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STEREO MICROSCOPES: TECHNICAL EVALUATION

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USAF SCHOOL OF AEROSPACE MEDICINE
Human Systems Division (AFSC)
Brooks Air Force Base, TX 78235-5301



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NOTICES

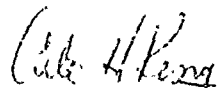
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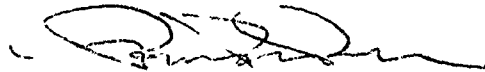
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This report has been reviewed and is approved for publication.



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19. ABSTRACT (Continue on reverse if necessary and identify by block number) The purpose of this study was to accomplish technical evaluations of various stereo microscopes which may be used in a dental laboratory. This report will provide assistance to base dental surgeons for selection of units for their particular requirements. The microscopes were compared against criteria developed by United States Air Force School of Aerospace Medicine (USAFSAM) evaluators. The user evaluations were performed at USAFSAM with the results presented herein.					
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STEREO MICROSCOPES: TECHNICAL EVALUATION

INTRODUCTION

In recent years the dental laboratory industry began using stereo microscopes, not only for quality assurance but for actual performance of various tasks. At this time their use is minimal; however, the benefits are obvious and usage is certain to increase. The United States Air Force (USAF) Dental Investigation Service (DIS) has undertaken a study to compare the features and capabilities of various stereo microscopes available on the market. The information in this study can be used by USAF dental clinics to assist in the selection of stereo microscopes to meet their particular clinical and laboratory requirements.

METHODS AND MATERIALS

Letters were sent to the stereo microscope manufacturers stating the criteria that best meet the needs of USAF dental laboratory. Because most microscopes may be "pieced" together to meet individual needs, the manufacturers sent the product that best meets the stated criteria. An evaluation of the physical characteristics was accomplished on each microscope using a standard questionnaire. To test the usability of each microscope, a group of 10 evaluators (technicians and dentists) were required to perform 2 tasks using each microscope.

Tasks could be performed in any order the evaluator preferred. The evaluators performed all tasks with each microscope before independently completing the questionnaire. The evaluators were allowed to freely use any microscope when completing the questionnaire. The order of evaluation was not randomized. The following tasks were performed by each evaluator:

1. Inspect the interior of a fixed partial denture metal substructure for detail reproduction, voids, and marginal fit.
2. Sharpen a pencil using a #25 surgical blade on a Bard Parker (simulates trimming a prepared margin on a Type IV die stone).

Each evaluator then completed a user's questionnaire. Areas were rated according to the following scale:

(1)	(2)	(3)	(4)	(5)
excellent	above average	average	below average	poor

The raw data may be found in the Appendix. Results were compiled and are reported in Table 1, showing the response distribution. Other data included the mode, or most frequent reported rating, and the range of the ratings. Following the user's evaluation, individuals were asked to rate each microscope by preference based on quality and function using the following scale:

best				worst
(1)	(2)	(3)	(4)	

TABLE 1. USERS EVALUATION RESULTS

QUESTIONS	MICROSCOPES	RESPONSES							MODE	RANGE
		Excel- lent (1)	Above Average (2)	Average (3)	Below Average (4)	Poor (5)	Not Rated			
Adjustment of interpupillary distance	Denerica KRX	1	3	6	-	-	-	3	1-3	
	Meiji EMZ-2	1	4	4	1	-	-	2,3	1-4	
	Nikon SMZ-1	3	5	1	1	-	-	2	1-4	
	Swift M81B	-	-	4	5	1	-	4	3-5	
Ability to focus	Denerica KRX	1	-	4	3	1	1	3	1-5	
	Meiji EMZ-2	2	3	5	-	-	-	3	1-3	
	Nikon SMZ-1	4	4	2	-	-	-	1,2	1-3	
	Swift M81B	1	-	5	3	-	1	3	1-4	
Individual eyepiece adjustment	Denerica KRX	-	1	3	5	1	-	4	2-5	
	Meiji EMZ-2	1	7	1	1	-	-	2	1-4	
	Nikon SMZ-1	3	4	2	1	-	-	2	1-4	
	Swift M81B	-	-	6	4	-	-	3	3-4	
Microscope stability	Denerica KRX	2	-	2	3	3	-	4,5	1-5	
	Meiji EMZ-2	1	3	6	-	-	-	3	1-3	
	Nikon SMZ-1	2	4	4	-	-	-	2,3	1-3	
	Swift M81B	1	1	7	1	-	-	3	1-4	
Field diameter at lowest magnification	Denerica KRX	1	1	7	1	-	-	3	1-4	
	Meiji EMZ-2	2	4	4	-	-	-	2,3	1-3	
	Nikon SMZ-1	3	4	3	-	-	-	2	1-3	
	Swift M81B	-	-	-	10	-	-	4	4	
Field diameter at highest magnification	Denerica KRX	1	4	4	1	-	-	2,3	1-4	
	Meiji EMZ-2	-	3	5	1	1	-	3	2-5	
	Nikon SMZ-1	1	5	1	3	-	-	2	1-4	
	Swift M81B	-	2	4	4	-	-	3,4	2-4	

TABLE 1. USERS EVALUATION RESULTS (cont)

