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FAA Tests Task-specific Eyeglass Lenses for Air Traffic Control Specialists

Aging results in diminishment of near-vision acuity, which can be corrected with prescription lenses. Researchers concluded that, for air traffic controllers who work at radar consoles, lenses with a wider field of view are generally preferable.

Robert L. Koenig
Aviation Writer

Presbyopia, a normal decrease in near-vision acuity that occurs with age, can be corrected with prescription lenses for eyeglasses or contact lenses. But researchers have found that conventional lenses do not meet all the visual demands placed on presbyopic air traffic controllers.

The purpose of the air traffic control (ATC) system in the United States is to separate aircraft to provide for a safe and expeditious flow of air traffic throughout the national airspace system (NAS). Air traffic controllers use radar and other electronic means to accomplish this goal.

The radar controller is responsible for monitoring each aircraft's status on a radar screen. He or she keeps track of each aircraft's position, course, speed and altitude and issues changes as required to keep the aircraft separated. In addition to stress tolerance and attention to detail, the radar controller must have excellent near vision.

Figure 1 (page 2) shows a layout of a typical radar console used by the air traffic control specialist (ATCS). Aircraft within radar range appear as moving "blips" on the radar screen. A computer-generated flight progress strip is kept for each aircraft



as long as it is under the specialist's control. The local airways map mounted above the console is available for ready reference.

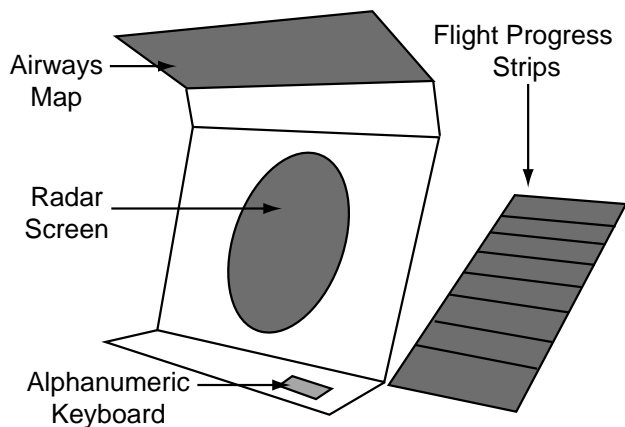
In a recent study, researchers at the U.S. Federal Aviation Administration (FAA) Civil Aeromedical Institute (CAMI) in Oklahoma City, Oklahoma, U.S., evaluated American Optical Corporation's TruVision Technica® — a task-specific lens design — to ascertain the visual benefits that the lens would provide for presbyopic ATCSs using radar displays.

The CAMI report, *The Use of Task-Specific Lenses by Presbyopic Air Traffic Controllers at the En Route Radar Console*, focused on presbyopic ATCSs at the Houston (Texas, U.S.) air route traffic control center (ARTCC).

Researchers cautioned that there were so few test subjects in the study (13 controllers) that the results may be compromised. Also, the study measured controllers' qualitative opinions of the lenses, rather than quantitative results from their use of the lenses.

Single-vision lenses are often used to correct near vision. Bifocal lenses correct both near and distant vision. Trifocal lenses add a

Layout of the En Route Radar Console



Source: U.S. Federal Aviation Administration Civil Aeromedical Institute

Figure 1

correction for intermediate-range vision. Executive — rectangular — bifocal and trifocal lenses provide more peripheral corrected vision than round lenses (Figure 2, page 3).

Segment Lines Remain Drawbacks of Multifocal Lenses

The disadvantages of bifocal and trifocal lenses are the division lines (segment lines) between the different prescriptions, which cause blurred zones or image jumps as the line of vision crosses the division lines. In an effort to correct presbyopia without creating division lines, optical researchers have devised “progressive addition lenses” (PALs). By providing a continuum of focus — from far to intermediate to near — PALs eliminate the division lines and thus the two major drawbacks of standard multifocal lenses.

