Digitizing Olin Eggen's Card Database

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Abstract The goal of the Eggen Card Database Project is to recover as many of the photometric observations from Olin Eggen's Card Database as possible and preserve these observations, in digital forms that are accessible by anyone. Any observations of interest to the AAVSO will be added to the AAVSO International Database (AID). Given to the AAVSO on long-term loan by the Cerro Tololo Inter-American Observatory, the database is a collection of over 78,000 index cards holding all Eggen's observations made between 1960 and 1990. The cards were electronically scanned and the resulting 108,000 card images have been published as a series of 2,216 PDF files, which are available from the AAVSO web site. The same images are also stored in an AAVSO online database where they are indexed by star name and card content. These images can be viewed using the EGGEN CARD PORTAL online tool. Eggen made observations using filter bands from five different photometric systems. He documented these observations using 15 different data recording formats. Each format represents a combination of filter magnitudes and color indexes. These observations are being transcribed onto spreadsheets, from which observations of value to the AAVSO are added to the AID. A total of 506 U, B, V, R, and I observations were added to the AID for the variable stars S Car and l Car. We would like the reader to search through the card database using the EGGEN CARD PORTAL for stars of particular interest. If such stars are found and retrieval of the observations is desired, e-mail the authors, and we will be happy to help retrieve those data for the reader.

1. Introduction

Olin Jeuck Eggen was born on July 9, 1919, in Rock County, Wisconsin. He earned a B.A. from the University of Wisconsin in 1940. After serving in World War II as a civilian with the U.S. Air Force, U.S. Navy, and as a courier for the Office of Strategic Services (OSS), he returned to the University of Wisconsin and earned a Ph.D. in astronomy in 1948. He held staff positions at Lick Observatory, Royal Greenwich Observatory, California Institute of Technology, Mt. Wilson Observatory, Mt. Stromlo Observatory (as Director), Australian National University, and Cerro Tololo Inter-American Observatory (Freeman *et al.* 2000). Eggen was well known as a proponent of small-telescope science.

Eggen was an extremely prolific researcher, publishing some 400 papers during his fifty-year career, with articles being written up until his death in 1998 from a heart attack. However, Eggen published only a small part of the enormous amount of data he collected over his lifetime.

The Eggen Archive is held in the Steenbock Library at University of Wisconsin, Madison. The AAVSO is most interested in this untapped data resource. All his observations were handwritten onto index cards that he kept in his office. Often, when a visitor would ask a question about a star, he would look up the coordinates, go to his card file, and retrieve observations that he had made of that target.

In early 2007, the AAVSO contacted Cerro Tololo Inter-American Observatory (CTIO) to find out what had happened to that card catalog, mainly because they were interested in some observations that Eggen had made on a variable star but had never published. CTIO had taken the cards out of Eggen's office upon his passing, and had placed them in storage at La Serena. Since they were not serving any useful purpose in storage, CTIO Director Alistair Walker gave the AAVSO the entire collection of 78,000 cards on long-term loan.

The American Astronomical Society (AAS) helped with a Small Research Grant in 2007 to pay for the equipment to scan the cards. John Menke gave a grant for the publishing of the scans (Henden 2009).

2. Tools and methods

The Eggen cards are presently stored at AAVSO Headquarters (Figure 1). One of several cards for the variable star S Car is shown in Figure 2. On the left side of the card are UBV observations and on the right side are RI observations. This card contains a portion of a sequence of observations spanning multiple cards. Note that Eggen didn't record the observation times on this card. This was a common practice when observing stars not considered to be variable and for some long period variables.

This card will serve as an example throughout section 2 to show how cards in Eggen's database progress from card box to AID observations.

Figure 1. The Eggen Card Database as it arrived from CTIO (Henden 2009).

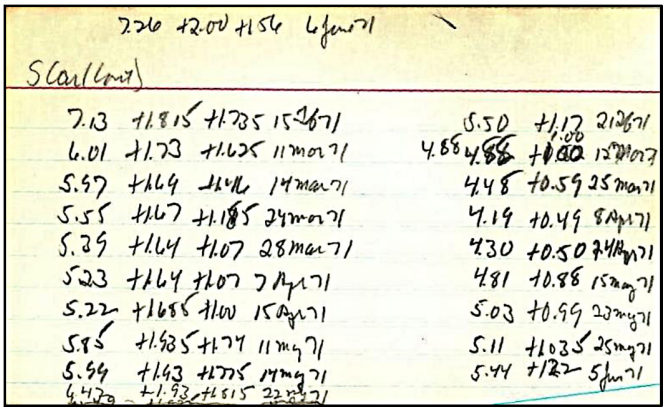

Figure 2. One of Eggen's cards documenting observations of the variable star S Car during 1971.

Table 1. Arrangement of bundles and PDF files in box 8B. The card shown in Figure 2 is addressed as page 5 of PDF file 7, in bundle C, in box 8B.

