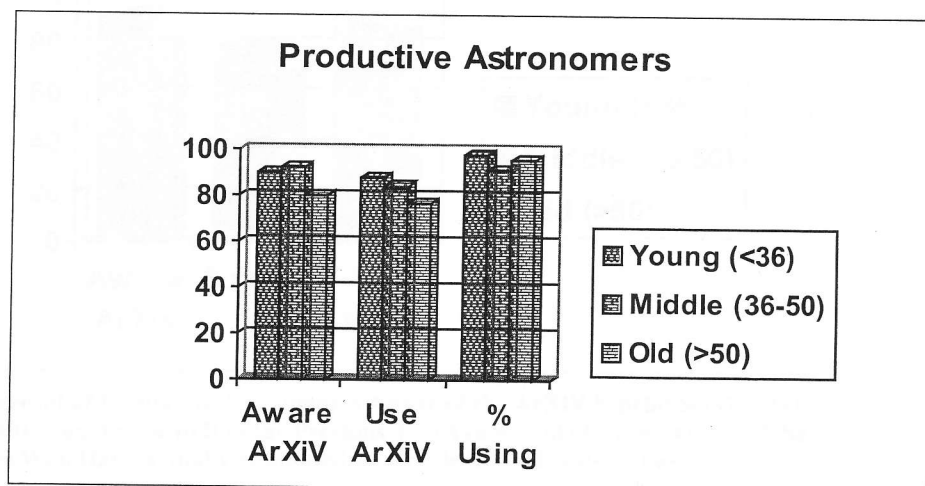


Figure 3a. Percent of Productive Astronomers Aware of and Reading E-prints on the ArXiv Server. The right-hand set of bars refers to the percent aware of the service who actually use it.

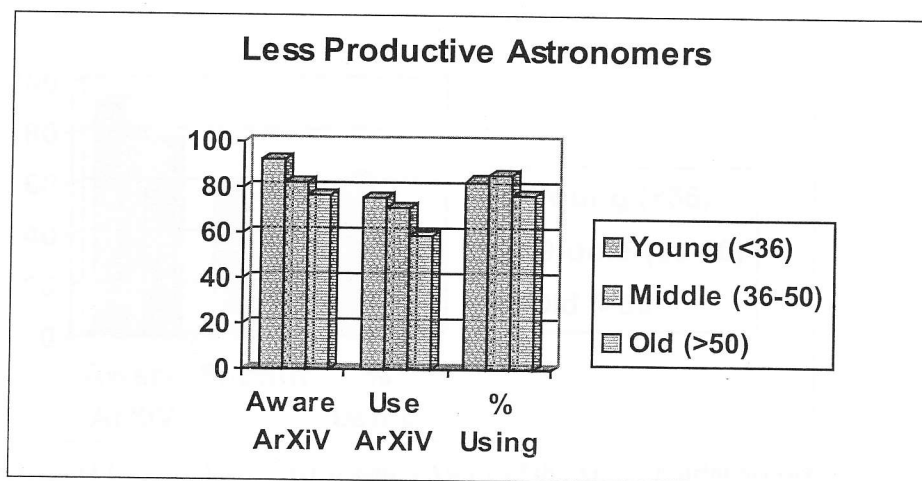


Figure 3b. Percent of Less Productive Astronomers Aware of and Reading E-prints on the ArXiv Server. The decline in usage with age is larger than it is for the ADS service.

The awareness of the ArXiv e-print server among the productive astronomers is marginally smaller than awareness of the ADS, but among the people who are aware of it, the percent reading from the ArXiv server is very high and independent of age. However, among the nonproductive users, the usage does fall off with age.

If we now consider the submission of articles to the ArXiv server, we see a more pronounced version of the same pattern. Figure 4 shows that productive astronomers are somewhat less likely to submit an article than to read from the ArXiv server. However, there is still very little dependence of usage upon the age of the user.

