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The coupling of a stereoscope and Macintosh computer

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Pacific University

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THE COUPLING OF A STEREOSCOPE AND MACINTOSH COMPUTER

By

STEVEN E. CLARK

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THE COUPLING OF A STEREOSCOPE AND MACINTOSH COMPUTER

BY

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Accepted by the faculty of the College of Optometry,
Pacific University, in partial fulfillment of the requirements
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Advisor: _____
Harold M. Haynes, O.D.

Biography Page

Steve Clark graduated with a doctor of Optometry degree from Pacific University College of Optometry in May of 1991. He received an Associate of Science from Mounthood Community College and a Bachelors of Science from Pacific University.

Steve was born in Portland Oregon but at the age of 8 moved just outside of Portland to Boring Oregon. Being a Native Oregonian Steve would like to be involved in a practice in the Portland area but has no specific opportunities set up at this point.

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With special thanks to my advisor, Dr. Harold M. Haynes, not only for his expertise in the field of Optometry but for his skill with wood working.

Abstract

This study has described a method for combining a Pedestal stereoscope and Macintosh Plus computer. A working model was constructed and its physical limitations were discussed. Existing software written for the Macintosh computer was also reviewed. The clinical feasibility was explored and possible directions for future research were recommended.

(Key Words: Stereoscope, Macintosh Plus, Computer)

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Introduction

This project was designed to determine the feasibility of using a Macintosh computer as a display screen for viewing with a standard stereoscope. It was among a list of projects suggested by Professor Harold M. Haynes. A computer search of the literature related to this topic was performed at the Pacific University Library which listed no published materials on this application. There are many factors which effect a project of this nature. These range from the physical characteristics of a given stereoscope and a selected computer to the applications possible by such a combination. Conceptually this project was separated into three tasks, (i) To explore the clinical feasibility using the Macintosh Plus as a stereoscope display field, (ii) Design and construction of a working model and, (iii) Evaluate the software programs available to construct suitable stereoscope halfviews for clinical use.

The Clinical Need for a Stereoscope-Computer Combination

The first task of this project was to explore whether there is a need for such a device. Once this need was envisaged a practical design was then be created. After the construction of a working model the uses and limitations of the stereoscope-computer combination can then be explored.

The basic stereoscope is invaluable in optometric testing and training. A satisfactory computer display can only enhance the ways in which a simple stereoscope is used. Halfviews can be easily manipulated by the doctor or patient. Targets can be designed with specific details in mind. What is done on screen in the office can be printed and taken home, using the picture you want with the target separation desired. The halfviews printed for home or in office use can be reprinted if they are damaged or lost. Existing pictures can then be edited or new ones created inside or outside of the stereoscope by either the doctor or the patient. The patient can perform drawing, and pointing tasks without touching the halfview directly.

Simple programs can also be written which involve movement of the halfviews. Rotations to include the whole or partial field of gaze and pursuits or saccades in any direction. Besides the expanded uses a computer brings to a simple stereoscope a computer is also a highly motivational tool. This may allow increased concentration and cooperation for a longer period of time.

Design of Equipment to Couple a Stereoscope And Macintosh Plus

In order to limit costs of designing a new stereoscope this project was designed to use an existing stereoscope which could be adapted for use with a Macintosh Plus monitor. Since existing materials are used the total design depends on the stereoscope head available. The two main designs would then come from a stereoscope with its own base or one attached at the front with the computer itself as the base. A Keystone pedestal stereoscope was use for this project. The support of the stereoscope head and computer should be made of a material readily available, easily manipulated, and low in cost. For this project wood (white pine) was chosen.

When designing a stereoscope-computer combination there are two important physical variables which require consideration. The ability to judge and manipulate the distance from the face plate to the screen and a central shield large enough to keep the fields of view separate to each eye. Most stereoscope heads generally accomplish this latter feature but a thin septum can be added to make the two fields completely separate. The main reason for the construction of the base is to control the physical distance between the monitor and the stereoscope. The stereoscope, or monitor can be moved forward or backward by sliding its support which can be marked to indicate specific distances. For an illustration of this see Figures 1a and 1b.