Nevertheless, general-purpose PALs have shortcomings: They cost more than ordinary lenses; they require more time before users become accustomed to them; and they are difficult to fit. Also, the area of the lens containing the prescription is relatively narrow, so there is distortion at the periphery of the lens.

In an effort to improve on PALs, optical researchers are developing other types of lenses for users of video display terminals (VDTs), which are similar to radar screens. Technica has a narrower distant viewing area than general-purpose PAL designs but provides wider intermediate and near-vision zones (Figure 3, page 4). The CAMI report said that some previous clinical trials had indicated that the Technica design gives VDT users “a more comfortable, usable correction than with standard multifocal lens designs.”

The Technica lens differs from general-purpose PAL designs in other respects, including:

- The distortion area is concentrated at the top of the lens, which is not normally looked through in close work; the distortion area is at the bottom of PALs; and,
- The intermediate-vision correction zone is at the center; the center of the PAL has distant-vision correction.

Because radar screens are similar to VDTs, the CAMI researchers hypothesized that the Technica lens would be equally suitable to correct the vision of presbyopic ATCSs; that, in effect, the visual benefits of the design could be transferred from the VDT screen to the radar screen.

The CAMI research involved 13 male presbyopic controllers. Each test subject worked at least 20 hours per week at en route radar consoles. The controllers ranged in age from 36 to 55. The “intermediate working distance” between the test subjects and their radar consoles varied from 84.7 centimeters (33.3 inches) to 95.1 centimeters (37.4 inches).

The controllers in the study met several requirements. Each had undergone a complete vision examination within the previous 12 months, and each wore prescription lenses for near or intermediate vision that met the parameters available in the Technica lens.

Subjects Issued Two Pairs of Eyeglasses

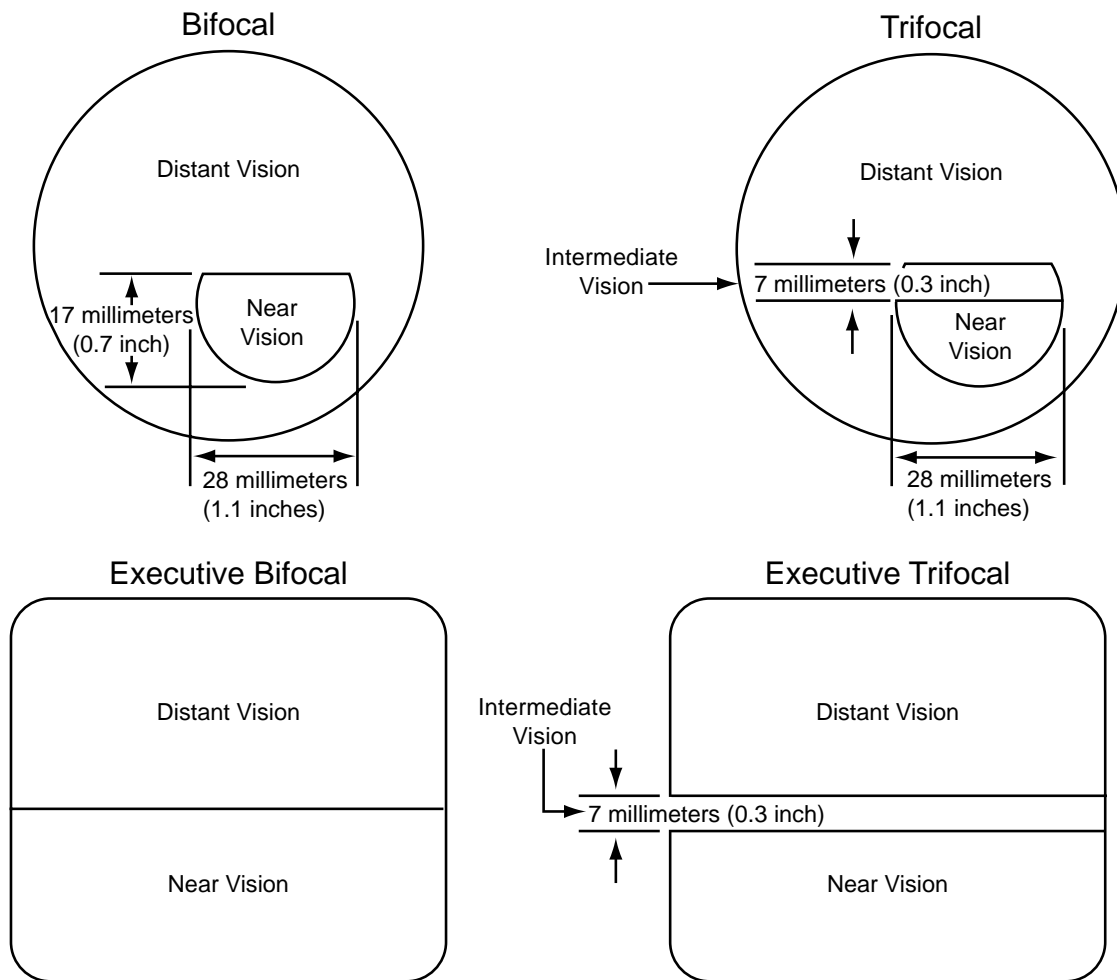
Before the tests began, ophthalmologists analyzed each test subject’s refractive prescription and eyeglasses and selected an eyeglass frame. They ordered two pairs of eyeglasses for each subject. One pair was a duplicate of the subject’s usual prescription lenses; the other pair contained the Technica lenses.