Box	*Bundle*	*PDF Files*
8B	A	1,2,3,4,5,6,7,8,9,10
	B	1,2,3,4,5,6,7,8,9,10,11,12,13
	C	1,2,3,4,5,6,7,8,9,10 ▶ Page 5
	D	1,2,3,4,5,6,7,8,9,10

2.1. Card scanning and publishing the card images

During the summers of 2007 and 2009, assistants scanned the 78,000 cards, creating over 108,000 images. The organization of the card images was based upon the organization of the physical cards in their 64 boxes. Each box was assigned an alphanumeric identification code. Some boxes contained groups of bundled cards, 258 in total. These bundles were assigned alphabetical identifiers.

The images were saved into 2,216 PDF files, grouped into 258 bundles which in turn were grouped into 64 boxes (Table 1). Individual cards images are found by their Box/Bundle/PDF file/Page address (Silvis 2013). This is not a one-to-one mapping between physical card and card image since many cards have data written on both sides, requiring two card images to be generated. The card in Figure 2 has the address "8B/C/7/5". Loose cards within a box are documented in separate PDF files under the bundle identifier of null. These card images are addressed as Box//PDF file/Page.

2.2. Indexing and classifying the cards

George Silvis, the project leader, copied the card images from the 2,216 PDF files into a MYSQL database residing on an AAVSO server. Indexing and categorizing the card images were performed using the EGGEN CARD PORTAL also developed by Silvis.

The card images are addressed using the same Box/Bundle/PDF file/Page system used for the original PDF files. Figure 3 shows the portal displaying card 8B/C/7/5, the card in Figure 2. The address has been entered in the input boxes in the line "Select Batch" line. This is a card search function which can be performed without needing special edit authorization. The "76" following the Request button shows the number of cards remaining in this PDF file after the card shown. The fields in the two "Edit Card:" lines cannot be altered without edit authority.

Card 8B/C/7/5 was retrieved from the database by entering "8B", "C", "7", and "5" into the "Box", "Bundle", "PDF", and "Page" boxes found on the "Select Batch" line. In the two "Edit Card" lines the card's color, orientation, and classification are displayed. Here the card's color is the default value of white, its orientation is "0" since the card did not need any rotation to properly view it, and its classification of "P" as a card with usable photometric observations. The "Note" box holds any comments concerning the card. To the right under the "Star" label is the star name assigned to this card. Next to it are buttons to display the SIMBAD entry for this star and a button to remove the name. Below the buttons is an input box for additional names, if more than one star is identified on the card (Silvis 2016a).

When indexing card images, the user must sign onto the portal by entering their AAVSO observer identification code and an edit authority password assigned by Silvis. The user enters the box and bundle codes (also assigned by Silvis) into the boxes labeled "Box" and "Bundle" on the second line. Next, "N", standing for not indexed, is entered into the "Classification" box, and finally the user presses the Request button. The first unindexed card image is then displayed.

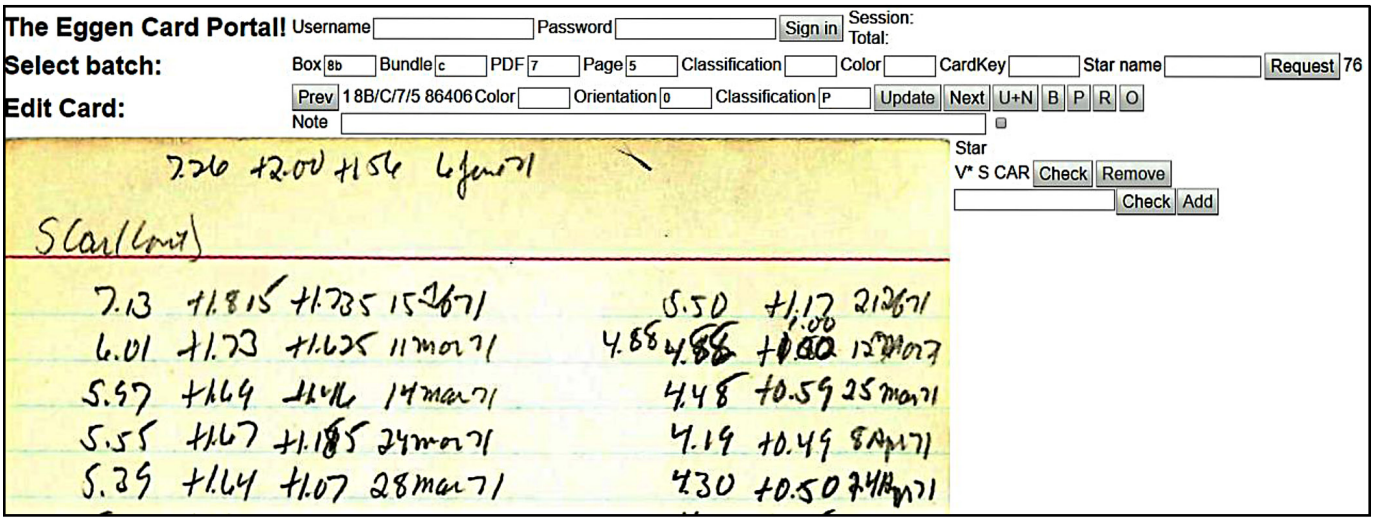

Figure 3. Card 8B/C/7/5 (Figure 2) as displayed on the EGGEN CARD PORTAL. Only a portion of the card is shown (Silvis 2016a).