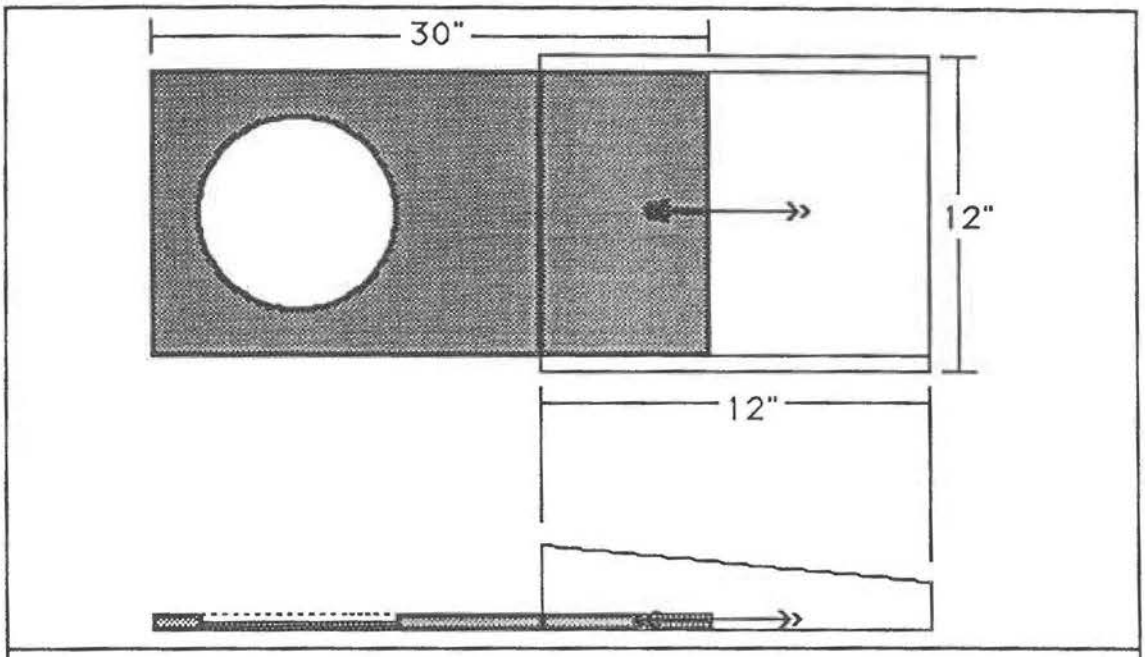


Figure 1a: Top and Side View of Macintosh-Stereoscope Support

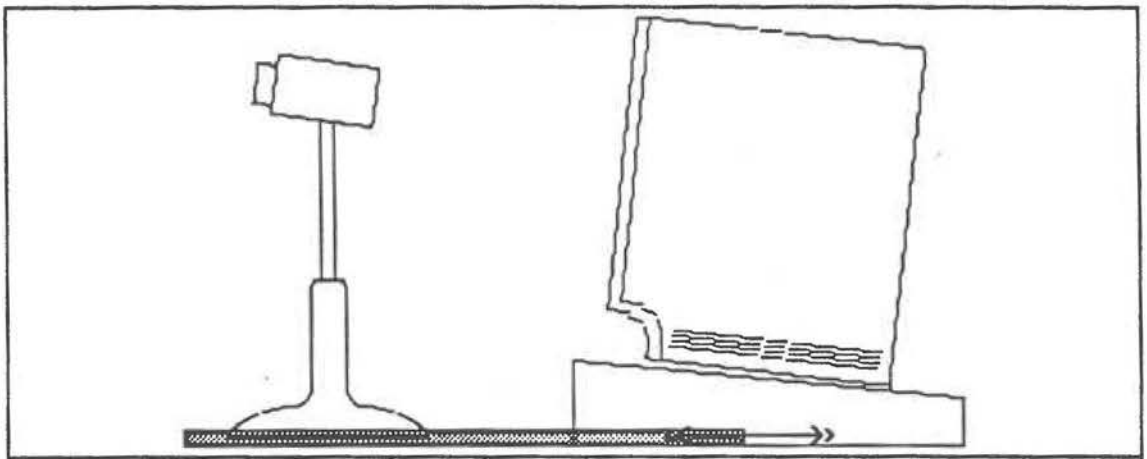


Figure 1b: Schematic diagram of Macintosh-Stereoscope Combination

The Physical Limitations of use due to the Physical Properties of the Stereoscope-Macintosh Combination

It was considered necessary to build the equipment shown in Figures 1a and 1b, to determine if the stereoscope-Macintosh combination will provide adequate or usable ranges.

The stereoscope used for this project was a Keystone No. 50, Skills Telebinocular which had a pair of 5 diopter lenses and a 95 mm optical center separation. The Macintosh screen has a height of 14 cm (5.5") and width of 18 cm (7"). The resolution of the monitor is rated at 72 dots per inch. This means that one pixel, dot or line will be 1/72 of an inch thick. Outside of the stereoscope this makes an angle of .09 degrees. Using the Loupe formula; magnification equals one plus the vertex distance times the power of the lens. The magnification for a 5 diopter lens would then be 1.6X.

When the stereoscope is set at simulated optical infinity, the distance from the monitor to the back (actually nodal point) of the objective lenses should be 20 cm. At this distance the horizontal vergence ranges possible depend on how well the opposite halfview is hidden from view. If the field is split directly down the center of the screen and one pixel is used as a target the following eye movement ranges are possible. Right/Left gaze of 12.3 degrees. An up/down gaze of 19 degrees, 47.5 prism diopters of convergence and 40 prism diopters of divergence.

When the horizontal width of the target is increased from one pixel width the maximum horizontal vergence ranges possible decrease. For an illustration of this see figure 2. For the specific values of how the vergence demand changes with different target sizes see Table 1 and 2. Note that these values are for a 20 cm shaft setting.