All subjects were asked to wear their Technica lenses for closeup leisure activities for one week. If they felt comfortable with the eyeglasses, they were assigned to wear them exclusively while working at radar consoles for the four-week initial test period.

At the end of those four weeks, each subject completed an initial evaluation questionnaire. During the fifth week, the subjects, when at work, alternated between the eyeglasses with Technica lenses and the eyeglasses with their usual lenses.

After the fifth week, the test subjects responded to a survey comparing their experiences when wearing the two types of lenses. Finally, three months later, researchers conducted a follow-up evaluation to determine if the test subjects were still wearing at work their preferred lenses.

Standard Bifocal and Trifocal Lens Designs



Source: U.S. Federal Aviation Administration Civil Aeromedical Institute

Figure 2

Test Subjects Preferred Their Usual Lenses

Of the controllers tested, 38.5 percent said that they preferred the Technica lenses to their original lenses while working at radar consoles. The remaining 61.5 percent, who expressed preference for their usual lenses at radar consoles, were using either single-vision lenses or bifocal/trifocal executive lenses, which incorporate “near and/or intermediate segments with large surface areas,” the report said (Table 1, page 4).

“For older presbyopic ATCSs, intermediate-distance viewing becomes more difficult with single-vision lenses, and traditional multifocal lenses are required,” the report said. Researchers found that 55.6 percent of the test subjects who were 44 years old or older preferred the Technica lenses.

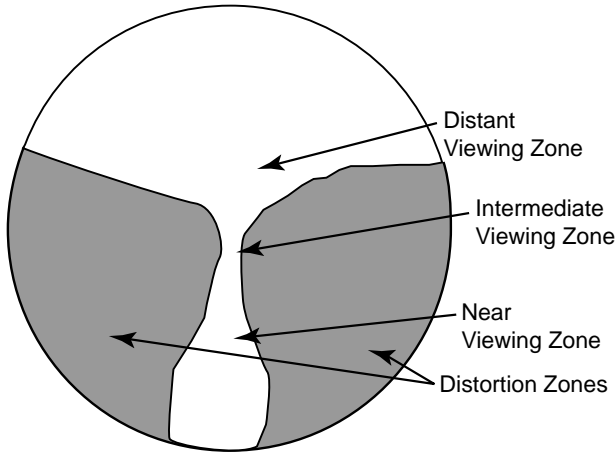
“However, for some individuals, the scanning requirements of an ATCS may not be compatible with the limitations imposed by the Technica’s relatively narrow intermediate viewing area and the [peripheral] distortions of the lens, compared to single-vision and other multifocal lens designs,” the report said. Despite the mixed reaction to the Technica design, the CAMI researchers said that “there is some evidence that some controllers felt its benefits were significant.”

