http://www.project10tothe100.com/submit_your_idea.html

1. James A. Worthey

2. 11 Rye Court, Gaithersburg MD 20878-1901, USA

3. jworthey@rcn.com

4. English

5. Jim Worthey

6. Gaithersburg

7. USA

8. (Name 50 **char**) Optical Insights for Better Lighting 36

9. (choose category) Education (tentatively, then stress students)

10. What one sentence best describes your idea? (maximum 150 characters)
Common fluorescent lighting washes out contrasts, but good lighting can be created through application of optics and color science. 131

11. Describe your idea in more depth. (maximum 300 words)
The goal is to improve lighting, allowing students and others to see clearly and to be productive and comfortable. Similar goals are often stated, but this project builds on basic research done from the 1970s until now by a handful of scientists.

The sun covers about 1/(100,000) of the sky. A luminous ceiling covers the whole sky, eliminating highlights, shading, and shadows, while covering all objects with "veiling reflections"---an image of the ceiling. At the same time, most fluorescent lights and many other lights have too little red and too little green, so they lose color contrasts. Lighting discussions usually leap to discuss "quantity of light," tossing aside the role of optics and color. Then they may back up to consider "lighting quality," but without cause-and-effect clarity that would guide design.

Makers of HDTV displays claim contrast ratios (dynamic range) as high as 16,000:1. In a 1990 article, I showed that dynamic range of real objects can be even higher than 16000 in daylight, but as low as 20:1 under a luminous ceiling. (Simple calculation, subject to refinement.)

I have published in science and engineering journals on these topics and have degrees in EE and Physics, and a PhD in Vision. My recent work concerns a new way to speak more clearly about fundamentals of color, including variations among sources of illumination. Using Jozef Cohen's non-arbitrary color space, I compare white lights by their vectorial composition. A light's spectrum is combined with the facts of color, and a graph shows details that usually are lost. ~~Background is at www.jimworthey.com~~. 263

12. What problem or issue does your idea address? (maximum 150 **words**)

The Heschong-Mahone schools report (on the web) shows that students learn better with daylight than with the usual fluorescent light. Less formally it observes that "windows and daylight" improved the mood of teachers and students. The report makes reasonable statements about differences among lights, and as far as it goes, it shows that commonly used lights are detrimental. It lacks what such discussions always lack: the optical concepts by which the obvious differences among lights can be quantified and discussed. My research shows that lighting affects contrast, but more must be done to fill in details and apply the ideas. 101

13. If your idea were to become a reality, who would benefit the most and how? (maximum 150 **words**)
Students and teachers are obvious groups, but all indoor workers would benefit because they could see more clearly with better lighting. Some will say they tolerate low-contrast lighting, but most would benefit from improved contrasts. There is no complaint against HDTV because the colors are too vibrant and blacks are too black. New light sources are being developed, but clear goals will give faster progress for the actual users. For example, LEDs offer new possibilities, but if wrongly applied they can lose color contrast in the same way as older lights. Other optical issues can also be botched. Manufacturers could add value by attention to detail, but again clear goals are needed. 112

14. What are the initial steps required to get this idea off the ground? (maximum 150 **words**)
A little research and publication can foster rapid change, by building on past work. I must publish more, especially about color. New workers need to have genuine interest and understanding, then they should not be micromanaged. The ideas concerning light source area can be extended by new measurements of object reflectances, light source luminances and other data, published with calculations and discussion. Scene luminances could be measured with meters and by methods of High Dynamic Range Photography. Demonstrations would advance the color ideas: with LEDs + electronics, a still life could be made colorful, then faded almost to gray. The goal should not be to invent lights for sale, but to make the possibilities clear for a wide audience. My newest color methods, including 3D graphing, could be made into user-friendly software. Natural daylight itself could be studied: what distinguishes the golden hour before sunset that cinematographers love? 148

15. Describe the optimal outcome should your idea be selected and successfully implemented. How would you measure it? (maximum 150 **words**)
Again, the goals are clear seeing and comfort, but the path involves science. The first outcomes will be published results, then awareness and comments by others. Questions and possible controversy can be met with more facts, details, and analysis, because the project is not about selling one over-simple idea. Measurement methods can be developed so that others can replicate results in their real-life situations. Within a larger context of calculations and measurements, small examples can be presented in print or video, so a picture book or an image-rich web site will be helpful. When a few "best practice" lights are developed, the benefits will be clear and change in the larger world of schools and workplaces will be unstoppable. 120
16. I agree to Project 10^{100}'s terms of service ✓
17. Enter the URL of your YouTube video. (none)
18. If you'd like to recommend a specific organization, or the ideal type of organization, to execute your plan, please do so here. (maximum 50 **words**)
Chemical Institute in Ljubljana, Slovenia; or Departamento de Óptica, Universidad de Granada, Spain; or Prof. Gernot Hoffman, Emden, Germany. Researchers need some love for physical

measurements and math methods. Places that do traditional lighting research are not good candidates. 39

19. Email me when the voting period begins. ✓
20. If my idea isn't chosen in this program, please contact me about organizations that are interested in funding it. ✓