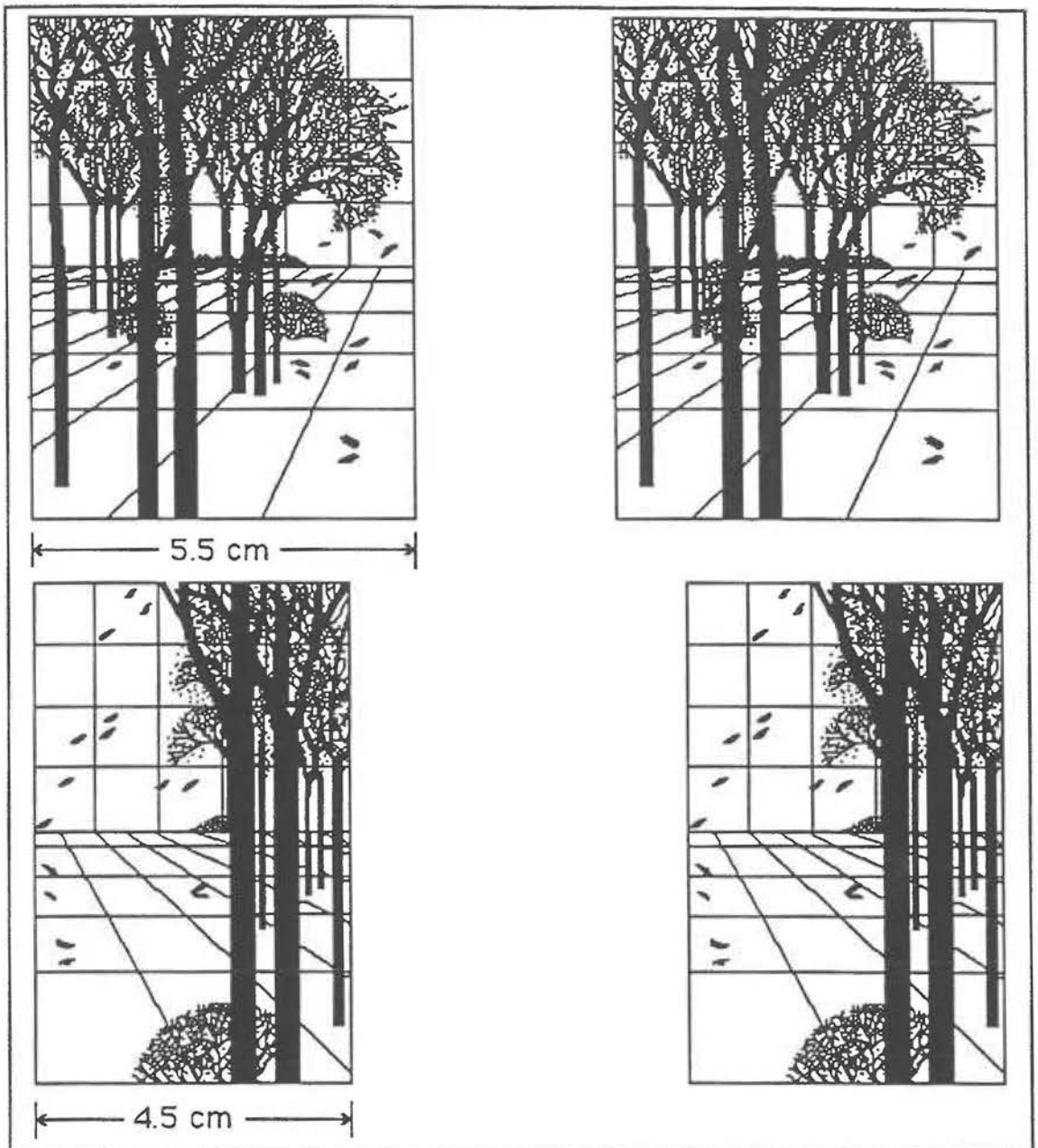


Figure 2: Illustration of how size affects maximum vergence

The top halfview is 5.5 cm in width giving a maximum divergence and convergence demands of 15 prism diopters and 17.5 prism diopters respectively. In contrast the bottom halfview is 4.5 cm in width and will have maximum divergence and convergence demands of 20 and 22.5 prism diopters.

Table 1

MAXIMUM DIVERGENCE POSSIBLE

Box Size in cm	85mm PD degrees	85mm PD Prism diopters	90mm PD degrees	90mm PD Prism diopters	95mm PD degrees	95mm PD Prism diopters
0	12.68	45	12.00	42.5	11.31	40
0.25	12.34	43.75	11.65	41.25	10.97	38.75
0.5	12.00	42.5	11.31	40	10.62	37.5
0.75	11.65	41.25	10.97	38.75	10.27	36.25
1	11.31	40	10.62	37.5	9.93	35
1.25	10.97	38.75	10.27	36.25	9.58	33.75
1.5	10.62	37.5	9.93	35	9.23	32.5
1.75	10.27	36.25	9.58	33.75	8.88	31.25
2	9.93	35	9.23	32.5	8.53	30
2.25	9.58	33.75	8.88	31.25	8.18	28.75
2.5	9.23	32.5	8.53	30	7.83	27.5
2.75	8.88	31.25	8.18	28.75	7.48	26.25
3	8.53	30	7.83	27.5	7.13	25
3.25	8.18	28.75	7.48	26.25	6.77	23.75
3.5	7.83	27.5	7.13	25	6.42	22.5
3.75	7.48	26.25	6.77	23.75	6.06	21.25
4	7.13	25	6.42	22.5	5.71	20
4.25	6.77	23.75	6.06	21.25	5.36	18.75
4.5	6.42	22.5	5.71	20	5.00	17.5
4.75	6.06	21.25	5.36	18.75	4.65	16.25
5	5.71	20	5.00	17.5	4.29	15
5.25	5.36	18.75	4.65	16.25	3.93	13.75
5.5	5.00	17.5	4.29	15	3.58	12.5
5.75	4.65	16.25	3.93	13.75	3.22	11.25
6	4.29	15	3.58	12.5	2.86	10
6.5	3.58	12.5	2.86	10	2.15	7.5
7	2.86	10	2.15	7.5	1.43	5
7.5	2.15	7.5	1.43	5	0.72	2.5
8	1.43	5	0.72	2.5	0.00	0
8.5	0.72	2.5	0.00	0		
9	0.00	0				

Table 2

MAXIMUM CONVERGENCE POSSIBLE

Box Size in cm	85mm PD degrees	85mm PD Prism diopters	90mm PD degrees	90mm PD Prism diopters	95mm PD degrees	95mm PD Prism diopters
0	23.99	42.5	25.36	45	26.72	47.5
0.25	23.31	41.25	24.68	43.75	26.04	46.25
0.5	22.62	40	23.99	42.5	25.36	45
0.75	21.93	38.75	23.31	41.25	24.68	43.75
1	21.24	37.5	22.62	40	23.99	42.5
1.25	20.55	36.25	21.93	38.75	23.31	41.25
1.5	19.85	35	21.24	37.5	22.62	40
1.75	19.16	33.75	20.55	36.25	21.93	38.75
2	18.46	32.5	19.85	35	21.24	37.5
2.25	17.76	31.25	19.16	33.75	20.55	36.25
2.5	17.06	30	18.46	32.5	19.85	35
2.75	16.36	28.75	17.76	31.25	19.16	33.75
3	15.66	27.5	17.06	30	18.46	32.5
3.25	14.95	26.25	16.36	28.75	17.76	31.25
3.5	14.25	25	15.66	27.5	17.06	30
3.75	13.54	23.75	14.95	26.25	16.36	28.75
4	12.84	22.5	14.25	25	15.66	27.5
4.25	12.13	21.25	13.54	23.75	14.95	26.25
4.5	11.42	20	12.84	22.5	14.25	25
4.75	10.71	18.75	12.13	21.25	13.54	23.75
5	10.00	17.5	11.42	20	12.84	22.5
5.25	9.29	16.25	10.71	18.75	12.13	21.25
5.5	8.58	15	10.00	17.5	11.42	20
5.75	7.87	13.75	9.29	16.25	10.71	18.75
6	7.15	12.5	8.58	15	10.00	17.5
6.5	5.72	10	7.15	12.5	8.58	15
7	4.30	7.5	5.72	10	7.15	12.5
7.5	2.86	5	4.30	7.5	5.72	10
8	1.43	2.5	2.86	5	4.30	7.5
8.5	0.00	0	1.43	2.5	2.86	5
9			0.00	0	1.43	2.5
9.5					0.00	0

Commercially Available Programs

There are many advantages to using existing software to design halfview targets for a Macintosh computer. The easiest way to start with a combination of this sort is with a paint or drawing program. There are a large number of paint programs available for the Macintosh computer. The ease of creating and editing a document varies with ones familiarity of a program. Each paint program that is available is usually similar in how a picture is created or drawn. Although once an object is drawn, how it can be manipulated or changed is what really distinguishes the programs from each other. Three well known paint programs which are available on the Macintosh include FullPaint by (Ann Arbor Software, Inc), SuperPaint by (Silicon Beach Software, Inc.), and Canvis by (Deneba Systems,Inc).