Each card may have multiple star designations written upon it. These designations may all be synonyms referring to the same star, a list of unrelated star names each referring to an individual star, or a mixture of the two. The user enters one of these names into the box next to the Check button, found to the right of the card image. Pressing the Check button starts a search by SIMBAD, the results of which will appear in a new browser tab.

The SIMBAD entry, if one is found for the name being checked, is verified to be Eggen's intended star by cross checking the star's coordinates, cross checking additional names on the card against the list of alternative names provided by SIMBAD, V band magnitude, spectral type, or other clues provided by the card. If the name represents the intended star, then pressing the "Add" button will assign the star name to the card.

If the card holds multiple star designations, then these names also need to be verified. Unrelated designations are added to the list of names assigned to the card while synonymous names are not.

Initially each card image is assigned the default classification "N" . When the card is indexed, the classification is reassigned to one of the following:

B Blank card.

S Special (not a star card, but some other document).

R To be reviewed (Let the supervisor look at this one).

P A card which identifies a single star or a list of unrelated stars. At least one star is found either by name or by coordinates in SIMBAD, and has usable photometric observations.

O A card for which none of the star references found on the card are found in SIMBAD.

D A card which identifies a single star or a list of unrelated stars. For each star found either by name or by coordinates in SIMBAD there are no usable observational data on the card.

Several properties of the card such as the color of the card, the card's orientation, and its new classification are entered on the first of two "Edit Card:" lines. Comments are typed into the "Note" box, above the card image. The card's classification is updated, by pressing the Update button, which replaces the existing "N" class with the new classification. The next card is displayed by pressing the "Next" button and the process is repeated.

The portal also provides a search function to find all cards indexed under a particular star identifier or one of the star's alternative names. No special authorization is needed to use the search feature. Enter the star identifier into the "Star name" box and press the "Request" button.

The reader may wish to use the EGGEN CARD PORTAL for the following example and gain a little hands-on experience with this database tool.

As an example, let's look for all the card images indexed under the name of "S Car". Enter "S Car" into the "Star name" box and click the "Request" button. The portal will display the first card in the sequence of cards indexed under "S Car" or one of its alternative star names. The star name displayed on each card in the sequence may differ from the search name.

To the right of the "Prev" button is displayed the text string "1 12B/E/1/37 77914" Displaying respectively the place of the card in the stack, the card's address in the database, and the cardkey which is discussed later. Continuing to press the Next button will increment through each card in the sequence, eventually arriving at the card addressed as 8B/C/7/5, the card shown in Figures 2 and 3.

The number of cards found in the search is displayed to the right of the "Request" button. The "Prev" and "Next" buttons, found above the displayed card, allow the viewer to move through the card sequence.

The number "86406" shows this card was the 86,406th image to be produced from the scanning of the original cards. This number is the cardkey number.

Both the cardkey and card address can be used to find an individual card image. The line labeled "Select batch" contains input boxes for entering the address of a specific card.

Finding the correct star from the designation(s) written on the card can be a problem. These Identifiers were written by Eggen for his own use and in his own handwriting. While the identification may have been clear to him it often is not clear to the person indexing the card. Often Eggen recorded more than one designation for the same star on the same card. This can be of great help if the handwriting is legible. Often when indexing a card with multiple designations we select the most legible and search upon that identifier.

Many cards have only a partial identifier such as "509", which could stand for HR 509, HD 509, LTT 509, and so on. The person indexing must query all of the possible names in SIMBAD. By comparing the star's coordinates, U, B, V, R, and I band magnitudes, and other star related data provided by SIMBAD against the data recorded on the card one hopes to determine which name is the correct one. If no coordinates were specified on the card, then the person indexing must choose between stars using whatever clues remain on the card. The magnitudes within the observations, a note on the spectral type, or a finder chart on the card may be the key to correct identification.

More information on star name conventions used by Eggen and how they relate to the catalogues used by SIMBAD can be found on the AAVSO web page https://www.aavso.org/content/eggen-card-instructions.

2.3. Identifying patterns in observational data and the corresponding photometric systems

While indexing these cards, we are always looking for new patterns in the recording of observational data. Fourteen different patterns used to record observational data have been found. The associated photometric systems have been identified for eleven of these patterns.

The photometric systems used by Eggen and recorded on his cards are as follows:

Eggen's UBV system, an equivalent version of the 1953 Johnson and Morgan system (Eggen and Sandage 1960; Bessell 2005).

Eggen's 102,65,62 narrowband system, which was used alongside his UBV system to make measurements of stars of type K5 and later. This system was used before Eggen's adoption of the RI system (Kron *et al.* 1953; Eggen 1967).

Eggen's RI system, based upon standard stars defined by Kron with additional standard stars of later spectral type added by Eggen (Eggen 1965; Bessell 2005).

Eggen's uvbyβ system, which while originally based upon

Table 2. The observational data formats found on Eggen's cards (Crast 2016).