QUESTIONS	MICROSCOPES	RESPONSES							MODE	RANGE
		Excel- lent (1)	Above Average (2)	Average (3)	Below Average (4)	Poor (5)	Not Rated			
Adjustability of illumination	Denerica KRX	1	2	4	-	1	2	3	1-5	
	Meiji EMZ-2	1	-	3	1	2	3	3	1-5	
	Nikon Ring Light	1	-	2	3	-	4	4	1-4	
	Nikon Halogen Light	1	4	1	1	-	3	2	1-4	
	Swift M81B	-	-	3	3	2	2	3,4	3-5	
Ability to eliminate shadows	Denerica KRX	1	4	5	-	-	-	3	1-3	
	Meiji EMZ-2	3	5	2	-	-	-	2	1-3	
	Nikon Ring Light	5	3	1	1	-	-	1	1-4	
	Nikon Halogen Light	1	4	2	3	-	-	2	1-4	
	Swift M81B	-	-	1	3	6	-	5	3-5	
Amount of illumination	Denerica KRX	1	1	5	2	1	-	3	1-5	
	Meiji EMZ-2	3	6	1	-	-	-	2	1-3	
	Nikon Ring Light	2	5	1	2	-	-	2	1-4	
	Nikon Halogen Light	1	7	1	1	-	-	2	1-4	
	Swift M81B	-	-	3	2	5	-	5	3-5	
Optical quality	Denerica KRX	1	3	6	-	-	-	3	1-3	
	Meiji EMZ-2	4	3	3	-	-	-	1	1-3	
	Nikon SMZ-1	8	1	1	-	-	-	1	1-3	
	Swift M81B	-	1	4	3	2	-	3	2-5	

TABLE 1. USERS EVALUATION RESULTS (cont)

QUESTIONS	MICROSCOPES	RESPONSES						MODE	RANGE
		Excel- lent (1)	Above Average (2)	Average (3)	Below Average (4)	Poor (5)	Not Rated		
Amount of working room under the microscope	Denerica KRX	5	4	1	-	-	-	5	1-3
	Meiji EMZ-2	-	5	5	-	-	-	2,3	2-3
	Nikon SMZ-1	1	4	5	-	-	-	3	1-3
	Swift M81B	-	-	7	2	1	-	3	3-5
		7X	10X	20X	30X	40X	45X	MODE	RANGE
Preferred level of magnification	Denerica KRX	-	6	4	-	-	-	10X	10X-20X
	Meiji EMZ-2	3	4	3	-	-	-	10X	7X-20X
	Nikon SMZ-1	2	5	3	-	-	-	10X	7X-20X
	Swift M81B	-	7	3	-	-	-	10X	10X-20X

TABLE 2. MICROSCOPE RANKING

QUESTIONS	MICROSCOPES	RESPONSES				MODE	RANGE
		Ranked #1	Ranked #2	Ranked #3	Ranked #4		
Ranking based on working qualities only	Denerica KRX	-	3	6	1	3	2-4
	Meiji EMZ-2	3	5	2	-	2	1-3
	Nikon SMZ-1	7	2	1	-	1	1-3
	Swift M81B	-	-	1	9	4	3-4
Ranking based on working qualities and unit price	Denerica KRX	1	2	6	1	3	1-4
	Meiji EMZ-2	5	3	2	-	1	1-3
	Nikon SMZ-1*	4	5	1	-	2	1-3
	Swift M81B	-	-	1	9	4	3-4

*The Nikon evaluated had two different light sources, the Dual Ring IV Fluorescent Illuminator and the Epi-Illuminator. The ranking of the Nikon was not affected by the light source used. The evaluators did, however, prefer one light source over the other. See discussion.

The costs of the microscopes were given to each evaluator, and they were once again asked to perform the same rating. The results of these findings are shown in Table 2. (Note: The price of the Nikon SMZ-1 reflected the price of both light sources.) Two light sources would not normally be required. A breakdown of individual prices is included in Table 3. A light source comparison of all the microscopes may be found in Figure 1.

To test the illumination level and light distribution, a grid 30 mm² was centered under the light source of each microscope. Readings were taken at each 10 mm spot on a vertical and horizontal axis. Additional readings were taken in each quadrant at a point 20 mm out from each axis. All light readings were taken off the RS-1 Reflectance Standard (barium sulfate plaque) using a Photo Research Spotmeter PR 1500. All readings are shown in foot candles (fc).

The following manufacturers elected to participate in this study:

MANUFACTURERS	MICROSCOPE TESTED AND MODEL NUMBER
Denerica Dental Corp 550 Frontage Road Northfield, IL 60093 1-800-336-7422	KRX Microscope Standard Swing-arm with Table Clamp and Lamps 10X and 20X Eyepiece Protective Lens Plastic Hood
Meiji-Labax USA, Inc 500 West Cummins Park, Suite 2350 Woburn, MA 01801 617-933-4409	EMZ-2 Zoom Stereo Body SWF 10X Eyepieces MA301/100 Ring Fluorescent Illuminator MA302 Adapter for Ring Illuminator P Pole Stand
Nikon Inc., Instrument Division 623 Stewart Ave Garden City, NY 11530 516-222-0200	SMZ-1 Stereo Head 10X Eyepiece Focusing Stand Dual Ring IV (Illuminator) EPI-Illuminator with Transformer
Seiler Instrument & Manufacturer Co. (Swift Microscopes) 170 E. Kirkham Ave. St. Louis, MO 63119 314-968-2282	M81B Microscope 10X Eyepieces M80B Stand with Built-in Illuminator