Each program mentioned has rulers with varying units of measurement (inches, centimeters, Picas etc.) which can be easily changed. These allow new or existing objects to be drawn at a particular size. This feature is very important when you are creating halfviews which need to be a specific size. FullPaint also has a feature called mouse spot which gives the x-y coordinates of where the mouse is located, which can be of help if more accuracy is needed. Another feature which is helpful for creating two identical objects is called Mirrors. This feature creates an identical design at the same time an object is being drawn.

Each program also has many different editing features. The more important ones include copy, paste, and invert. Once the object is created using this function, it can be copied and then pasted. This creates a duplicate of the original which can then be placed at the demand required. At this time the duplicate can also be inverted (the black in the drawing turned white and the white in the drawing turned black).

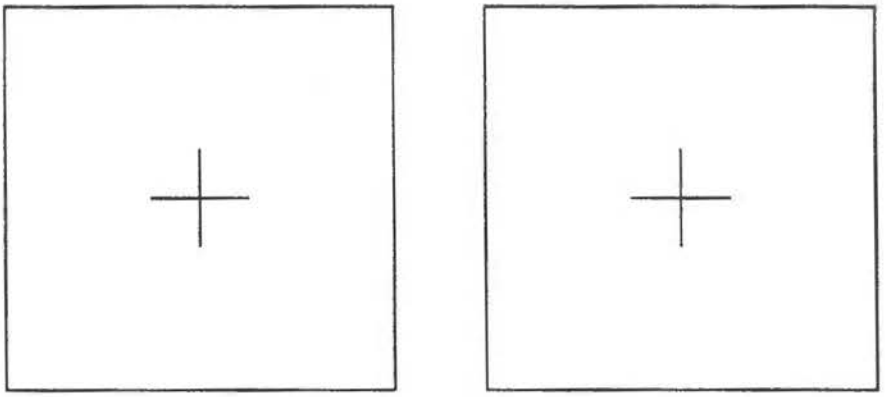
Once the halfview is in place it can then be manipulated by the mouse to change the demand. SuperPaint has an extra feature which allows the halfview to be moved by using the keyboard. This allows for more precise movement, not allowing any change in the vertical demand.

When performing stereoscope procedures on screen FullPaint and SuperPaint allow you to use the full screen with out any conflicting objects such as menu titles, tool box, and scroll bars. With the Canvas program the menu titles can't be removed but the tool box can be moved so it's hidden off the edge of the screen. The one item which favors the Canvas program is the ability to put over 100 halfviews on one document. FullPaint and Superpaint can hold only hold 2 halfviews per document. With 1 megabyte of memory Fullpaint can have a total of four documents and Superpaint can have seven. Having more halfviews on one document allows them to be changed from halfview to halfview without having to reboot a new document or change from document to document. Although with the addition of a harddisc the speed of changing from document to document increases dramatically.

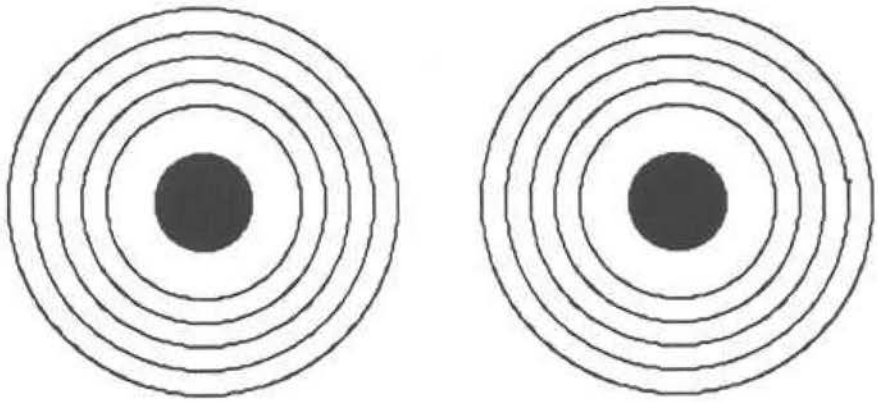
CREATING HALFVIEWS FOR CLINICAL USE

Duplicating existing pictures or halfviews to a specific size can be easily done. For example a set of stereoscope cards for the detection of aniseikonia created by Dr Hepine of Technic New Era Optical Co. can be redrawn on screen the same size as the originals. These cards can bee seen in Figures 3a-3e.