Format Name	*Associated Photometric(s) System*	*Map of Observational Data (on Card)*[1]	*Corresponding Magnitude, Color Index, or Other Value*	*Remarks*	*Example Card*[2]
UBV	Eggen UBV	Md <±d> <±d>	V (B–V) (U–B)	note 4	5B/A/4/14
RI	Eggen RI	Md <±d>	R (R–I)		5B/A/4/14
VRIphase	Eggen UBV & RI	Md Md ±d d	V R (R–I) phase		19A/B/5/12
phaseVRI	Eggen UBV & RI	d Md Md ±d	phase V R (R–I)		D1/C/5/28
102,65,62	Eggen 102,65,62	±d ±d Md	(65–62) (102–65) (102)	(102) ≡ m_{102}	B6//1/16
102,65	Eggen 102,65,62	"[" Md ±d "]"	(102) (102-65)	(102) ≡ m_{102}	6A/A/15/9
uvbyβ	Eggen uvbyβ[6]	Md ±i ±i ±i <Md>	V' $(b–y)_1$' m_1' c_1' Hβ'	not cc[4, 6]	D1/C/1/1
uvbyβ(cc)	Eggen uvbyβ[7]	Md ±i ±i ±i <Md>	V $(b–y)_1$ M_1 C_1 Hβ	cc[4, 7]	B6//34/16
DDO	note 3	Md ±i ±i ±i	(48) na na na	(48) ≡ m_{48}[5]	B3//27/10
Hβ	Eggen uvbyβ	Md	Hβ		B6//1/29
[.2.]^n	unknown	"[" Md ±d "]"^{n}	na na]^n	note 9	B6//32/26
[.4.]	unknown	"[" Md ±i ±I ±I "]"	na na na na		B6//34/15
[.4.]^n	unknown	"[" Md ±i ±i ±i "]"^{n}	na na na na]^n	note 9	B6//34/16
M±±±M±	note 8	Md ±i ±i ±i Md ±i	(48) na na na na na		B5//8/42
[1/2 D T]	uvbyβ	⌈Md ±i ±i ±i <Md> date <time>⌉ ⌊Md ±i ±i ±i <Md>⌋	⌈V' $(b–y)_1$' m_1' c_1' Hβ' date <time>⌉ ⌊V' $(b–y)_1$' m_1' c_1' Hβ'	note 10	C4/C/3/61

Notes:

1. *Some records may vary with respect to color index format, such as ±i instead of ±d.*
2. *Example cards can be viewed by entering the card address into the* EGGEN CARD PORTAL.
3. *David Dunlap Observatory (DDO) The identity of the three indexes in the DDO data and what processing is still required to convert these values to those in Eggen's published tables are not fully understood. Therefore, labels have not been assigned yet.*
4. *Value of first Md is close to or equal to SIMBAD's V magnitude.*
5. *Value of first Md is greater than SIMBAD's V magnitude by 0.1 magnitude or more.*
6. *Color indexes and Hβ are those computed using Strömgren's uvby system. Eggen's transformation equations need to be applied. The observational data are not computationally complete (cc).*
7. *Color indexes and Hβ have been transformed using Eggen's equations prior to recording on card. Denoted "cc" for computationally complete observational data.*
8. *The M±±± portion is a DDO observation. The remaining M± has not been resolved. The identity of the three indexes in the DDO data and what processing is still needed to convert these values to those in Eggen's published tables are not fully understood. Therefore, labels have not been assigned yet.*
9. *"]^n" represents the value of the exponent n.*
10. *Two observations within a single set of square brackets, sharing a single date and optional time. Both observations use either the Eggen uvbyβ or uvbyβ(cc) system. The top observation is for the star named on the card. The bottom observation is for a nearby star.*

the uvbyβ system introduced by Bengt Strömgren and extended by David Crawford, was later adopted as an independent system due to a defective v filter (Strömgren 1966; Crawford and Perry 1966; Eggen 1976).

The David Dunlap Observatory (DDO) system, developed by Robert D. McClure and Sidney van den Bergh. Eggen also added his own standard stars to the original list to extend this system for later spectral type stars (McClure and van den Bergh 1968; Eggen 1990).

Table 2 summarizes the data recording patterns (data formats) found on the cards. Except for the [1/2 D T] format, the date and time of the observation are not shown as part of the data formats. The map of each format shows the ordering of the data values and the expected data type of each value. The key word here is "expected," as some observations will have data values of a type not matching what is specified below. The most common data type variation is the use of decimal numbers when integers are expected and vice-versa. Some measurements are not always included within the observation and are defined as optional. Some observations use literal characters such as "[]" to distinguish between data records with similar mappings.

The last column of Table 2 contains the addresses of sample cards which contain observations in the data format named in column 1. These cards may be viewed using the EGGEN CARD PORTAL discussed in section 2.1.

Table 3 defines the terms used in Table 2.

2.4. Recording and organizing the observations using spreadsheets

Spreadsheets allow us to enter the observational data in an orderly manner using the mappings defined in Table 2 as guides for photometric system identification and correct data input. The spreadsheet also allows us to manipulate the data to make it suitable for WEBOBS input, and document the observations for future reference.

