

O P T I C A L

R E S E A R C H

A S S O C I A T E S

March 31, 2010

To Whom It May Concern:

RE: Panoramic Reverse Galilean Telescope for Underwater Vision - PRGTUV

Optical Research Associates (ORA®) is the industry's leading supplier of imaging and illumination design/analysis software: CODE V® and *LightTools*®. Our Engineering Services group is the largest independent supplier of optical systems design with more than 4,800 completed projects in imaging, illumination, and optical systems engineering. Working with our distribution partners, we now have customers in more than 25 countries.

ORA was founded in 1963 to provide leading-edge optical design services. ORA's primary vision to accelerate the development and adoption of optical technology throughout the world has led to its definitive role as an innovative solutions supplier to the optics industry. We employ over 50 engineers, including members of a dedicated technical support staff available to all users of its software products. Our success also lies in the expertise of its employees, 16 of whom hold Ph.D.'s, 11 in Optical Sciences or Optics.

ORA engineers maintain an active program of publication in peer-reviewed journals, as well as presenting papers at conferences. In the last 5 years alone, we have published over 48 publications in engineering journals, ranging on such diverse topics as:

- Optimization for illumination systems
- Fundamental aberration theory
- The alignment of telescopes
- Techniques for the design of tolerance insensitive optical systems
- Design of an Advanced Helmet Mounted Device (AHMD) for use in flight simulators.

One of our most interesting presentations remains (even 10 years after completion of the work) the Panoramic Reverse Galilean Telescope for Underwater Vision, which we carried out for HydroOptix. Though seemingly simple – after all, ordinary dive masks consist merely of a flat window – the design of an underwater viewing port having unity magnification, freedom from distortion, high resolution, no color fringing, and no

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dioptric focus error, is a surprisingly difficult task. Using custom design and analysis algorithms created specifically for the PRGTUV project in CODE V's MacroPlus language, we were able to achieve a remarkable degree of correction, facilitating good hand-eye coordination.

Working with a separate engineering firm, HydroOptix carried out a finite element analysis (FEA) to ensure that the hyperbaric pressure requirements of the dive mask would be met, and built several highly successful prototypes. Because the visual experience differs so strongly from that of an ordinary mask, divers have remarked that the visual experience is "as if there is no water."

Optical designers around the world have commented that our presentation of our solution to this challenging design problem illustrates interesting design concepts. We at ORA hope one day soon the professional dive industry will recognize and adopt the efficiency and safety benefits of greatly expanded, low distortion underwater vision for its workers.

Sincerely,

A handwritten signature in black ink that reads "John R. Rogers". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

John R. Rogers
Principal Engineer