When using their usual lenses at work, 10 of the 13 controllers had complained of blurred vision, and five complained of eyestrain. Other complaints, cited less often, included headaches and limited working distance related to lens design (Table 2, page 5).

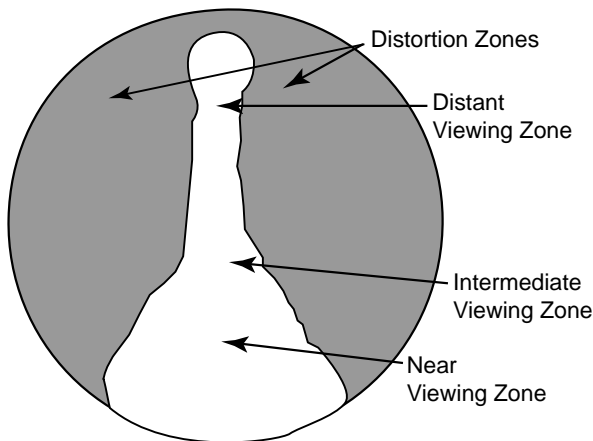
Fewer test subjects (five) complained of blurred vision while using the Technica lenses, but the total number of controllers

Comparison of Progressive Addition Lens and TruVision Technica® Lens

Progressive Addition Lens (PAL)



TruVision Technica Lens



Source: U.S. Federal Aviation Administration Civil Aeromedical Institute

Figure 3

complaining of eyestrain was slightly higher (six) with the Technica lenses. Meanwhile, the study found that the most numerous complaints about Technica lenses related to distortions (eight) and the narrow field of view (10) (Table 3, page 5).

“The Technica [lenses] reduced eyestrain in two of five subjects while inducing it in three others,” the CAMI report said. “Blurred vision was eliminated in five of 10 subjects who had reported this problem with their [usual lenses].”

Of the 13 controllers, five (38.5 percent of the total) had complained that their usual lenses had led to work-related stress. The five who later said that they preferred Technica lenses “reported decreased work-related stress, increased

Table 1
Air Traffic Control Specialist Preferences
By Age and Type of Lens Worn

Subject No.	Age	Current Prescription Lens	Preferred Prescription
1	44	Bifocal	Technica
2	40	Single Vision	*
3	48	Trifocal (Executive)	*
4	47	Single Vision	Technica
5	49	Bifocal (Executive)	*
6	51	Bifocal	Technica
7	36	Single Vision	*
8	45	Single Vision	*
9	53	Single Vision	*
10	55	Single Vision	*
11	47	Progressive	Technica
12	36	Single Vision	*
13	45	Single Vision	Technica

Note: * denotes that subject preferred usual lenses.

Source: U.S. Federal Aviation Administration Civil Aeromedical Institute

efficiency, and/or a decrease of fatigue” when using Technica lenses.

The researchers wrote: “It is possible that older ATCSs accustomed to the wider viewing areas of their [usual] lens designs would require a prolonged adaptation period to rehabilitate their visual scanning skills and [would] learn to ignore the negative features reported with the Technica — namely, the limited field of view and peripheral distortion.”

In conclusion, CAMI researchers said that their test results suggested that, for en route controllers who work at radar consoles, “a lens with a wider field of view (single-vision or executive) is generally preferable to a Technica lens design.

“However, Technica may be preferable for those ATCSs using smaller multifocal lens designs or general purpose PALs. Although the Technica provides a relatively wide intermediate and near vision area, it may not be wide enough for the visual scanning required for work at the radar console,” the report said. For that reason, researchers suggested, some controllers complained about distortion and limited field of view.