The "Eggen Photometry" workbook served as a proof of concept to demonstrate that we could transcribe UBV and RI observations from the cards of a few variable stars and add those observations into the AID. The workbook was developed using GOOGLE SHEETS software. The workbook is stored in the Google cloud which allows shared access to the sheet by multiple users. Anyone with a link to the workbook may view it on a read-only basis. Users must log into a Google account to gain edit access. Access authority and resource contention, when multiple users are accessing the workbook at the same time, is handled by the Google cloud. S Car and l Car were the first stars to be entered into AID. A total of 300 U, B, V, R, and I observations were entered for S Car and 206 for l Car (Silvis 2015).

"Eggen Card Database: Photometric Observations Ver 3.0" is our current workbook. It too was written using GOOGLE SHEETS and is stored in the Google cloud. Its goal is to capture as many photometric observations as possible as they are recorded on the cards, regardless of photometric system.

Table 3. Terms used in Tables 2, 4, and 5 (Crast 2016).

Term	*Description*	*Term*	*Description*
d	a decimal number	n	a number in decimal or integer form
i	an integer	t	a text string
Md	relative magnitude in the form of a decimal number	< >	an optional term (optional in the sense that the recorded observation may not contain the corresponding value)
±d	a signed decimal number representing a color index	|	A|B (the value can be A or B)
±i	a signed integer representing a color index	na	not available or not yet defined
U,V,B,R,I	Johnson U-,V-,B-,R-, and I-band magnitudes, respectively	c_1'	Continuum parameter derived using Strömgren's uvby system calculations but using Eggen's v filter. This value still requires Eggen's uvbyβ transformation.
m_1'	Metal abundance parameter derived using Strömgren's uvby system calculations but using Eggen's v filter. Value still requires the application of Eggen's uvbyβ transformation.	C_1	Transformed value of c_1'
M_1	Transformed value of m_1'	$(b–y)_1$'	(b–y) index derived using Strömgren's uvby system calculations. Still requires the application of Eggen's uvbyβ transformation.
tag	date tag—Epoch of star coordinates found on some cards, especially cards with DDO obs	$(b–y)_1$	Transformed value of $(b–y)_1$'
Hβ or β	hydrogen beta absorption line magnitude	V'	V_E included with Eggen's uvbyβ records
(A–B)	Color index Magnitude A – Magnitude B	u,v,b,y	Eggen's four-color system u, v, b, and y filters, respectively
V_E,V_J,V_K	V band magnitude derived from the UBV system defined by Eggen, Johnson, and Kron, respectively	—	unassigned spreadsheet cell
cc	Computationally complete. The uvbyβ observation does not need Eggen's transformation applied by spreadsheet	" "	Text string literal contained within the data record

Problems such as observations having illegible date or data, or difficulty figuring out the correct data format are frequently encountered. Our spreadsheet allows entry of observations with data, date, or time problems. These problem observations are marked with a generic format of ".?." so that they can still be recorded and flagged for later review and resolution.

In addition, all card images which do not contain usable observational data are recorded on the spreadsheet under a generic "NoObs" format.

Each sheet of the database workbook is assigned to one star and each row of that sheet documents an observation. The photometric system(s) used for each observation are identified by the data format, other comments, or labels on the cards. Each row holds:

The address of the image, within the card image database, that has the observation.

The card's color; white is the default if no value is assigned.

The date and time of the observation in both Gregorian calendar and Julian date formats. All dates and times are displayed in GMT.

The format in which the observational data were written on the card.

Input observational data which are entered onto the input area using the chosen format.

The results of any numerical calculation, or reordering of the input data.

The AAVSO observer code of the person entering the observation.

Comments concerning the observational data.

Status on whether the observation(s) has been entered into the AID.

The input record generated for WEBOBS for entry of the observation(s) into the AID.

The data type for each input and output cell within a row is defined by assigning each row a data format chosen using Table 2 as a guide. The chosen format is assigned to the row by selecting it from a menu showing valid format entries (see the Card Data Format column in Figure 4). By selecting the same format in the heading menu the correct data mapping will be displayed in the headings. The column headings show the data type terms and corresponding magnitude, index, or other value.

Table 4 lists the data formats and the heading for each cell in the "Data From Cards" section of a star's spreadsheet. Note that the uvbyβ format has two variations. The difference between the two is the application of Eggen's transformation equations to the observational data. The uvbyβ observations still require the application of Eggen's transformation equations to produce the values shown in Eggen's papers. For the uvbyβ(cc) observations Eggen's transformations were applied before Eggen recorded the observations on the card. The uvbyβ(cc) observations are termed computationally complete (cc).

Table 5 displays the layout of the output section of a row for each data format. The output section is shown in Figure 4 under the heading "Data for WebObs".

Figures 4 and 5 display portions of the S Car sheet showing observations transcribed from the card in Figure 2. Figure 5 shows the dates and times of observation in Gregorian and Julian formats. When no time of observation is recorded on the card then only the date is entered in to the "Date Time (UTC)" cell and the time of observation defaults to midnight. This default is also reflected in the Julian Date (JD) cell. Observational dates can be entered on the spreadsheet in either Gregorian or JD format to match the format recorded on the card. A spreadsheet routine fills in the blank "Date Time" or "JD" cell and processes the "Data from Cards" observation records into the proper form for storage in the corresponding "Data for WebObs" section shown in Figure 4.

