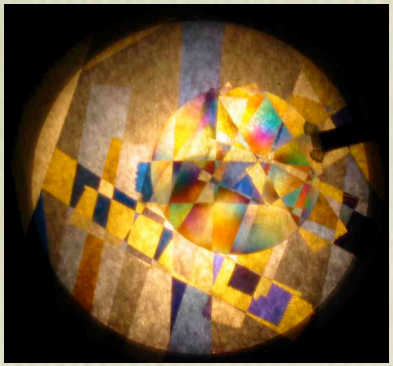
International Workshop
Science Education in Schools

Stephen M. Pompea
National Optical Astronomy Observatory
Tucson, Arizona
USA



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Informal Education Learning Activities

- Voluntary and self-directed, life-long, motivated mainly by intrinsic interests, curiosity, exploration, manipulation, fantasy, task completion, and social interaction.
- Informal learning occurs in an out-of-school setting and can be linear or non-linear
- Often self-paced and visual- or object-oriented.
- Provides an experiential base and motivation for further activity and learning.

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Project Funding

- National Science Foundation, Division of Informal Science Education, P.I. Anthony Johnson
- Program Officer: Dr. Sylvia James
- Support from SPIE, OSA, NOAO

Knowledge and Wonder

… for all knowledge and wonder (which is the seed of knowledge) is an impression of pleasure in itself …

–Francis Bacon

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Project History

- 2001 National Science Foundation Planning Grant to Optical Society of America, SPIE-The International Society for Optical Engineering
- Result: *Optics Education: A Blueprint for the 21st Century*
- Recognition that professional societies have obligations/expertise to K-12 as well as to membership-oriented focus.
- Optics as a “stealth” field, contributing to many others
- Ubiquity of optics in everyday life in contrast to noticeable absence of optics in K-12 and informal education
- 22 recommendations, interventional strategies
- Importance of strategic partnerships

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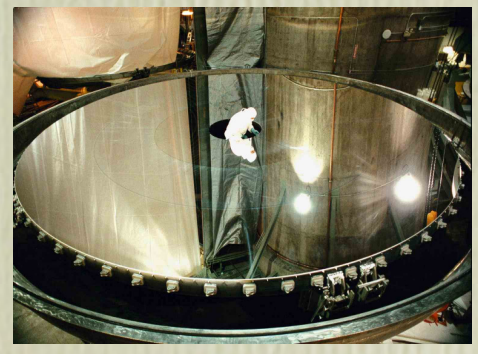
Role of Optics Resource Volunteers

- Each society has over 15,000 professional members.
- Over 2000 are conducting educational activities
- Train and utilize this volunteer force for optics education
- Need to utilize other mentors (undergraduates, graduate students, technicians, other practitioners)



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Results of Planning Grant: Focus on Middle School Age, Informal Setting, Broad Audience

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Organization of Current HOO Program

OSA – The Optical Society of America
Project Principal Investigator Anthony Johnson

SPIE – The International Society for Optical Engineering Project Co-PI Eugene Arthurs

NOAO – The National Optical Astronomy Observatory
Project Co-PI and Project Director Stephen Pompea

--3-year program in year 4 no-cost extension
All money committed by August 31, 2007

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Our Approach:

- Experimentation
- Inquiry-oriented
- Build sense of ownership
- Create prolonged engagement
- “Fun and exciting”
- Career awareness

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Professional Development Program is Essential

Strong (but flexible) professional development for educators and optics resource volunteers