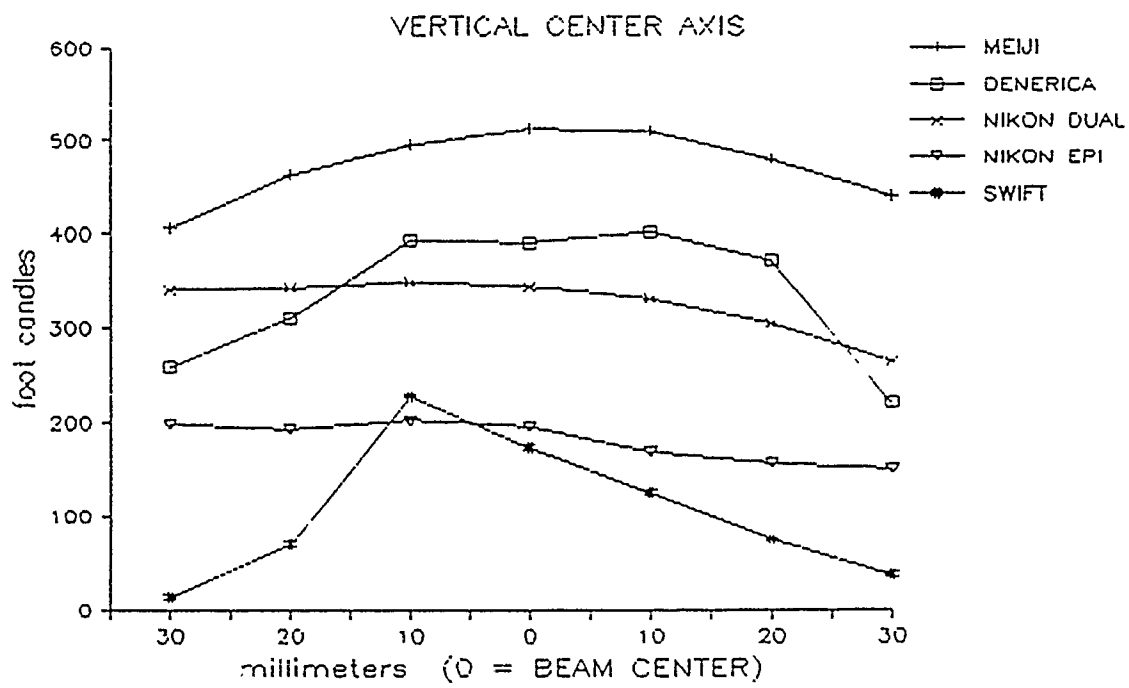
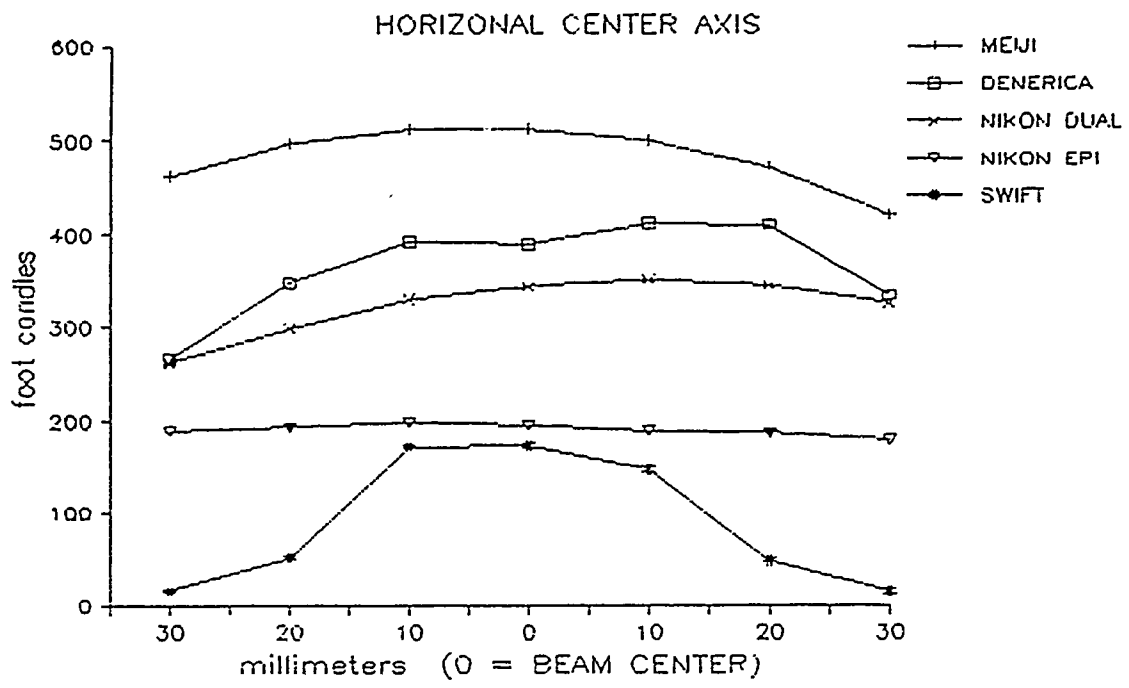


Figure 1. Microscope light comparison.

The physical characteristics of each of the microscopes evaluated are shown in Table 3. The following is a brief explanation of each area:

- TYPE OF MAGNIFICATION. There are generally 2 magnification types available: step and zoom. A step magnification will be in focus at specific levels while a zoom magnification will be similar to a telephoto lens and zoom from one magnification level to the next.
- ADJUSTABLE EYEPIECES. Most microscopes will have 1 or 2 eyepieces which will allow the user to adjust for individual differences in each eye.
- EYEPIECE MAGNIFICATION. This is the magnification level of the eyepiece, which when multiplied by the MAGNIFICATION RANGE will equal the total magnification.
- MAGNIFICATION RANGE. This is the magnification level which the microscope is capable of depending on the type of eyepieces and attachments.
- TOTAL MAGNIFICATION. This is the amount of magnification which the microscope is capable of. This number is dependent on the type of eyepieces and auxiliary lenses.
- ROTATIONAL HEAD. This allows the head to be turned different directions.
- DIAMETER OF FIELD. This is the diameter of the field of vision when looking through the microscope at different magnification levels.
- FOCAL DISTANCE FROM THE TUBE HEAD: This is the measured distance from the bottom of the head to the point where the object is in focus.
- MAXIMUM VERTICAL WORKING DISTANCE. When the microscope is in its maximum vertical extension, this is the distance from the bottom of the head to the top of the base. This number minus the FOCAL DISTANCE FROM THE HEAD gives you the amount of actual working room. Measurements less than 150 mm are unacceptable, 150 mm - 165 mm are adequate and over 165 mm is preferred.
- LIGHT SOURCE TYPE. This is the type of light source.
- LIGHT SOURCE TEMPERATURE. This refers to the color temperature of the light source as rated in Kelvin (K).
- BASE SIZE. This is the size of the base as rated in width (W), depth (D) and height (H).
- e GOVERNMENT COST OF THE MICROSCOPE. This is the price of the microscope as of 1 June 1989. All microscopes are "pieced" together so be sure to contact the manufacturer before ordering.
- GOVERNMENT COST OF THE LIGHT SOURCE. This price is current as of 1 June 1989. The manufacturer should always be contacted for a current price.