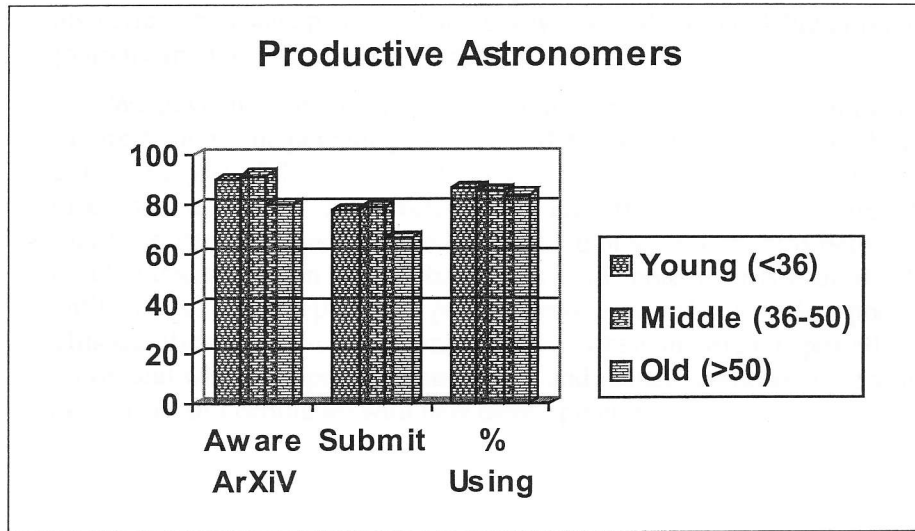


Figure 4a. Percent of Productive Astronomers Aware of the ArXiv E-print Service, Who Have Submitted an Article to It in the Previous Two Years, and of Those Aware of the Service Who Have Actually Submitted an Article in the Previous Two Years.

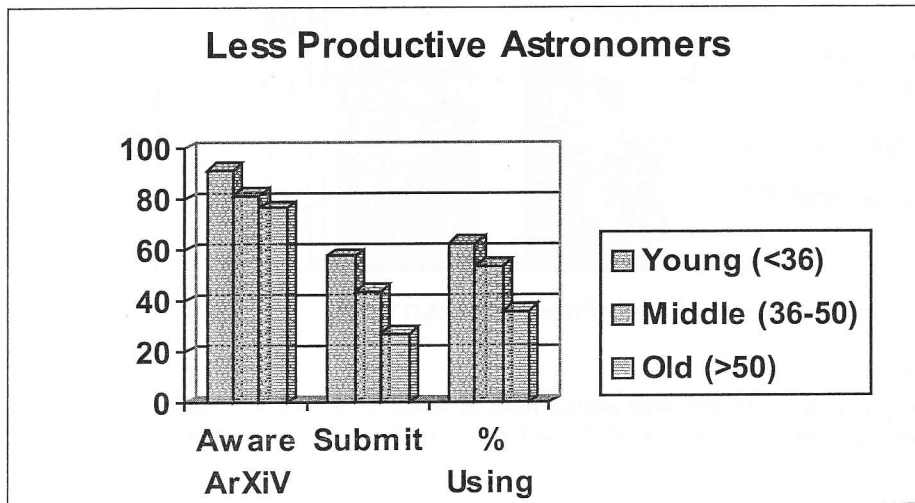


Figure 4b. Percent of Less Productive Astronomers Aware of the ArXiv E-print Service, Who Have Submitted an Article to It in the Previous Two Years, and of Those Aware of the Service Who Have Actually Submitted an Article in the Previous Two Years.

On the other hand, the less productive users are much less likely to have submitted an article to the ArXiv server, and there is a strong dependence upon the age of the user. Only one-third of the nonproductive users over age 50 have submitted an article within the previous two years. In part this result may be due to the difficulty of submitting articles. The ArXiv is not known as being a user-friendly service, particularly for the new user. Within the astronomical community it has been referred to as a “user-belligerent” service. From our results, it seems clear that the productive user will do whatever is necessary to use the service, regardless of age. The less productive users, even the younger ones, do not feel as motivated to learn how to use a difficult service.

Ease of use is not the only factor governing usage. The perceived value of a resource will also affect the usage patterns. Our survey asked about the value of both the peer-reviewed journals and the non-reviewed e-print servers.

We gave the respondents five categories, ranging from worthless to critical to their work. Figure 5 shows the percentage of respondents who found the journals and the e-print servers either “Very Useful” or “Critical” to their work. Figure 5a shows the responses for the purpose of keeping up with recent developments. Here the journals are preferred slightly over the e-print server even though there is a time lag of several months between when the manuscript is submitted and when it is published. As a side note, over two-thirds of the respondents wait until an article is accepted by a peer-reviewed journal before they post it on an e-print server. This significantly reduces the time between when an article is posted to the ArXiv e-print server and when it appears in the journal and reduces somewhat the value of the e-print server as a means of keeping up with new developments.