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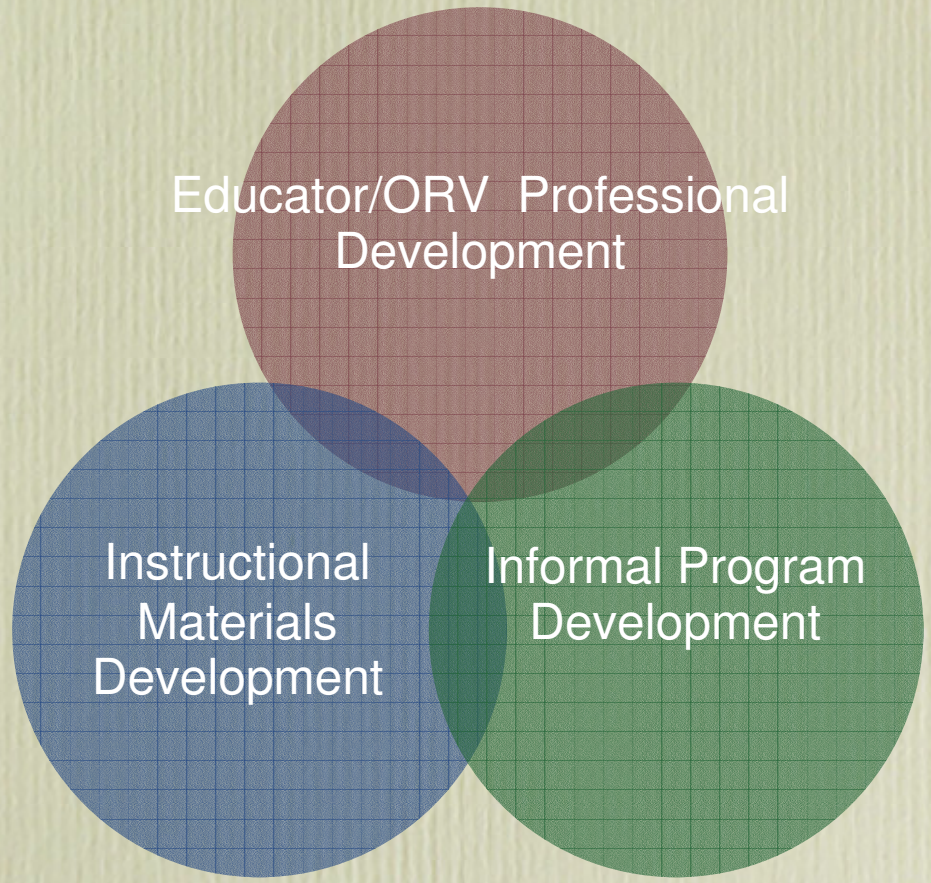
Intersection of Hands-On Optics Functions



Builds on Understanding of Children and their View of the Nature of Light

- Light is a source, may be an effect, but is not an entity (Guesne)
- Light paths and rays not well understood (Ramadas and Driver)
- Focus on seeing as the active process (not light reflecting from objects)
- Basic misunderstanding of shadows and even where they appear.
- Poor understanding of images and their location (Goldberg and McDermott)
- Poor understanding of how filters work and of colors. (Zylbersztajn and Watts) What is “black”?
- Reflections must be specular (Anderson and Smith)

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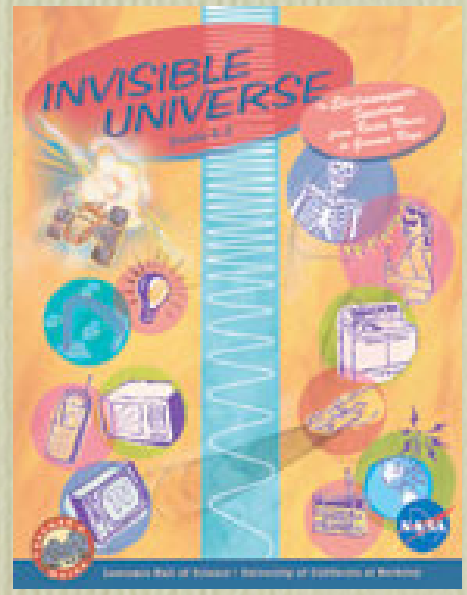
HOO Modules: Builds on Existing Materials and Workshops:

e.g., *Invisible Universe* Teacher's Guide and workshops at the National Science Teacher's Association, numerous SPIE and OSA efforts



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Project Goals

- Create links from the professional optics community to the informal science education community
- Reach underrepresented middle school cohorts in science and technology and connect with their parents, teachers, school districts and communities
- Provide opportunities for the target populations to succeed in collaborative learning and problem solving through inquiry-based, hands-on applications of optical and engineering skill and knowledge
- Increase science and technology knowledge for students and increase awareness of optics as a discipline and career that cross-cuts numerous fields

