



Lighting Innovation for a Smarter Tomorrow

# Smart Lighting: The Next Wave in Solid State Lighting

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# Smart Lighting Engineering Research Center

- A (very) Brief History of Lighting FINSTITUTE OF TECHNOLOGY
- What is "Smart





The Smart Lighting ERC









#### **Creative Transformations The Schumpeterian Factor**

- "The interaction of technological innovation with the competitive marketplace is the fundamental driving force in capitalist industrial progress." (Schumpeter, 1942)
- "...a normally healthy economy was not one in equilibrium, but one that was constantly being disrupted by technological innovation." (The Economist (on Schumpeter), 1999)

As cited by Dr. Joseph Bordogna NSF ERC Annual Meeting November, 2000

# No Innovation?

# No Economic Growth





- Started in 1985
- Goal: Boost US Competitiveness in the World Market Place
- Method: Drive University Industry collaboration to new levels:
  - New Innovation

= new business, more jobs

Better Engineering Education

= more productive workforce

Drive an Engineering Culture change in both Academia and Industry



#### **ERCs** Today





# INNOVATION

- 621 Patents
- Over 2000 technology licenses
- 142 new Companies started

# EDUCATION

- Over 11,000 Engineering Degrees
- 830 New Engineering Courses
- 206 new textbooks





- Multi University
- Global Industrial Outreach
- Expanded K-12 and University Outreach
- Strong Diversity Focus
- Strong Entrepreneurial Spirit
- Transformative R&D









#### CANACCORD Adams

Second Cycle Report, 2009

- Taiwan, Japan and Korea are leading the SSL charge
- Samsung, in particular, is making HUGE investments in LED technology and Intellectual Property
- China will soon emerge as the largest supplier of LED Lighting

How does the US become a global partner in the future of Lighting?





# THE CASE FOR A NATIONAL RESEARCH PROGRAM ON SEMICONDUCTOR LIGHTING

Roland Haitz and Fred Kish, Hewlett-Packard Company, Palo Alto, CA 94304

Jeff Tsao and Jeff Nelson, Sandia National Laboratories, Albuquerque, NM 87185-0601



#### **Evolution of Lighting**



# The Birth of Solid State Lighting





Japan's MITI sets aggressive goal:

#### 120 Lm/W by 2010

- 1998 White LED performance:
  - 18 Lm/W (about same as bulb)
- Goal setting was not technology based

120 Lm/W was needed to meet Kyoto Protocol Commitments

About the same time, Dr. Y. S. Park at the Office of Naval Research held a small meeting of LED and Lighting experts – to ask the Question: Is LED based Illumination possible?



SemiLEDs' Customers Confirm New I-core™ LED Achieves Over 120 lm/W 2009-12-31



• Also demonstrated in production by Nichia and Cree (perhaps more)

1998

- Demonstrated in lab by 4 or 5 other companies
- Now, what do we do with it???





## What Could We Do with SSL?







## Chickens are BIG Business





# How can Lighting impact Poultry Revenues?



#### CFL versus Bulbs: Birds Eye View





Tina M. Widowski, Linda J. Keeling, and Ian J. H. Duncan Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario, Canada N1G 2W1. Received 27 November 1991, accepted 18 February 1992.



## Circadian Adjusted Lighting





	Outdoor Source	Indoor Source	
8000K	Snow, Water Blue Sky		
6500K	Large Shadows Blue Sky		
	Average Day Light, Central Latitudes	Xenon Flash	
5500K	Noon Sunlight	Blue Bulb Flash Cube	
4500K	Average Day Light, Northern Hemisphere	Fluorescent "Warm White" Tubes	
	Early Morning Late Afternoon, and Evening	Clear Flash Bulbs	
	Sunlight	Photofloods	
20001		Photolamps	
SUCC		Household 150/200w 60/40w 25w	
2000K		Candlelight	





✓ Light Intensity
✓ Light Duration
✓ Spectral Characteristics
✓ Fluorescent Flicker

# Improved production

# Lower operating costs

- ? Daylight Tracking
- ? Unique color combinations
- ? Near UV exposure





# Smart Lighting for Humanity



# What are Smart Lighting Systems?

#### **Controllable Devices**

			emitte		11
					2000 K
sneed	color	polarization	efficiency	pattern	color

# temperature

#### lighting













communications imaging & sensing

Smart Systems



The Smart Lighting ERC will introduce new technology at all steps of the LED supply chain



# **Smart Lighting Opportunities**





Productivity







# How will long life impact Lighting?





When you don't need to change the bulb... Do you still need a socket?



#### The Future is Hard to See







# 1995



