LIGHT TRESPASS

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ABSTRACT Light trespass is a real problem to astronomers, and, to some extent, to the general public. There is really no valid excuse for most of our existing light trespass. If we were all aware of the problems, we could rather easily implement solutions to cure the problems.

PREAMBLE

Before I describe some of the problems associated with outdoor lighting, I would like to tell you a little about the Illuminating Engineering Society of North America. It is a small society, having less than 1,000 members. Among these are a few academics, including a couple of astronomers. However, most members earn their living selling light. This activity takes various forms, such as selling equipment, providing energy, and designing and maintaining lighting systems.

Moreover, since the IES membership is business oriented, it is sensitive to public demands. The membership makes things that sell and that satisfy a public demand. So a major problem, insofar as light pollution is concerned, is the education of the public. The public is ignorant about many things that affect their environment. But they have even greater difficulty comprehending that anything as good and useful as light can be a pollutant.

A certain amount of salesmanship is necessary to show the public the benefits of light. But soon the demand for light becomes insatiable, since there is a faith that associates light with comfort and safety. Evidence of this demand is displayed on most university campuses, which are among the most illuminated areas in the country (and not often as well as they should be).

DISCUSSION

I have been trying for a long time, more than 25 years, to get people concerned about light trespass and the control of outdoor light. However, I have found that there is much more interest in the production of light. We cannot get

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1. Al Tanner died suddenly a month before the meeting was held. His paper was essentially finished, and was edited and presented at the sessions by Dave Crawford, thanks to the efforts of Al's wife and family.

by without light at night.

If you think about it, you will realize that our civilization is based on our ability to produce light. We can only imagine what it was like before we had light. Everything must have stopped when the sun went down. And there must have been a fearful wait for its return.

Then some forgotten genius found that fire could be brought into the entrance to the cave. Greenpeace and the Sierra Club protested, but public opinion prevailed. For the first time there was warmth and men could tell stories, work on their weapons, and scribble on the walls. Civilization as we know it had been born.

The wonderful Ice Age cave paintings at Lascaux and Altamera were made by the light of stone lamps burning tallow more than 30,000 years ago. Now it is ironic that light, installed for tourists, is encouraging the growth of slimes that are eating away the limestone in some of the caves.

There wasn't much change in lighting hardware for a long time. Fire, in the form of lamps and candles, provided our light for millennia.

Light was feeble and expensive. Little of it was wasted. It was used indoors for the most part. At night, the outdoors was a fearsome place. The need for light was obvious and the Roman city of Antioch in Syria had streetlights in the Fourth Century. European cities followed with installations of candles and, later, oil lamps.

Many cities had streetlights long before they had paved streets or sewers. It is said, frequently, that street lighting engineers are members of the world's oldest profession [Astronomers say that too!].

Despite the generally expressed need for streetlights, there were objectors. In the year 1816, a man in Cologne, Germany, wrote to his newspaper complaining that, among other things, streetlighting would cause a loss of fear of the darkness and that drunkenness and depravity would increase. He pointed out, also, that the constant illumination of the streets by night would rob festive illuminations of their charm.

About that time, citizens in Philadelphia protested the construction of a gas works in much the same way that their descendants protest the construction of nuclear power plants.

Despite the few objections, streetlighting spread rapidly. Gas lighting systems were installed in every major city. These were followed, in turn, by arc lights and incandescent lamps.

Light pollution was on its way. Writing more than 50 years ago, the Belgian astronomer Minnaert advised his readers to avoid the lights of towns if they were to see the wonders he described.

But the real problems with light arose with the widespread use of discharge lamps within the past 30 years. A combination of cheap electrical energy and high efficacy lamps led to the great expansion in outdoor lighting. Now, we can do most things as well at night as during the day.

Now Arizona resorts invite guest to play tennis on lighted courts or spend a quiet evening counting the lights of Phoenix spread out like an endless carpet. What happened to the desert stars?

Incidentally, from any one point when conditions are good, you can see about 2000 stars, at the darkest sites. But there must be over 50,000 outdoor lights in Phoenix.

In my mind, light trespass and light pollution are the same. But that is just

my opinion. When I realized that there was a problem with stray light over 25 years ago, I though that I was alone. No one else seemed interested, least of all the manufacturers of lighting equipment.

Then, about ten years ago, I obtained a copy of the Kitt Peak Report that was written by Art Hoag and A.R. Peterson. That report, together with the pressure that was being generated by Lick Observatory, near San Jose, led to the formation of the Light Trespass Subcommittee of the Roadway Lighting Committee of the IES.