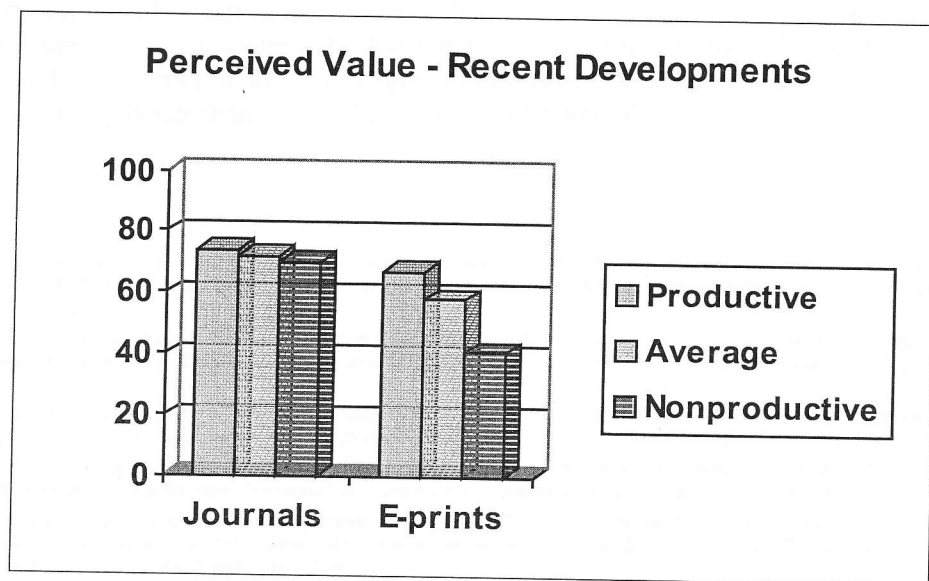


Figure 5a. Perceived Value of Information Resource. Percent of respondents rating resource as “Critical” or “Very Useful” for keeping up with recent developments.

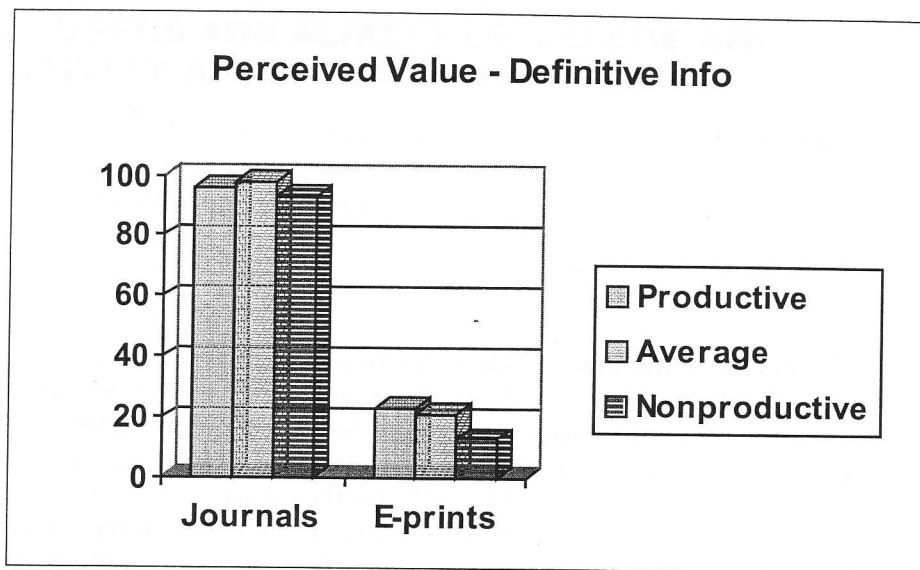


Figure 5b. Percent of Respondents Rating Resource as “Critical” or “Very Useful” for Obtaining Definitive Information. Note that astronomers prefer the journal for definitive information by an overwhelming factor. The use of e-prints seems to be reserved for rapid communication.

Figure 5b shows the responses for users seeking definitive information. It is immediately obvious that the peer-reviewed journals are the service of choice for finding definitive information—which we defined as information older than two years.

We believe that the usefulness of the journals as exhibited in Figure 5 is the result of the journals being part of a complete information system that exists for astronomy. The combination of the journals, the searchable abstract database, the complete full text backfiles, and the online astronomical data centers provides an integrated, interoperable online resource that serves the user community better than any of the components taken alone.

Notes

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