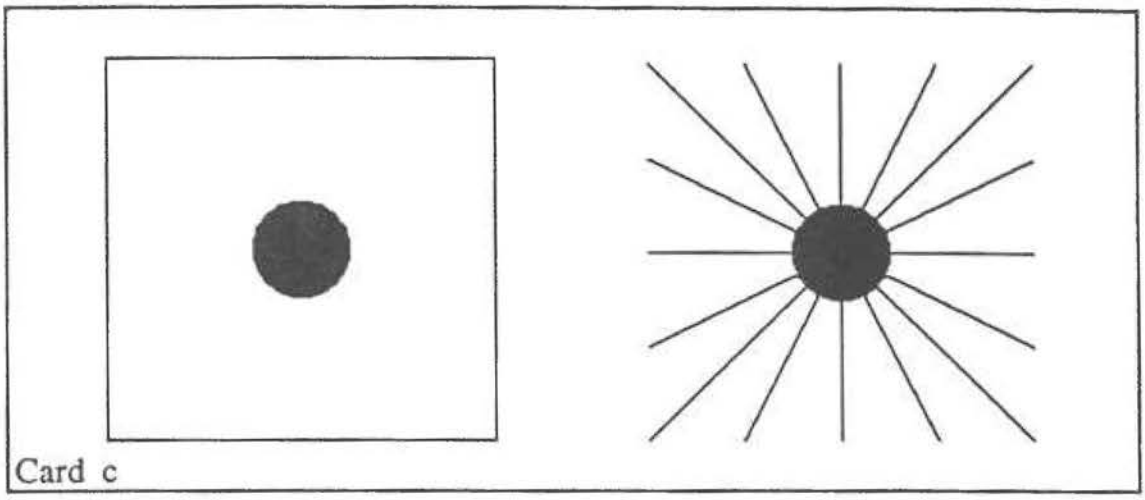
Figure 3a-3e: Stereoscope Cards for the Detection of Aniseikonia



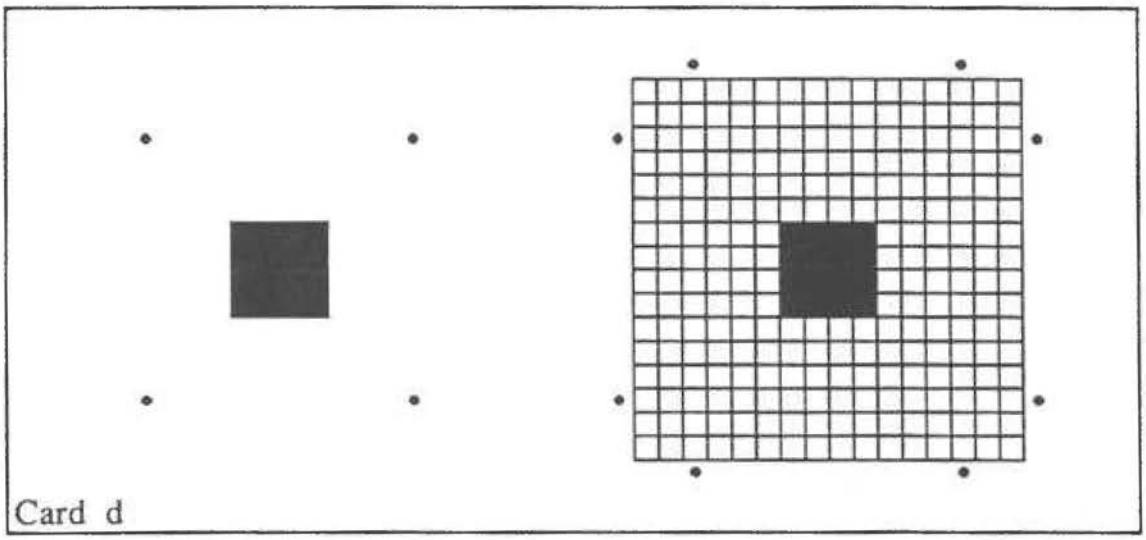
Card a



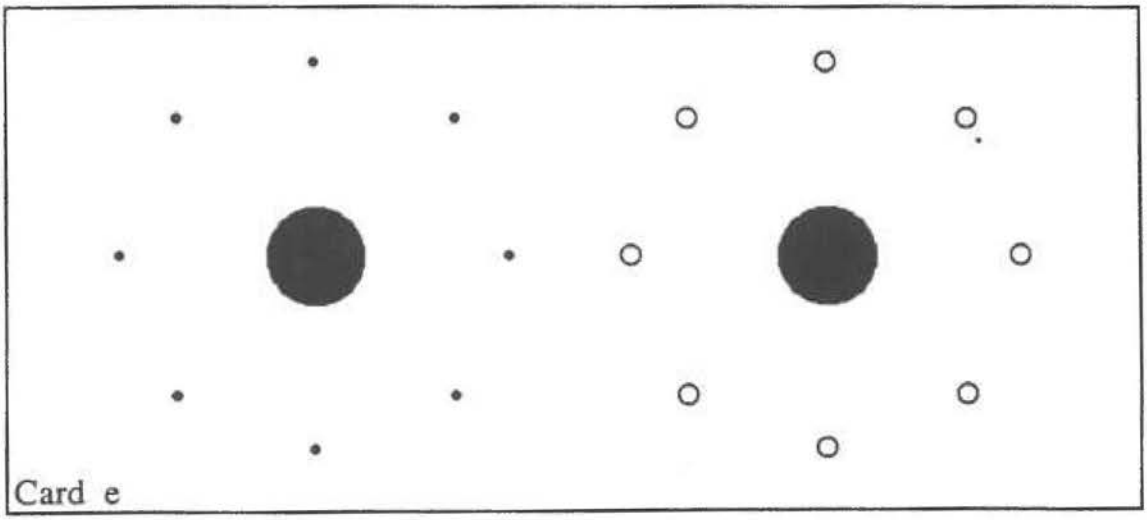
Card b



Card c



Card d



Card e

Existing halfviews can be changed to elicit a luster response. This is done by using the invert image feature under the edit menu. Examples of this can be seen in Figure 4a and 4b.

