AAVSO DATA PROCESSING: TEN YEARS OF COMPUTERIZATION

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In 1926 Leon Campbell, the Recording Secretary of the AAVSO, wrote the first article describing the processing of the AAVSO observations. The methods he used were as follows. First the observations were plotted on graph paper, each star on a separate sheet. Then each observation was copied into a ledger book. Each month's observations were published in Popular Astronomy. Each year the preceding year's observed maxima and minima were determined and were published in the Harvard Circular, and the next year's predicted maxima and minima were published in the Harvard Annals. In all this work, the only tools available to Mr. Campbell were pencil, paper, a typewriter, and probably a mechanical adding machine.

Things have changed since then. The technological revolution has put us into the age that was only dreamed about in the 1920's. Indeed, in the last ten years, the AAVSO itself has undergone two technological revolutions of its own--of small scope within the big picture, but of tremendous importance to the Association.

Since the founding of the AAVSO in 1911, the annual number of observations reported to us has been increasing exponentially. There were only 17,990 observations in 1926, but there were 171,185 of them in the fiscal year 1975-76. The steep part of the exponential curve begins between 1955 and 1960. Perhaps it is no coincidence that this was the time of Sputnik, and of the beginning of the space race. Suddenly astronomy was "big science," invaded by government and industry and promoted by the press. Big money flowed to universities and to observatories.

Paradoxically, the work of amateur astronomers then became even more important than it had been before. Professionals felt they could not spare the time or the equipment for continuous programs of variable star observing. It became necessary for us to publish our observations in a form readily usable by professional astronomers.

In 1967 (under the directorship of Margaret Mayall) the observations began to be recorded on IBM cards instead of in the ledger book. Keypunch machines, a verifier (which is used to check the cards for keypunching errors), and a mechanical card sorter were leased, and computer time was given to us by the Smithsonian Astrophysical Observatory. For the AAVSO, the computer age had begun.

AAVSO Report 28, published in 1970, was produced using the computer. It contained light curves of ten-day means of long-period variables from 1961 to 1963. All calculations as well as the printing of the plots were done by the computer.

Light curves had a clear advantage over lists of observations. With ever-growing heaps of data, it is necessary to make their meaning as immediately clear as possible. Not only are voluminous listings inconvenient, but also when visual observations are concerned, the shape of the light curve is as important as the actual magnitude values, which generally show a scatter of no less than ± 0.2 magnitudes. Because the hand plots are mere "working plots," and because it was unthinkable to re-draft in India ink the hundreds of thousands of dots marked on them, computerized graphics were (and are) seen as the only choice.

Computerization had other advantages. The punched cards could be handled en masse--sorted by machine, or used as input to computer programs. In principle, mathematical treatment no longer required human brainwork once the requisite computer programs had been written. As the yearly number of observations continued to soar, it became more and more clear that using the methods of 1926 again would be like taking a Stanley Steamer onto an urban expressway.

In the middle 1970's (under the present directorship) more innovations were made. The first was the policy of keypunching and verifying observations as they came in. Though there was a backlog of several years' data to be punched, it was decided that the backlog should receive second priority, since professional astronomers most often are interested in recent data. The backlog, by the way, has now been keypunched, while the processing of current data has been kept completely up to date.

In early 1976, AAVSO data processing was as follows. First the incoming observers' reports were keypunched. Then the punched cards were verified and corrected. Each month's batch of cards was sorted with a mechanical card sorter so that the observations of each star were all together and in order of Julian Date. The sorted cards were read into the computer, which gave us back a listing of them. From this listing, the hand plots were updated. The cards themselves were stored in AAVSO Headquarters.

Overlooking some minor modifications in the computer program for plotting, the production of the AAVSO Reports was by the same method as was used for Report 28.

Then, in the summer of 1976, we got intimations of the leaps in efficiency and sophistication that we might yet effect. That summer, the preceding ten years' data, all on IBM cards, were recorded on magnetic tape. About 1.3 million cards (one for each observation) were read into the computer over three months. Though this job was done to prevent the destruction of the data in case of a fire at AAVSO Headquarters, it was clear that the tapes would be much more convenient than the original cards for input to computer programs.

Accordingly, student assistant Richard Strazdas set to work writing programs (in the language FORTRAN) to handle the taped data. He wrote three that were very useful. The first, called VALID, reads raw data from a tape; makes them ready for further handling by correcting errors in designation (such errors in the observers' reports are not systematically screened prior to this step); and records the data thus handled onto a second tape. The second program, called BSORT, replaces the mechanical card sorter. It reads the observations off one tape, sorts them by star and date, and records them sorted onto a second tape. The third program, called BMERGE, reads two tapes of sorted data and records these data combined and sorted all together onto a third tape.

Meanwhile, it was decided that it would be wise to take advantage of some advances in computer graphics. The Center for Astrophysics (the institution which now comprises the Harvard College Observatory and the Smithsonian Astrophysical Observatory) had two computer plotting units, a Versatec and a Calcomp. The two work on completely different principles (electrostatic vs. ink, respectively), but each is essentially a mechanical draftsman. The AAVSO had never used these units. Instead, all our plotting had been done on a line printer, which is a teletype that prints a whole line at a time, rather than only one character. Making a plot with a line printer is like drawing a picture with a typewriter. All you can use are the letters of the alphabet, dashes and some other symbols, and

numerals, all of a set size and with a particular spacing, hence the subtlety of your artistic expression is necessarily limited. In this case, it was impossible to place data points any closer together than 1/10 of an inch. For this reason, it was necessary to plot one-day, five-day, or ten-day means rather than the individual observations themselves.

Strazdas wrote a computer program to utilize the plotting units. The new plots do show the individual observations themselves, and therefore also provide a clear and direct representation of their density and scatter. See a plot of SS Cyg for 1976 done in the new style, Page 23 of this issue of JAAVSO. These plots are to be used for future AAVSO Reports. (Incidentally, they are also easier to edit than the old plots.)

The new computer programs constitute the second of the AAVSO technological revolutions, the first having been the original switch to computer processing. The essence of the latest change is a partial conversion from card-based to magnetic-tape-based data processing, and from line-printer graphics to plotter graphics.

Right now, August 1977, the monthly routine is as follows. First the observers' reports are keypunched, the cards are verified, and cards that have keypunching errors are corrected (no change here). Then the cards are read onto magnetic tape. The data, read from the tape, are run through VALID, then through BSORT. A listing of the sorted data is obtained. From this listing the hand plots are updated (no change here). The cards are stored in AAVSO Headquarters, and the tapes are stored at the computer center of the Center for Astrophysics.

For the next AAVSO Report, we shall combine and sort (using VALID, BSORT, and BMERGE as required) all the data from Julian Day 2442300 to 2443300. Preliminary plots will be obtained from the Versatec plotter and the final plots will be run on the Calcomp plotter.

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ASTEROID PHOTOMETRY AND THE ALPO MINOR PLANETS SECTION

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ABSTRACT

The ALPO Minor Planets Section is developing a program of asteroid photometry and invites interested observers to participate. The goal is to determine the periods of rotation, valuable in physical studies of these bodies. Photoelectric photometry is the most powerful method, but systematic visual observations can be valuable. Predictions of passages of minor planets through the AAVSO chart fields are published in the Section's Minor Planet Bulletin and additionally distributed to active observers. Suitable photometry report forms are available free of charge. In August of 1974, three members of the Section redetermined and corrected the period of 18 Melpomene. Other successes have included 41 Daphne, 270 Anahita, and 1580 Betulia.