Since any star recorded on an Eggen card may be referenced by more than one identifier we needed to choose one identifier for the spreadsheet which is in common use and is compatible with the conventions for star name use in astronomical papers. The source we chose was the main star identifier returned from an identifier query of the SIMBAD Astronomical Database. This identifier also becomes the sheet name. The brief description and V band magnitude from the identifier query are also entered on the sheet.

Table 4. Mapping of observational data values onto spreadsheet input data columns (Crast 2016).

Format Name	*Map of Spreadsheet Input Data*							*Corresponding Magnitude, Color Index, or Value*						
UBV	Md	<±d>	<±d>	—	—	—	—	V	(B–V)	(U–B)	—	—	—	—
RI	Md	<±d>	—	—	—	—	—	R	(R–I)	—	—	—	—	—
VRIphase	Md	Md	±d	d	—	—	—	V	R	(R–I)	phase	—	—	—
phaseVRI[8]	d	Md	Md	±d	—	—	—	phase	V	R	(R–I)	—	—	—
102,65,62	±d	±d	Md	—	—	—	—	(65–62)	(102–65)	(102)	—	—	—	—
102,65	Md	±d	—	—	—	—	—	(102)	(65–62)	—	—	—	—	—
uvbyβ[1, 7]	Md	±i	±i	±i	<Md>	—	<t>	V'	$(b-y)_1$'	m_1'	c_1'	Hβ'	—	tag[3]
uvbyβ(cc)[1, 7]	Md	±i	±i	±i	<Md>	—	<t>	V	$(b-y)_1$	M_1	C_1	Hβ	—	tag[3]
DDO	Md	±i	±i	±i	—	—	<t>	(48)	na	na	na	—	—	tag[3]
Hβ	Md	—	—	—	—	—	—	Hβ	—	—	—	—	—	—
[.note 2.][n]	Md	±d	—	—	d	—	<t>	na	na	na	na	][n2]	na	tag[3]
[.note 4.]	Md	±i	±i	±i	—	—	<t>	na	na	na	na	na	na	tag[3]
[.note 4.][n]	Md	±i	±i	±i	d	—	<t>	na	na	na	na	][n2]	na	tag[3]
M±±±M±	Md	±i	±i	±i	Md	±d	<t>	(48)	na	na	na	na	na	tag[3]
.?.[5]	t	t	t	t	t	t	t	text	text	text	text	text	text	text[4]
NoObs[6]	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Notes:

1. *uvbyβ—Eggen's transformation calculations must be applied to observation values V', (b-y)', m_1', and c_1'; uvbyβ (cc)—Eggen's transformation calculations were applied to observation values before observation was recorded on the card.*
2. *The value of the numerical exponent n.*
3. *Enter a date tag if one exists.*
4. *Write values into cells in corresponding order as they appear on card.*
5. *The .?. format is a generic format for identifying and recording problem observations requiring more investigation.*
6. *NoObs is a generic description for a card which has no usable photometric observations. This is used to record cards indexed under the star name which would otherwise be undocumented due to a lack of observations. Such cards would include those with attached paper tapes and cards with comparisons between Eggen's observations and observations made by other astronomers.*
7. *Each observation from a [1/2 D T] observation pair (see Table 2) is recorded on its respective star sheet using the uvbyβ or uvbyβ(cc) format. The same date and time (if the time exists) are recorded for each star. The comment section of each record is updated to record the bundling of the two observations.*
8. *A variation of the VRIphase format requiring spreadsheet headings and processing changes.*

Table 5. Mapping of processed values onto the spreadsheet output data columns (Crast 2016).

Format Name	*Map of Spreadsheet Output Data*							*Corresponding Magnitude, Color Index, or Other Value*						
UBV	Md	Md	Md	—	—	—	—	U	B	V	—	—	—	—
RI	—	—	—	Md	Md	—	—	—	—	—	R	I	—	—
VRIphase & phaseVRI	—	—	Md	Md	Md	d	—	—	—	V	R	I	note2	—
102,65,62	Md	±d	±d	—	Md	—	—	(102)	(65–62)	(102–65)	—	I_J[1]	—	—
102,65	Md	±d	—	—	—	—	—	(102)	(65–62)	—	—	I_J[1]	—	—
uvbyβ & uvbyβ(cc)[3]	—	—	Md	±i	±i	±i	Md	—	—	V	(b–y)	M_1	C_1	Hβ
DDO	Md	±d	±d	±d	—	—	—	(48)	(45–48)	(42–45)	(41–42)	—	—	—
[.note 2.][n]	na	na	na	na	na	na	na	na	na	na	na	na	na	na
[.note 4.]	na	na	na	na	na	na	na	na	na	na	na	na	na	na
[.note 4.][n]	na	na	na	na	na	na	na	na	na	na	na	na	na	—
Hβ	Md	—	—	—	—	—	—	Hβ	—	—	—	—	—	—
M±±±M±	Md	±d	±d	±d	Md	Md	—	(48)	(45–48)	(42–45)	(38–42)	na	na	—
.?.	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Notes:

1. *$I_J = 0.15 \times m_{102}$ (Eggen 1976)*
2. *phase*
3. *The uvbyβ(cc) format signals to the spreadsheet processing routine that Eggen's transformation calculations have been applied to this observation prior to its recording. No further calculations need to be performed for this datum.*

NOTE: Data Entry Completed																		
Data for WebObs							Card Data Format	Data From Cards							M - magnitude ± - color index d - decimal i - integer n - dec | <> - optional A|B - A or B		
U	B	V	--	--	--	--	click ▼ below for menu	V	(B-V)	(U-B)	--	--	--	--	<<< Color Mag/Index		logged by
							UBV	Md	<±d>	<±d>	--	--	--	--	<<< Format		
9.695	7.92	5.99					UBV	5.99	1.93	1.775							SGEO
10.215	8.4	6.47					UBV	6.47	1.93	1.815							SGEO
			5.5	6.67			RI	5.5	1.17								SGEO
			4.88	5.88			RI	4.88	1								SGEO
			4.48	5.07			RI	4.48	0.59								SGEO
			4.19	4.68			RI	4.19	0.49								SGEO
			4.3	4.8			RI	4.3	0.5								SGEO
			4.81	5.69			RI	4.81	0.88								SGEO
			5.03	6.02			RI	5.03	0.99								SGEO

Figure 4. Observations transcribed from Eggen card 8B/C/7/5 (Figure 2) to the S Car spreadsheet in Eggen Card Database: Photometric Observations. The UBV column headings for the "Data for WebObs" and "Data from Cards" columns were set by choosing "UBV" from the menu displayed by clicking on the "▼" symbol in the highlighted cell. The uppermost yellow block on the right side of the spreadsheet is a short summary of the data type terms documented in Table 3 (Crast and Silvis 2016).

1	Star name:	S Car	Variable Star of Mira C	NOTE: Data Entry Completed						
2	V magnitude:	5.710	query SIMBAD							
3	⇦ INDEX	This research has made use of the SIMBAD database, operated at CDS, Strasbourg, France.		Data for WebObs						
4										
5	Card Coord	Card Color	JD	Date Time (UTC)	U	B	V	--	--	--
26	8B/C/7/5	W	2441085.50000	14/05/1971 00:00:00	9.695	7.92	5.99			
27	8B/C/7/5	W	2441093.50000	22/05/1971 00:00:00	10.215	8.4	6.47			
28	8B/C/7/5	W	2441003.50000	21/02/1971 00:00:00				5.5	6.67	
29	8B/C/7/5	W	2441022.50000	12/03/1971 00:00:00				4.88	5.88	
30	8B/C/7/5	W	2441035.50000	25/03/1971 00:00:00				4.48	5.07	
31	8B/C/7/5	W	2441049.50000	08/04/1971 00:00:00				4.19	4.68	
32	8B/C/7/5	W	2441065.50000	24/04/1971 00:00:00				4.3	4.8	
33	8B/C/7/5	W	2441086.50000	15/05/1971 00:00:00				4.81	5.69	
34	8B/C/7/5	W	2441094.50000	23/05/1971 00:00:00				5.03	6.02	

Figure 5. The time and date section for the same observations of S Car shown in Figure 4. The card color is specified as "W" for white. The "query SIMBAD" cell holds a hyperlink to the SIMBAD identifier query result for the "Star name:" entry. The headings in rows 1–5 are frozen in position, allowing the viewer to scroll through the data rows and still view or change the column headings above the "Data from Cards" and "Data for WebObs" sections (Crast and Silvis 2016).

3. Results

The indexing phase of the project is nearing completion. As this paper was being written another box holding another 500 cards was discovered. These cards have yet to be scanned and organized into PDF files.

A minimum of 15,503 cards have been classified as "P". This number will increase as the cards classified "D", "R", and "O" are re-examined later.

The PDF files discussed in section 2.1 can be viewed and downloaded from the AAVSO at the Olin Eggen Observation Cards web page.

AAVSO Bulletin stars also found in the card database are listed in Table 6. No search for AAVSO comparison and check stars has been performed yet.

Six data formats—UBV, RI, uvbyβ, uvbyβ(cc), VRIphase, and phaseVRI—hold observations in the U, B, V, R, and I bands that can be added to the AID. The remaining unmapped formats may also hold useful observational data for AID as well.

The Eggen Card Database workbook contains 53 star sheets in various stages of completion. Most of the sheets document observations of standard stars for Eggen's customized photometric systems. Data from these sheets are used for computing the transformation constants for Eggen's uvbyβ system and the transformation coefficients for standardizing his DDO observations. See Appendices 1–3 in the "Eggen Card Database: Photometric Observations" workbook for documentation. The uvbyβ system transformation constants have been computed and are used when processing uvbyβ formatted observational data

4. Future work

In the next phase of this project we will:

1. Begin the extraction of the photometric observations from the cards and entering them into AID. Priority will go to AAVSO-related stars and special requests from the astronomical community.