TABLE 3. PHYSICAL CHARACTERISTICS

	DENERICA KRX	MEIJI EMZ-2	NIKON SMZ-1	SWIFT M81B
Type of magnification	Step	Zoom	Zoom	Step
Adjustable eyepieces	Right and Left	Right and Left	Right and Left	Left only
Eyepiece magnification	20X	10X	10X	10X
Magnification range	0.5, 1.0	0.7 - 4.5	0.7 - 3.0	1.0, 2.0
Total magnification	10X, 20X	7X - 45X	7X - 30X	10X, 20X
Rotational head	yes	yes	yes	yes
Diameter of field	10X - 27.5 mm 20X - 12.5 mm	7X - 32.8 mm 45X - 5.1 mm	7X - 30 mm 30X - 7.0 mm	10X - 18 mm 20X - 9 mm
Focal distance from tube head	10X - 181 mm 20X - 151 mm	70 mm	7X - 98 mm 30X - 89 mm	10X - 82 mm 20X - 83 mm
Maximum vertical working distance	Unlimited	202 mm	154 mm	151 mm
Light source type	Two 5 W lights	Ring Light	Ring Light 10 W Bulb	20 W Above 10 W Lower
Light source temperature	2640 K	5660 K	10 W - 3550 K Ring - 4080 K	3080 K
Base size	None	W - 150 mm D - 230 mm H - 32 mm	W - 180 mm D - 240 mm H - 30 mm	W - 150 mm D - 215 mm H - 51 mm
Government cost of microscope	\$1107.00	\$1509.00	\$1095.00	\$635.50
Government cost of light source	Included	Included	Ring-\$310.00 10 W-\$214.00	Included

DISCUSSION

Denerica KRX

The KRX (Fig. 2) has right and left adjustable eyepieces. The magnification range is 0.5 or 1.0 which, when used with the 20X eyepieces, gives a total step magnification of 10X or 20X. This microscope may be mounted with an articulated arm which can be swung into position or between several individuals. There are three lengths available, short (75 cm), standard (95 cm), and long (110 cm). This type of mounting leaves the bench top uncluttered; however, if several individuals use the same microscope, they will have to readjust the eyepieces and the interpupillary distance each time. Depending on the extension of the arm, individuals used to resting the bridge of the nose or eyes on the microscope will find stability a problem. Use of the articulated arm does allow for an infinite amount of working room under the head. (Note: A stationary table top stand and various types of mounting brackets are also available.) The KRX does not have a means for focusing. Focusing is accomplished by moving the object up or down under the microscope head into the correct field of vision. The object does not stay in focus when changing magnification levels.

Illumination level on this unit was above average (Fig. 3). The illumination was quite high along the axis with some dimming at the corners. The two lights are easily adjustable, having approximate life of 240 h, and cost \$7.80 each.

The evaluators rated the Denerica KRX average in most categories. Some areas which were rated low (ability to focus, adjustment of the eyepieces, and microscope stability) would most likely improve as users become more familiar with the instrument. The evaluators rated the amount of illumination as average and the amount of working room under the microscope as excellent. Cost of this unit is \$952.00 including 10X eyepieces and lights. The model we tested had 20X eyepieces which cost an additional \$155.00.

Meiji EMZ-2

The Meiji EMZ-2 (Fig. 4) has right and left adjustable eyepieces. Using the provided 10X eyepieces the magnification would zoom from 7X to 45X. This higher magnification would not be required for general work, but may be useful when checking acid etch retainers. The focusing ring surrounds the microscope head, which makes it very easy to use. The EMZ-2 is the only microscope tested where the focal distance remained constant through all magnification levels. The amount of working room under the head (202 mm) is adequate for most procedures. The field diameter at the lowest magnification (7X - 32.8 mm) is higher than other types of tested microscopes.

The ring light is excellent. The overall illuminance is higher than other types, remains constant on all areas of the measured grid (Fig. 5), and produces few shadows. The color temperature is close to natural daylight, which may be beneficial for some tasks.

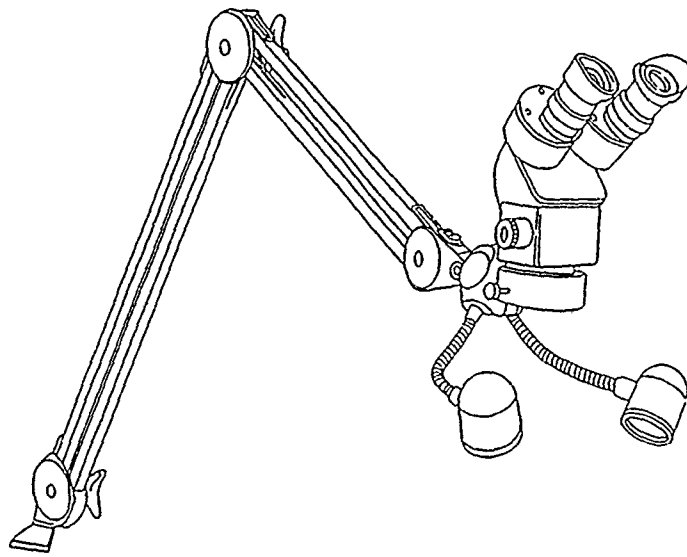


Figure 2. Denerica KRX.