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Goals and Plan

1. Target underserved middle-school aged audience
2. Use a volunteer network as mentors “Resource Agents”
3. Team volunteers with MESA teachers
4. Develop 6 modules with optics parts
5. Design professional development course for educators and volunteers
6. Develop a resource book for the volunteers to work in an educational hands-on environment.
7. Provide program for career awareness and capstone events

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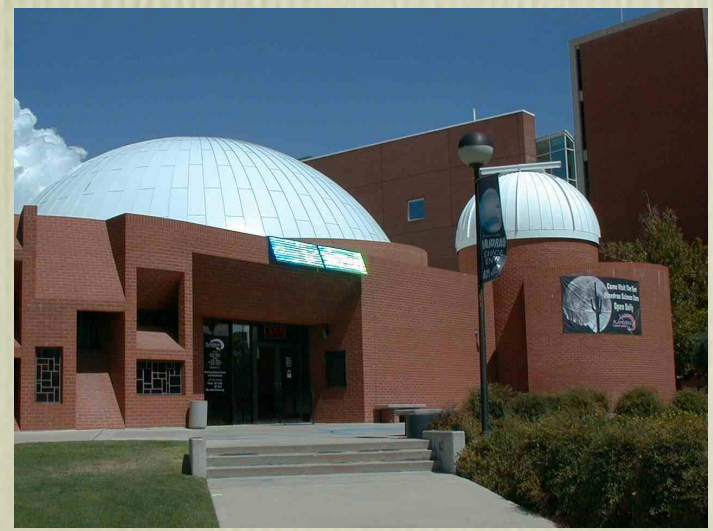
Primary Audiences for Hands-On Optics

1. MESA programs: Arizona, Colorado, California, Maryland, New Mexico, Oregon, Washington

2. Science Centers: Adventure Science Center, California Science Center, Chabot Science Center, Flandrau Science Center, Imiloa Astronomy Center of Hawaii, New York Hall of Science, Orlando Science Center



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Selection Criteria for Science Centers

- Reach an underserved audience
- Interest in long-term physical science education
- Integration with current programs
- Number of kids reached/hours per kid
- Presence of volunteer community
- Long-term commitment of staff/management

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What the project provides:

- HOO kits, curricula, advice (e.g.,camp plans)
- Professional development for staff
- Materials for informational programs and festivals

What we need from our partners:

- A specific plan for use of HOO materials
- A coordinated plan for staff professional development
- Metrics on usage, formative feedback

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Report from Orlando Science Center

These are the numbers for September 10, 2006 through January 12, 2007

Program Type	# of Classes	# of Students	Total
Elementary Discovery Labs using HOO	3	30	90.00
21st Century Elementary Outreach	9	26	234.00
NEW Middle and High School Focused Experience (Microscopy and Telescopes)	1	35	35.00
Middle School Optics Outreach	2	30	60.00
DDL Weekends using optics at 1 or more stations	32	150	4800.00
DDL Weekdays using optics at 1 or more stations	5	150	750.00
Science Live Shows using HOO for guests	10	150	1500.00
Optics cart demos	10	150	1500.00
Darden Theater Shows (Chem and Physics shows)	5	242	1210.00
Grand Total			**10179.00**

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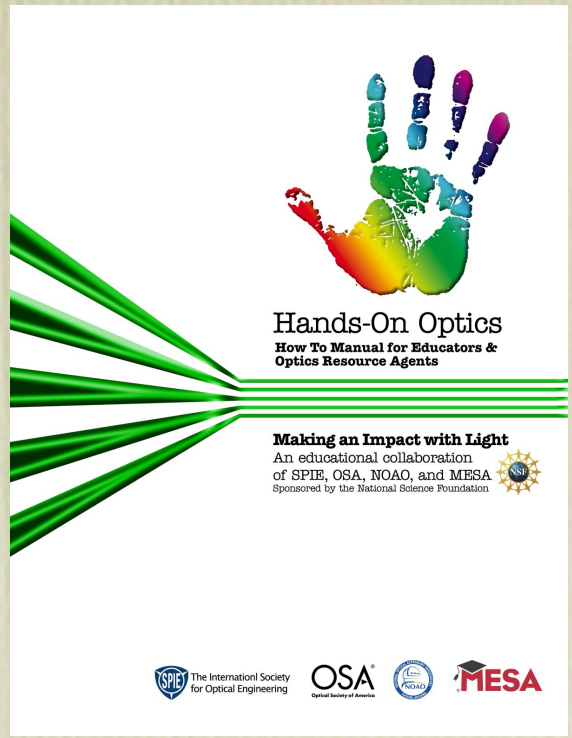
HOO Modules