The CAMI researchers also said that Technica lenses might be more acceptable for controllers who use traditional VDTs, such as at automated flight service stations, rather than radar consoles. “Although not a panacea for all presbyopic

Table 2
Subjective Complaints about
Usual Lenses in Work Environment

Symptoms	With Original Prescription (Subject number)
Eyestrain	2, 3, 7, 8, 13
Blurred Vision	2, 4, 5, 7, 8, 9, 10, 11, 12, 13
Headaches	1, 2, 11, 13
Neck Pain	1, 3, 6
Back Pain	1, 6
Sore/Scratchy Eyes	2
Distortions	7
Limited Field of Vision	3, 11
Glare/Reflections	2, 7
Limited Working Distance	5, 10, 12

Source: U.S. Federal Aviation Administration Civil Aeromedical Institute

Table 3
Subjective Complaints about
Technica Lenses in Work Environment

Symptoms	With Technica Prescription (Subject number)
Eyestrain	2, 5, 7, 8, 9, 10
Blurred Vision	2, 7, 8, 9, 10,
Headaches	7
Neck Pain	7
Back Pain	
Sore/Scratchy Eyes	
Distortions	1, 2, 5, 7, 8, 9, 12, 13
Limited Field of Vision	1, 2, 5, 6, 7, 8, 9, 10, 12, 13
Glare/Reflections	6, 7, 8, 9
Limited Working Distance	3, 7

Source: U.S. Federal Aviation Administration Civil Aeromedical Institute

controllers who need corrected vision for near and intermediate distances, the Technica is a viable option for eyecare practitioners correcting ATCSs with occupational vision problems,” the report said.

Scientists who study demographic trends predict that during the next decade there will be a substantial increase in the number of presbyopic controllers, many of whom “will be full-performance ATCSs working at the radar console[s].” That is

one reason why the report recommends further research on vision correction for presbyopic controllers.

Unremarkable Results Suggest Too Few Test Subjects

Although the information in the current study is useful, the research in Houston “was compromised by the small number of participating controllers.” Thirty controllers in Houston responded to CAMI’s original request for test subjects, but only 13 were chosen for the research, for various reasons. “Age may have contributed to this since, for en route controllers, there is not only a maximum entry age (i.e., may not have reached their 31st birthday prior to initial appointment), but also a mandatory separation at 56 years of age from positions requiring direct separation and control of air traffic,” the report said.

Researchers suggested that other reasons for the low participation rate included changing work schedules, the limited number of presbyopic controllers who actually work at radar consoles, concern by some controllers about giving additional medical information to the FAA, and that some controllers were satisfied with their present eyeglasses.

“A study with quantitative test results of controller performance would have been preferred,” the report said. “However, a performance-based test was not an option in this study, since we could not interrupt the ATCSs while they were at work. The use of subjective responses to survey questions, which are not easily quantifiable and are sometimes difficult to interpret, was the most practical method of evaluating the usability and feasibility of these ophthalmic lenses on the job.”♦

Editorial note: This article was adapted from *The Use of Task-Specific Lenses by Presbyopic Air Traffic Controllers at the En Route Radar Console*, Report no. DOT/FAA/AM-96/27, December 1996, written by Van B. Nakagawara and Kathryn J. Wood of the U.S. Federal Aviation Administration Civil Aeromedical Institute in Oklahoma City, Oklahoma. The 23-page report includes illustrations and charts, as well as a list of references and two appendices showing the forms used by the researchers to evaluate the lenses.

About the Author

Robert L. Koenig is a Berlin, Germany-based correspondent who specializes in transportation and science issues. He has written on aviation matters for Science magazine and the Journal of Commerce. Before his move to Germany, he was a Washington, D.C., newspaper correspondent for the St. Louis Post-Dispatch, for which he covered transportation issues. He won the National Press Club’s top award for Washington correspondents in 1994. Koenig has master’s degrees from the University of Missouri School of Journalism and from Tulane University in New Orleans, Louisiana.



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