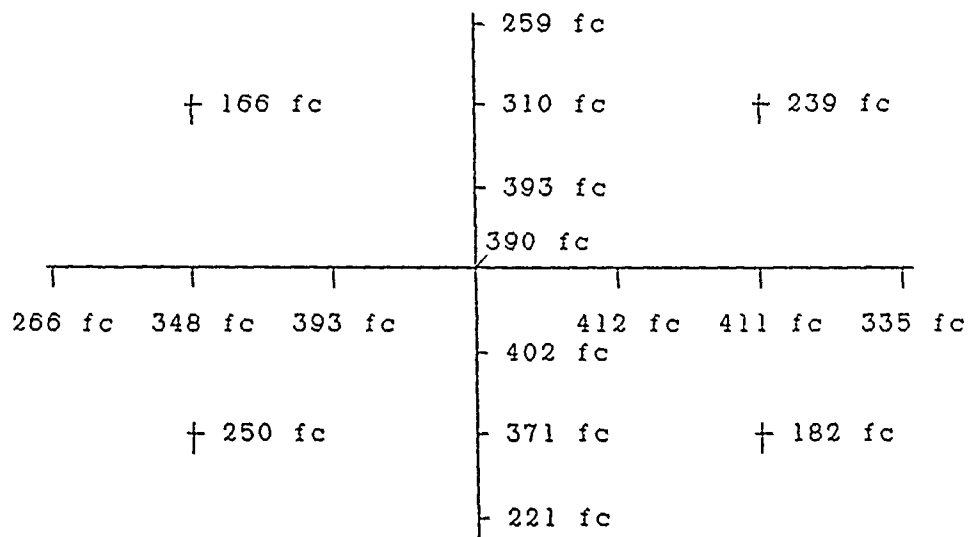


Figure 3. Denerica KRX light pattern.

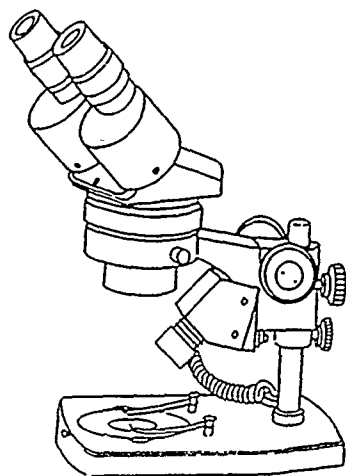


Figure 4. Meiji EMZ-2.

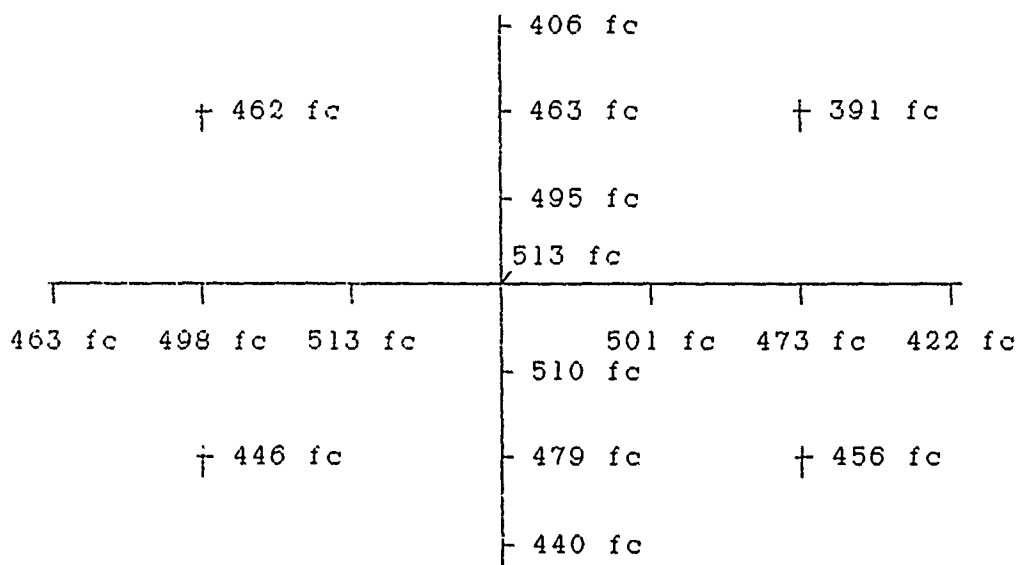


Figure 5. Meiji EMZ-2 light pattern.

The evaluators rated the Meiji EMZ-2 average to excellent in most areas. The field diameter was rated the lowest at highest magnification. However, this magnification level would have minimal usage. The areas rating the highest were the ability to eliminate shadows, amount of illumination, and the optical quality. Cost of this unit is \$1,509.00 from the manufacturer. Some distributors may give discounts.

Nikon SMZ-1

When using the 10X eyepieces, the Nikon SMZ-1 (Fig. 6) has a magnification range of 7X to 30X. However, as the magnification level changes, the focal distance from the head does not remain constant. The amount of working room under the microscope (154 mm) is adequate for viewing an average size dental cast. If additional room is needed, there is a variety of available stands. The field diameter at the lowest magnification (30 mm) is large enough for easy viewing.

Two types of lights were tested, the Dual Ring IV Fluorescent Illuminator (ring light) and the Epi-Illuminator with a 10 watt halogen bulb. The ring light produced a very even illuminance with very few shadows (Fig. 7). The Epi-Illuminator provided sufficient lighting with slightly more shadows (Fig. 8).