- Playful, Exploratory
- Appeal to “Non-Science” Student
- Challenge-Oriented
- Balance of Low/High Tech
- Tied to US National Science Education Process and Content Standards, Mathematics Standards, and Technology Education Standards



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Module Summary

Module	Concept	Key Activities
1. Laser Challenges	reflection off of a plane mirror	"Hit the Target"
2. Kaleidoscope Adventures	multiple reflections	"Kaleidoscopes and Periscopes"
3. Magnificent Magnifications	image formation	"Building a Telescope"
4. Peculiar Polarizations	polarization and color	"Testing for Stress"
5. Ultraviolet and Infrared Light	EM spectrum, fluorescence and infrared	"Glowing Things"
6. Communicating on a Beam of Light	information transmission	Laser Communication of Sound

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Activities in One Module

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Module One-continued

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Continued

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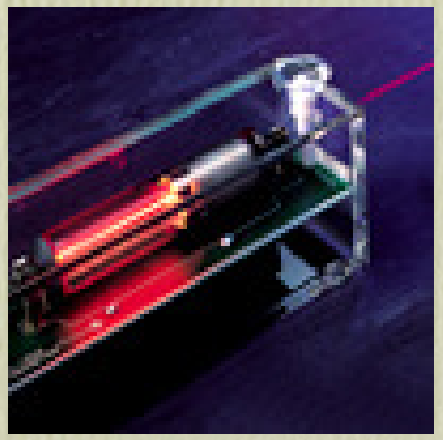
Sample Items in Kits

HOO Challenges: Module 6 Laser Communication The Old Way…



Clear modulated laser: $475

Laser communication receiver kit: $139

Grand Total:

$614

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Our Kit < $100

The Receiver

MESA Competition 2007 (prolonged engagement)

- 4th Year, Took place April, 2007 in Tucson
- Changed to a version of “Hit the target”
- Teams received kits to practice
- 37 teams signed up
- 4th year

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Some New Audiences: Boys and Girls Clubs

South Tucson and Sells Boys and Girls Clubs

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Boys and Girls Club in Sells
(Tohono O'odham Nation)

- 1.5 hours every other week
- At least 15 children per session
- Ages mostly between 7-12 years old
- Program was very well received
- Of 3 dozen kids on the last day

— 90% of the kids had consistently participated in HOO

— 90% wanted the program to continue

Special optics event at Pisinemo (with Tohono O'odham summer day camp)

Boys and Girls Club
South Tucson (Hispanic Community)

- Two 1.5 hour sessions twice week
- 73 children participated; an average of 22 students each day.
- An equal number of boys and girls
- Twice as many 7-10 year olds as 11-14 year olds
- As a capstone, 18 children with the highest attendance record traveled to Kitt Peak National Observatory for the Nightly Observing Program.