2. Continue to identify new data formats and variations of currently identified formats.

3. Create expanded documentation concerning what types of stars are recorded within Eggen's database.

4. Start to identify variable, comparison, and check stars in AID that have usable data in Eggen's card database.

Table 6. *AAVSO Bulletin* stars found in Eggen's card database (Silvis 2016b).

R And	R Cnc	V Cet	R Dra	T Hya	T Nor	W Pup	R Tri
T And	V Cnc	W Cet	T Eri	X Hya	R Oct	S Pyx	S Tuc
SV And	W Cnc	Z Cet	R Gem	RU Hya	R Oph	R Ret	T Tuc
R Aql	R CVn	o Cet	S Gem	R Leo	V Oph	R Sgr	R UMa
R Aqr	T CVn	S Col	V Gem	R LMi	X Oph	RR Sgr	S UMa
T Aqr	R CMi	T Col	T Gru	R Lep	Z Oph	RU Sgr	T UMa
W Aql	S CMi	R Com	S Her	S Lib	RU Oph	S Sco	Y Vel
S Aql	R Car	S CrB	T Her	U Lib	R Ori	RR Sco	R Vir
R Ari	S Car	V CrB	U Her	RS Lib	S Ori	RS Sco	RU Vir
S Ari	R Cas	R Cyg	W Her	S Lup	U Ori	RZ Sco	S Vir
R Aur	V Cas	S Cyg	RS Her	R Lyn	S Pav	S Scl	SS Vir
W Aur	T Cen	U Cyg	RU Her	W Lyr	R Peg	T Scl	SU Vir
X Aur	W Cen	RS Cyg	SS Her	S Mic	T Phe	U Scl	R Vul
R Boo	X Cen	RT Cyg	R Hor	V Mon	V Phe	V Scl	
S Boo	T Cep	RU Cyg	T Hor	X Mon	S Pic	X Scl	
S Cam	R Cet	χ Cyg	R Hya	Y Mon	T Pic	R Ser	
X Cam	U Cet	S Del	S Hya	RR Mon	R Psc	U Ser	

5. Continue to investigate and implement a plan for organizing the many stars named in Eggen's card database. Multiple database workbooks will be needed at some point in time.

6. Develop a more secure storage system for our data and processing software. The cloud is not the most secure means of storing critical data. We need to bring these data back under the control and security of the AAVSO.

7. Begin education of a small team to transcribe observations from the portal to the spreadsheet-based database.

8. Improve the quality control process over observational data transcription and with any data processing being performed by the spreadsheet programs.

9. Continue our investigative work on the unresolved observational data formats and make the necessary changes to the spreadsheet database.

10. Improve the performance of our spreadsheet's processing and organizing tasks. Our implementation of reading from and writing to the spreadsheet significantly degrades performance. The necessity of working within the Google cloud and not locally on the user's home system can degrade performance greatly when network traffic or cloud usage is heavy.

11. Begin work to modify the workbook to make the data more accessible to the AAVSO Variable Star Index (VSX).

5. Summary

Our intentions for now are to leave the transcription of data to the spreadsheet to a few volunteers familiar with the use of the Eggen Portal, the identification of the various data formats on the cards, and the data entry procedures for the spreadsheets. A small team can more easily deal with the ongoing changes being made to the spreadsheet code and The Eggen Card Database Reference and still ensure that we are producing a quality product.

What we would like the reader to do is search through the card database using the EGGEN CARD PORTAL for stars of interest to them. If such stars are found and retrieval of the observations is desired, please e-mail George Silvis, the team leader, and we will be happy to help retrieve those data. Questions concerning the data formats and use of the spreadsheet should be directed to Jack Crast.

If you would like to become part of the Eggen team, send an e-mail to George Silvis.

6. Acknowledgements

This research has made use of:

- The SIMBAD database, operated at CDS, Strasbourg, France
- The Asiago Database on Photometric Systems (ADPS)
- The WEBDA database, operated at the Department of Theoretical Physics and Astrophysics of Masaryk University.

Without the generosity of the American Astronomical Society (AAS) and John Menke we could not have scanned the cards or published the PDF files.

Table 7. Volunteers who have indexed the Eggen cards.

Volunteer	*Cards*
Carlos Adib	40
Wendy Bauer	783
Michael Cook	1
Jack Crast	18,960
Duane Dedrickson	6,754
Mark de Jong	1,183
Michael Geldorp	319
Richard Glassner	48
David Jackson	99
James Kay	90
Kris Larsen	2
Ranald McIntosh	260
Bob Neuman	96
John Ritzel	37,013
Jeff Robertson	327
Michael Saladyga	5,275
Ed Schmidt	3,436
George Silvis	22,852
Elizabeth Waagen	1,679
Glen Ward	1,337
Doug Welch	606
Paul York	782

Arne Henden and Matt Templeton of the AAVSO have been very generous with their ongoing technical help.

We of course wish to thank those who volunteered to tackle the difficult job of indexing cards; they are listed in Table 7.

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