The evaluators rated the Nikon SMZ-1 above average to excellent in most areas. They felt the apparent optical quality of the SMZ-1 was significantly higher than other instruments. The areas receiving average ratings include the amount of working room under the microscope and the microscope stability. The Dual Ring IV Fluorescent Illuminator was preferred over the Epi-Illuminator due to the greater illumination and fewer shadows. Cost of this unit is \$1,095.00, which includes 10X eyepieces. The Dual Ring IV Fluorescent Illuminator cost \$310.00, and the Epi-Illuminator with transformer and bulb is \$214.00.

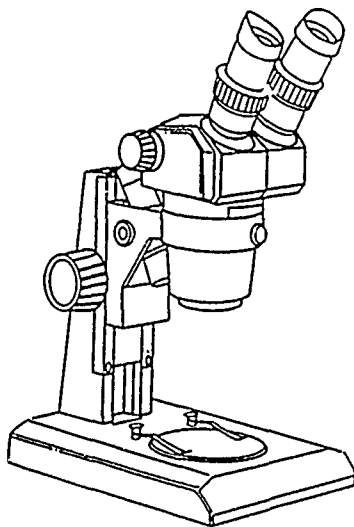


Figure 6. Nikon SMZ-1.

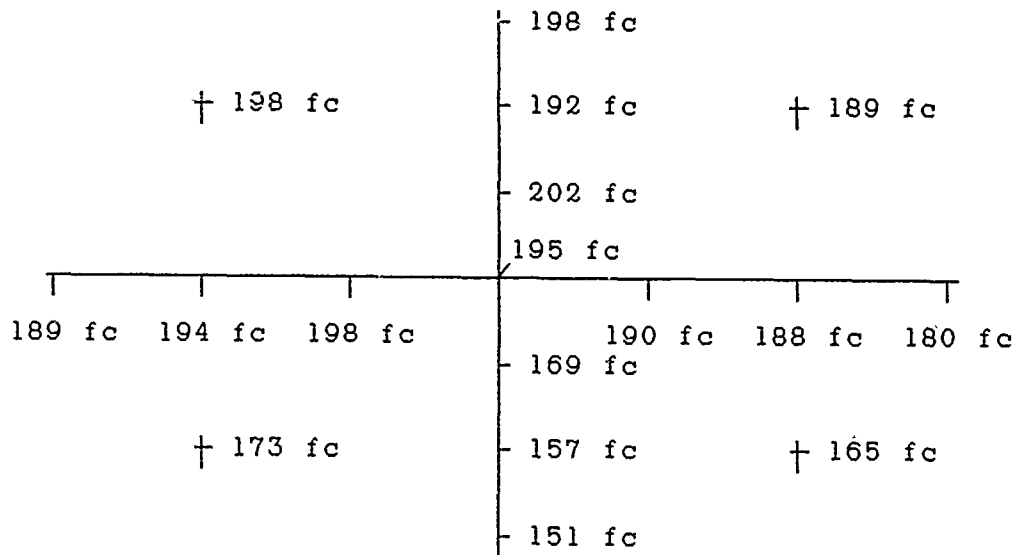


Figure 7. Nikon SMZ-1 with Dual Ring IV Fluorescent Illuminator light pattern.

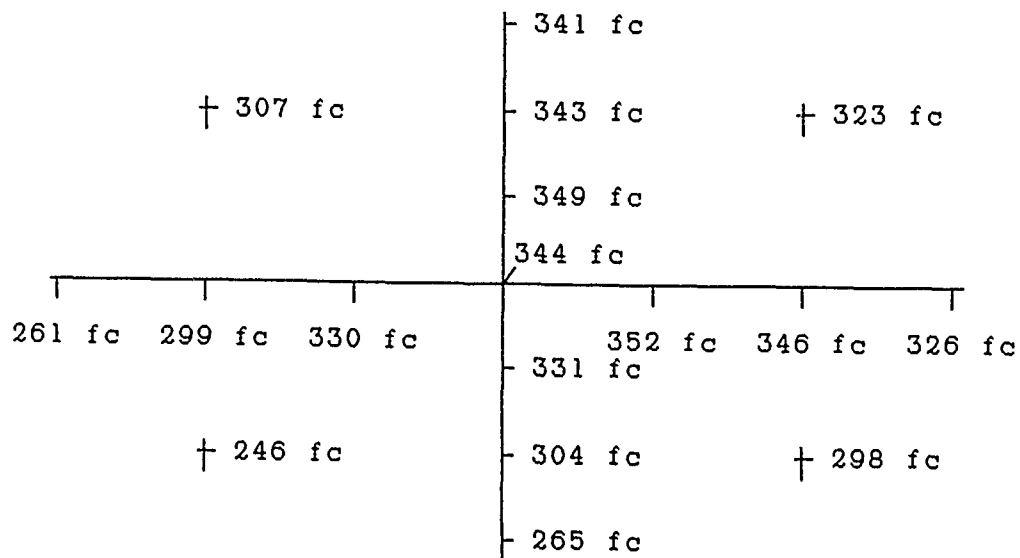


Figure 8. Nikon SMZ-1 With Epi-Illuminator light pattern.

Swift M81B

The Swift M81B (Fig. 9) had the lowest cost of the microscopes tested. When using 10X eyepieces the M81B would step from 10X to 20X. When using the lowest setting, the field diameter is quite small (18 mm). The maximum vertical working distance is 151 mm, which would be adequate for viewing most dental casts.

The Swift M81B was tested with the M80B Stand. This stand has a built-in illuminator for above or below lighting. Illumination would seldom be required from below, and all testing was accomplished using only the top illuminator. Illumination was quite low. While the 173 fc (Fig. 10) of light in the center of the grid was adequate, the light quickly diminished around the perimeter. The illumination levels were extremely low towards the edge and on the corners of the grid.