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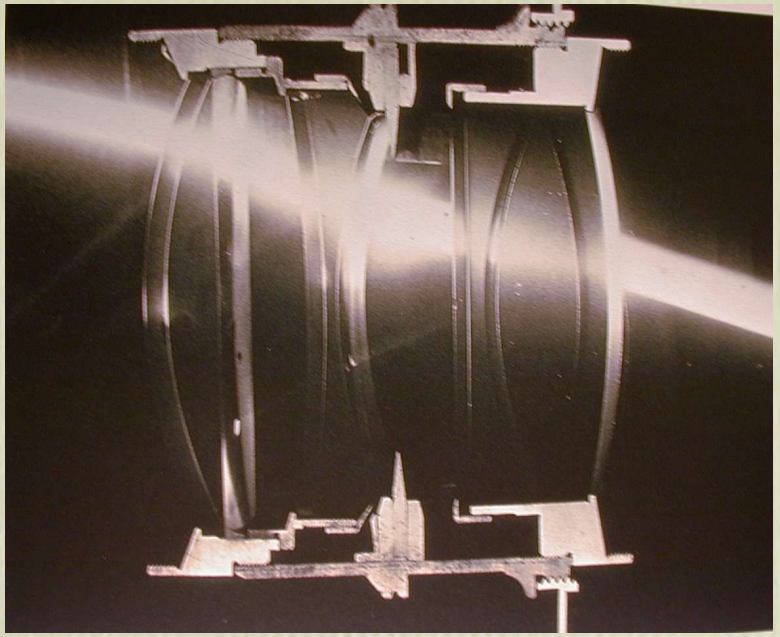
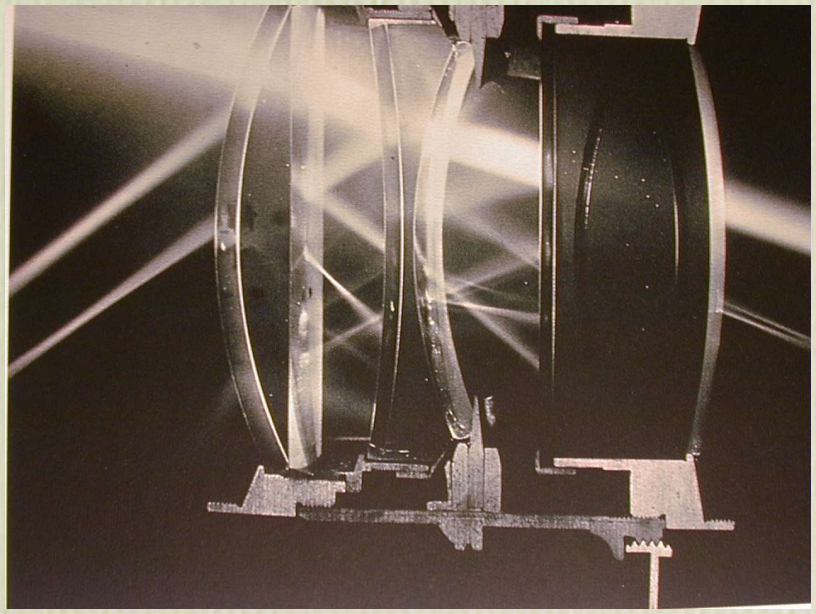
HOO Outcomes/Project Performance

High throughput/high contrast optical/educational system



or

Low throughput/high contrast optical/educational system



Optics Resource Volunteer Connection

- Volunteers are experts, but who is an expert?
- 180+ volunteers trained in 11 states, more being trained at each site
- Pairing teacher/ORV not always successful, but many success stories
- 2,100 volunteer hours recorded to date (January!)
- Project goal of 3,200 hours will be met

Program Evolution: Astronomy from the Ground Up (AFGU)

- Created Module 3 mini-kits for AFGU-Used by OSA, SPIE
- Not a classroom set of materials but an introduction to one module
- Expect to reach 100 small science center and nature center educators per year with abbreviated professional development program
- One site has become a full HOO site
- Many have done large special optics events

Program Evolution: Timothy Smith Network of Community Centers (Roxbury, Massachusetts)

- 24 Participants from 20 Community Centers
- Ideal venue for informal program
- First professional development workshop held Nov. 2006, revisit this month

This makes 25 HOO workshops (2-day each)

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Hands-On Optics in the Future

- OSA and SPIE–workshops planned
- Support for current HOO sites
- Widespread kit dissemination through Learning Technologies Inc.
- NOAO-Science Foundation Arizona grant
- NOAO-Adaptive optics kit development through NSF Giant Segmented Mirror Telescope Project

HOO is now a core NOAO project

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Final Thoughts

- Demand for high-quality materials, training
- Use of undergraduates very valuable in the program
- Flexibility with science centers
- Importance of solid professional development
- Optics Resource Volunteers have been valuable
- Expansion

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