Figure 4a

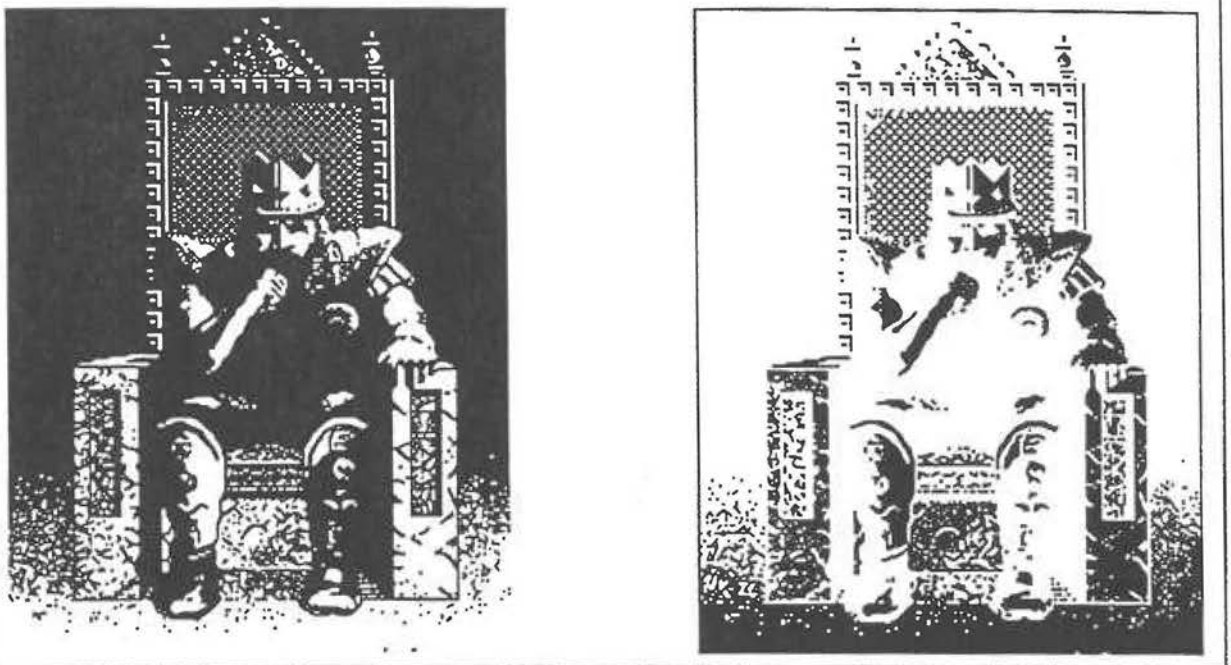
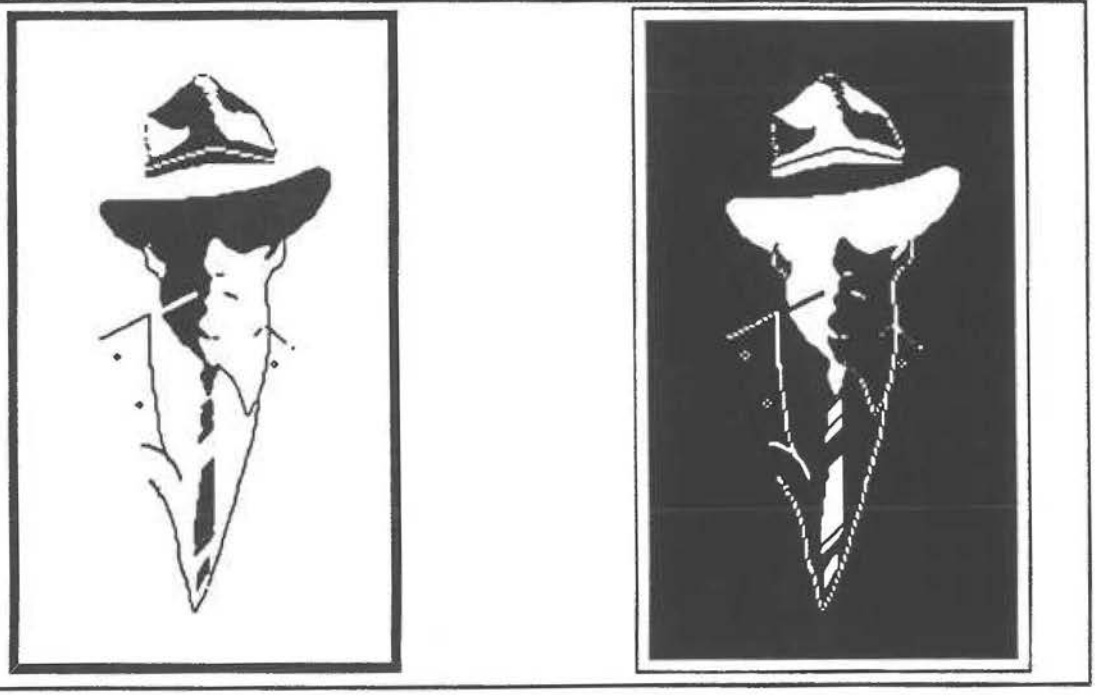
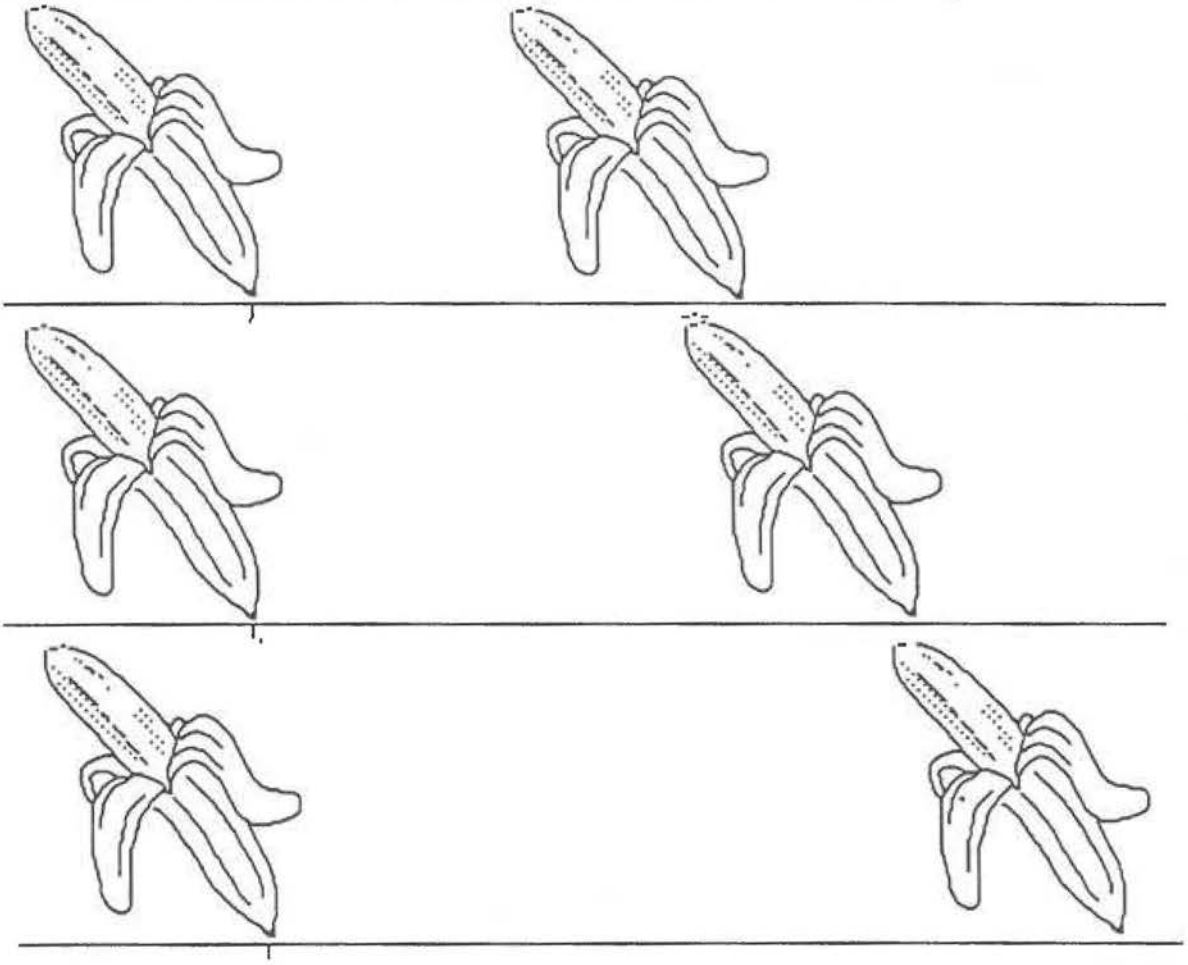