However, I don't think that everyone, except some astronomers, agree that there is a problem. Astronomers can measure what they call "light pollution." But "light trespass" is harder to define. It is what you say it is. There are many things that can be called "light trespass."

Developers in Tucson dream of creating the next Phoenix or Los Angeles, with their sky glows. Such things can happen in 25 years or less. Many people like to look at distant city lights, but property owners get upset when a street light is placed in front of their bedroom window. Of course, street lights must go in front of somebody's house. But with a little attention to shielding, or a cut-off light fixture, one can solve the problem. If one has the talent, or the money, one can control stray light. There is excellent tennis court lighting now, for example, with essentially no stray light or light trespass of any kind.

As I said before, streetlighting is an old business that has taken many forms. At one time, cities built monumental systems. The old electroliers were expected to provide light by night and be art objects by day. Frequently, developers install copies, or imitations, of old units to offset the drab appearance of modern architecture. The lighting fixtures are for day display rather than as light sources, in many cases. They do not do a good job of lighting.

An old system can be made very bright. Old gas lighting fixtures now have three 400 watt HPS lamps in them. They illuminate the facades of building but are not very efficient in their use of light. Perhaps only 10 percent of the light lands directly on the street. Many such street lighting systems waste more light than they use.

Glare shields are sometimes installed, but often do little good. They have been in use for a long time, as well as black paint. All in an effort to cut the glare from a poor fixture. I am not certain if progress is slow or fast. It is somewhere in between -- sort of half-fast.

Cut-off luminaires have become popular in many places. They reduce stray light to a great deal, and are usually quite efficient. At night, they provide guidance, no glare, and a well lit street.

So far, I have talked mostly about light trespass. But there is no doubt that much of the stray light reaches the sky and, in some places, disturbs astronomers.

One of the key questions is: "How much light reaches the sky?" I have looked into a cobra-head luminaire vs. a shoe-box type. It appears that the cut-off fixture produces about 30 percent less light to the sky, direct and reflected (assuming 18 percent, the standard gray card value).

But it is really more complicated. There are many obstacles and multiple reflections off the ground and buildings. There is also no doubt that some fixtures are better than others at minimizing up-light. There are other factors too, such as details of the installation. One I know is on a a tree lined street. Originally, the street lights were mounted at a height of 17 feet, under the tree canopy. Then the system was modernized to a 30 foot

mounting height, above the canopy. At night, little light gets to the street. Overall, a great increase in energy use, and the lighting is worse than it was before the modernization.

Nationwide, there is a lot of light going into the sky. It is measured in megawatts and it is all wasted energy. However, light is something that we generally don't relate to strip mining or offshore drilling.

It is only a question of a few years until the entire southwest of the U.S.A. is unfit for earth bound astronomy, despite the otherwise good conditions for observing. In 1940, the population of the State of Arizona was less than 500,000. Now Phoenix alone has more than three time this, and Tucson has grown to over a half a million itself. The state will continue to grow, population-wise.

Similar things are happening elsewhere, and astronomers in many locations are moving to darker sky sites. But the lights chase them everywhere. The English now have their large telescope in the Canary Islands, and the University of California and Caltech are building their very large telescope on the Island of Hawaii rather than in California.

Professional astronomy will continue to exist. But the rest of us will be losing something when we lose sight of the stars.

Mankind has watched the heavens since his beginnings. I think that all of us are affected by a vision of a starry sky. Robert Frost, a San Francisco poet (he was born there), wrote of a man who burned his house down to collect the insurance so he could buy a telescope to view the wonders of the heavens.

We must realize that modern light sources are bright. A common 250 watt HPS lamp viewed from a distance of 24 miles would appear as bright as a star of the 1st magnitude. That same lamp at a distance of 300 feet provides illuminance equal to that of the full moon.

Finally, astronomers are bothered by the spectral energy distribution of some lamps. A color improved mercury vapor lamp still has some gaps in the spectrum, but engineers want to fill these so as to improve the color rendition. The HPS lamp fills in the majority of the visual spectrum.

Astronomers have expressed a strong preference for low pressure sodium vapor lamps, with their monochromatic spectrum, as it preserves the dark sky at all colors except that of the sodium doublet lines. LPS, fortunately for the astronomers, is a very efficient lighting source.

CONCLUSION:

If anyone has been able to see the thread of my remarks, I hope it is: that the production and application of light is something that we should undertake very thoughtfully. We have come a long way in our ability to produce light. But we haven't gone much farther than Benjamin Franklin in its distribution and control.

[Note added by D. L. Crawford: IDA, Inc., has on file most of Al's excellent collection of slides illustrating the issues, courtesy of Al's family. He had used them effectively in many talks.]