The evaluators rated the Swift M81B poor to average in most areas. Microscope stability, ability to focus, eyepiece adjustment and the amount of working room under the microscope were rated as average while many other areas were below average. The evaluators were particularly displeased with the lighting system. The poor illumination around the perimeter of the grid was the result of a poorly diffused light source. This poor illumination made it difficult to eliminate shadows. The cost of this unit is \$635.50, which includes the microscope, eyepieces, and light.

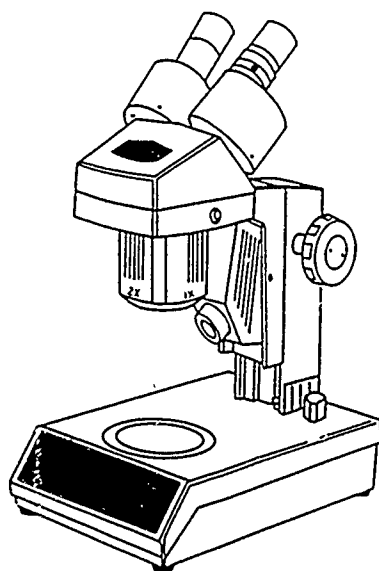


Figure 9. Swift M81B.

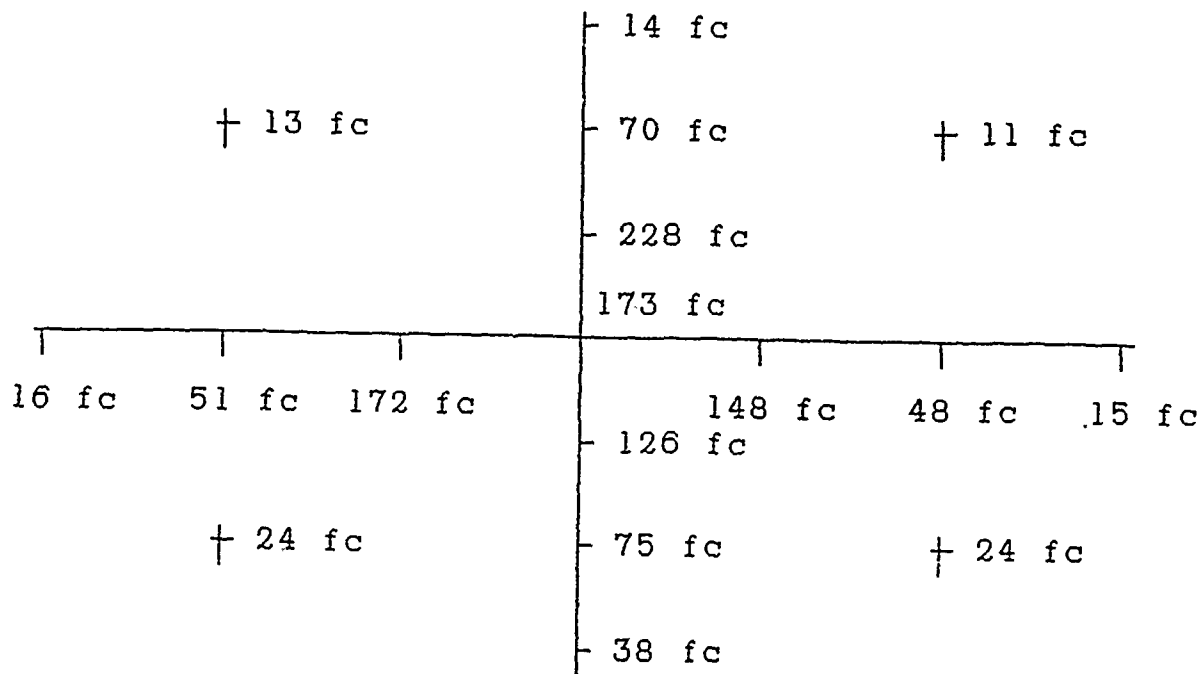


Figure 10. Swift M81B light pattern

CONCLUSION

Adequate working distances under the microscope head is critical when selecting a microscope for a dental laboratory. Many times an entire cast will be placed under the head for viewing. To ensure sufficient working distances, find the difference between the focal distance from the head and the maximum vertical working distance.

Minimum measurements of 50 mm are adequate but less than ideal, considering an average cast is 63.5 mm tall, measurements of over 60 mm are preferred.

An adequate light source is a prime consideration when working under a microscope. Due to the nature of this work, only above lighting is useful. While the diameter of the field may be quite small, additional surrounding light is required to eliminate shadows. This need for added light can be seen by comparing the illumination levels of the various microscopes (Figure 1) and then comparing the results of the user's evaluation in these areas. Adequate illumination becomes even more important with microscopes equipped with photo tubes as poor lighting will usually result in substandard pictures.

Microscopes may be purchased with a variety of magnification levels. As seen in Table 1, the most preferred level of magnification was never more than 20X. The only time high levels may be required would be to check the etch on various metal or ceramic surfaces. Selecting microscopes with only lower magnification levels may be a cost savings.

As with any expensive instrument, measures must be taken to preserve the working mechanisms. Most microscopes may be purchased with a protective filter cap fitting over the end of the head. This small, inexpensive item is a requirement which will protect the lenses from dust and abrasion. Protective dust covers are also available to protect the entire microscope when not in use.

Depending on the type of stand, additional bench space may be required. The most preferred type of bench would be the pedestal type, 121.9 cm long. This type of bench allows the operator to place the microscope next to the work area and slide back and forth without running into any bench legs or drawers. If bench space is limited, a microscope on an articulated arm such as the Denerica KRX should be considered.