Figure 4b



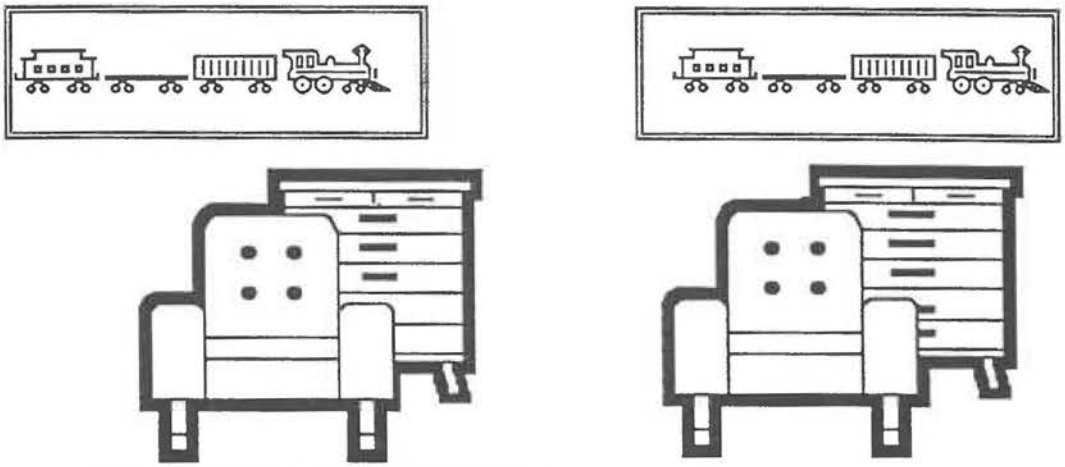
With SuperPaint the halfview can be moved using the keyboard. This feature also allows you to do smooth vergences with any picture. Figure 5 demonstrates this technique. Also, each paint program allows enough space in the vertical meridian to allow for the use of jump ductions or for many small or large targets. See Figures 6a - 6d for examples of these halfviews.

Figure 5: Each consecutive card shows the demand being increased



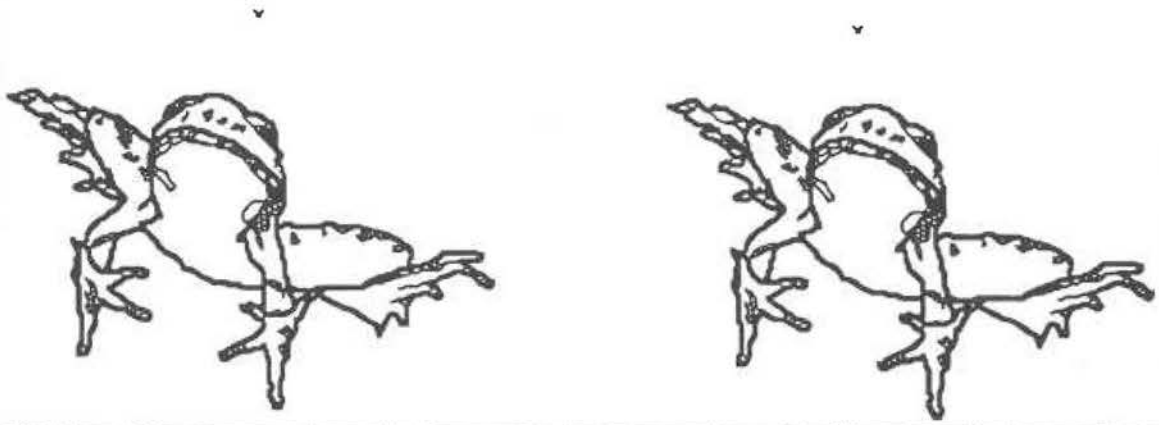
Although only one target can be moved in this manner.

Figure 6a



Each piece of furniture is at a different demand.

Figure 6b



The fly and the Frog are also at different demand levels.