Analyzing the "P" value (Kendall Coefficient of Concordance) gives a measure of agreement between raters for ranking the microscopes. When the "P" value is ≤ 0.01 , the agreement is unlikely to have occurred by chance.

When analyzing the ranking in Table 2, all values were less than 0.01. Based on working qualities, the Nikon SMZ-1 was the microscope of choice, followed by the Meiji EMZ-2, the Denerica KRX, and the Swift M81B. When factoring in the cost, the Meiji EMZ-2 was the microscope of choice followed by the Nikon SMZ-1, the Denerica KRX, and the Swift M81B.

RECOMMENDATIONS

There is little doubt the use of a microscope can dramatically improve the quality of many prosthesis fabricated in a dental laboratory. The microscopes with better optics and lighting systems appear to be worth the extra cost. Because we are considering equipping many laboratories with possibly their first microscope, poorly operating instruments will result in little to no usage.

Each U. S. Air Force dental facility should evaluate their own particular requirements before selecting a microscope. Because of the low rating of the Swift M81B in this study, it is not recommended. If bench space is limited and several individuals must use the same instrument, the Denerica KRX with the articulated arm is the instrument of choice. If budgeting and bench space are no problem, then the Meiji EMZ-2 or the Nikon SMZ-1 is highly recommended.

APPENDIX

LABORATORY EVALUATIONS RAW DATA

RATER	POINTS OF EVALUATION										
	1	2	3	4	5	6	7	8	9	10	11
DENERICA KRX											
1	3	3	4	4	2	2	3	3	3	3	2
2	2	3	3	3	3	2	2	3	3	3	3
3	3	3	3	1	3	3	3	3	3	2	2
4	3	4	4	3	3	1	3	2	2	2	1
5	3	4	4	4	3	2	NR	1	3	3	2
6	2	1	2	5	1	3	1	2	4	3	1
7	2	5	4	5	3	4	3	2	4	1	2
8	1	4	5	4	4	3	2	3	5	2	1
9	3	NR	4	1	3	3	5	2	3	3	1
10	3	3	3	5	3	2	NR	3	1	3	1
MEIJI EMZ-2											
1	3	3	2	3	2	5	5	2	2	2	3
2	3	2	2	3	2	3	4	1	3	3	3
3	2	3	1	2	3	4	3	2	2	3	2
4	2	3	2	3	3	3	3	2	2	2	2
5	3	3	3	3	2	3	1	1	1	1	3
6	2	1	2	2	1	3	5	3	2	2	2
7	1	1	2	1	2	2	NR	2	2	1	2
8	4	2	2	2	3	2	NR	3	1	1	2
9	2	2	2	3	3	2	3	2	1	3	3
10	3	3	4	3	1	3	NR	1	2	1	3

NR = Not Rated

RATER	POINTS OF EVALUATION										
	1	2	3	4	5	6	7a/b	8a/b	9a/b	10	11

NIKON SMZ-1

1	2	2	3	3	3	4	3/2	3/2	2/2	3	1
2	2	1	2	2	3	2	4/2	4/2	4/2	1	2
3	1	1	2	3	2	3	4/3	2/2	3/1	2	2
4	1	3	1	3	3	2	3/1	1/3	4/2	1	2
5	3	1	4	1	2	1	4/2	1/3	2/3	1	3
6	1	2	3	1	1	2	NR/2	1/4	1/4	1	3
7	2	2	1	2	1	2	NR/4	2/4	2/2	1	2
8	2	1	1	3	1	4	1/NR	1/2	1/2	1	3
9	4	2	2	2	2	2	NR/NR	1/1	2/2	1	3
10	2	3	2	2	2	4	NR/NR	2/4	2/2	1	3

SWIFT M81B

	1	2	3	4	5	6	7	8	9	10	11
1	3	3	3	3	4	3	4	5	5	4	3
2	4	4	3	3	4	4	3	5	4	5	4
3	4	4	3	3	4	4	5	4	3	4	3
4	3	3	4	4	4	3	4	3	3	3	3
5	3	3	4	3	4	3	3	4	5	3	5
6	4	4	4	2	4	4	3	5	5	3	3
7	5	NR	3	3	4	2	4	4	5	2	3
8	4	3	3	3	4	2	NR	5	4	4	3
9	3	3	4	1	4	3	5	5	3	3	4
10	4	1	3	3	4	4	NR	5	5	5	3

NR = Not Rated
a = Ring light
b = Halogen light

PREFERRED MAGNIFICATION RANGES

RATER	DENERICA KRX	MEIJI EMZ-2	NIKON SMZ-1	SWIFT M81B
1	10X	10X	10X	10X
2	10X	20X	10X	20X
3	20X	10X	10X	10X
4	10X	7X	7X	10X
5	20X	7X	10X	10X
6	20X	10X	20X	10X
7	10X	20X	20X	20X
8	10X	10X	10X	20X
9	10X	7X	7X	10X
10	20X	20X	20X	10X

RANKING BASED ON WORKING QUALITIES

RATER	DENERICA KRX	MEIJI EMZ-2	NIKON SMZ-1	SWIFT M81B
1	3	2	1	4
2	3	1	2	4
3	3	2	1	4
4	3	1	2	4
5	2	1	3	4
6	2	3	1	4
7	2	3	1	4
8	4	2	1	3
9	3	2	1	4
10	3	2	1	4

RANKING BASED ON WORKING QUALITIES AND PRICE

RATER	DENERICA KRX	MEIJI EMZ-2	NIKON SMZ-1	SWIFT M81B
1	3	1	2	4
2	3	1	2	4
3	3	2	1	4
4	3	1	2	4
5	2	1	3	4
6	2	3	1	4
7	1	3	2	4
8	4	2	1	3
9	3	1	2	4
10	3	2	1	4