Figure 6c: Multiple Small Halfviews

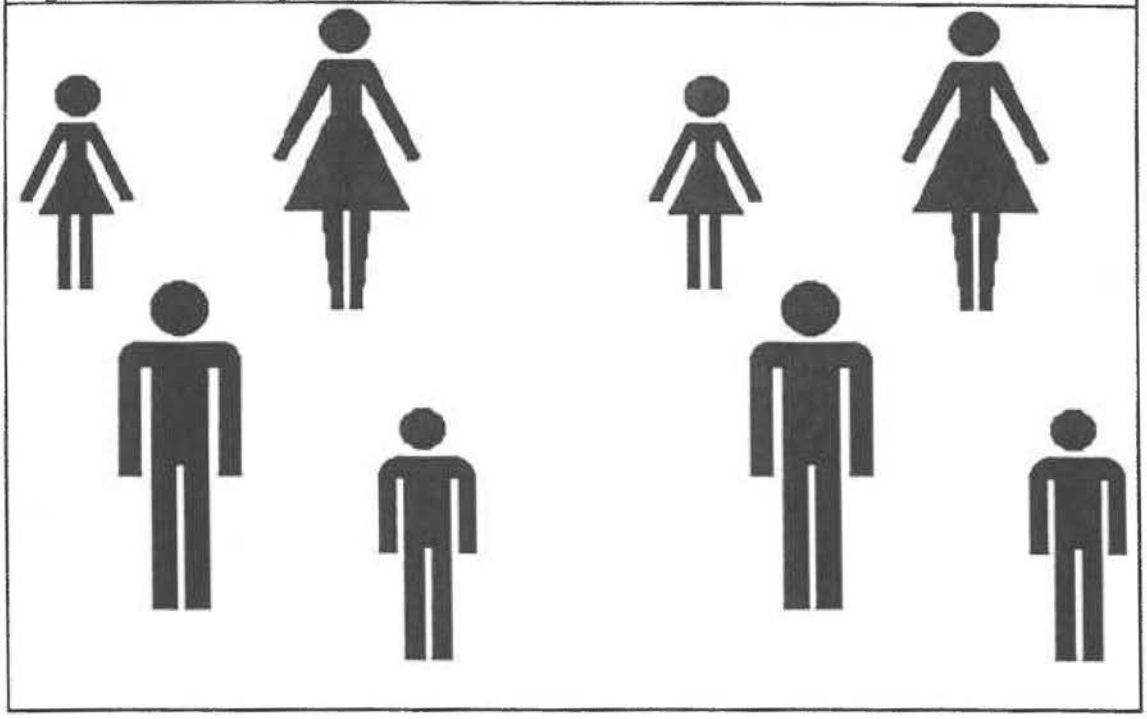
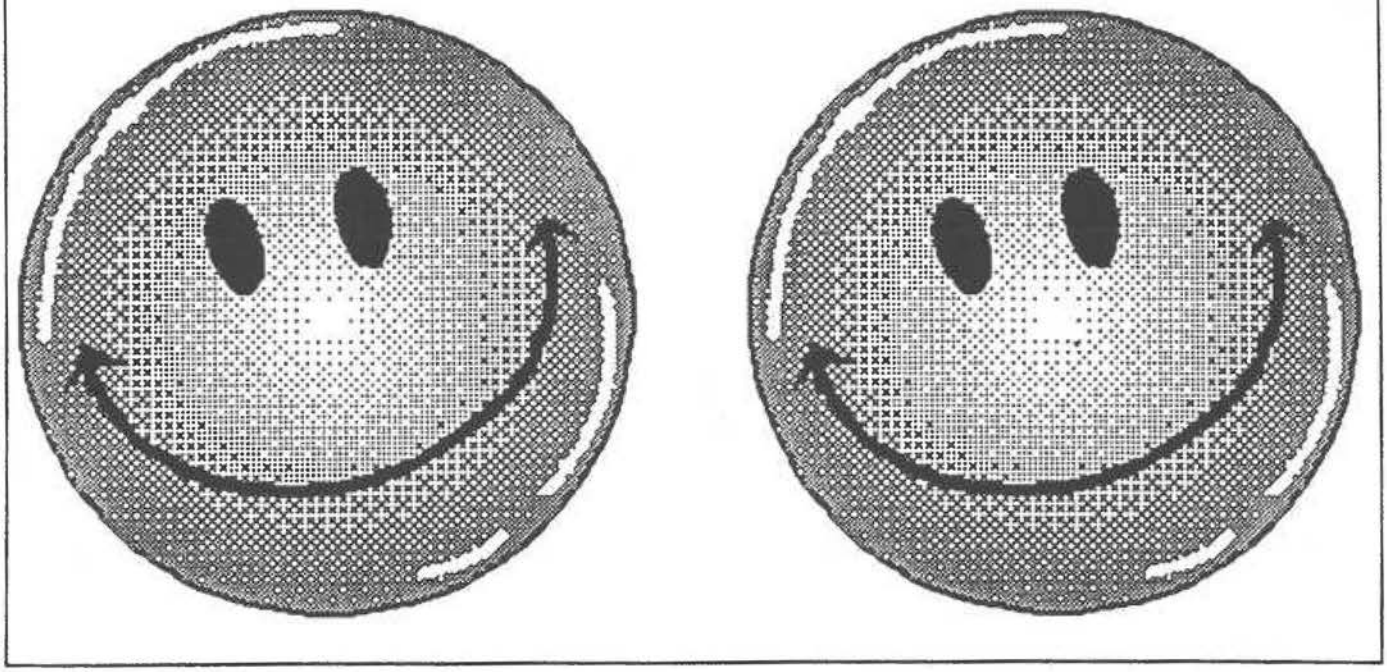


Figure 6d : Large Halfview



Results

This study shows that it is feasible to construct a wooden base which can be used to couple a pedestal stereoscope and a Macintosh computer. With this combination, adequate vergence and duction ranges for clinical use exist. The activities shown in this project dealt with similar activities also available with a standard stereoscope. A stereoscope computer combination was shown to add many advantages. These include the ability to easily change, manipulate, and create your own halfviews. Along with this added variability the stereoscope-Macintosh combination could give better concentration and cooperation from patients.

Suggestions for Future Research

The need for more research on this device is great. The area of most benefit would be one which is clinical in nature. This would mean the designing and possible Implementation of programs which involve interactive games and scenes into visual testing and training. One of the easiest ways to add movement of this sort involves the program hypercard with its scripting language HyperTalk. Programs of this type add a whole new dimension to an old instrument.