

Wardrobe Malfunctions

And Other Lessons Learned from Early Adopters of Illuminated Clothing Technology

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Outline

- Types of lights used in clothing & accessories



- Markets for lighted clothing

- Key features and improvements desired by consumers



- The future of lighted clothing



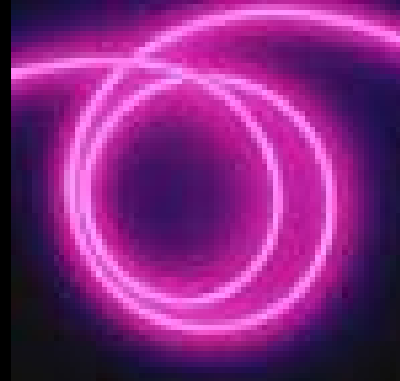
Types of lights used in illuminated clothing



Incandescent
bulbs



Reflective,
fluorescent,
phosphorescent,
& chemiluminescent
materials

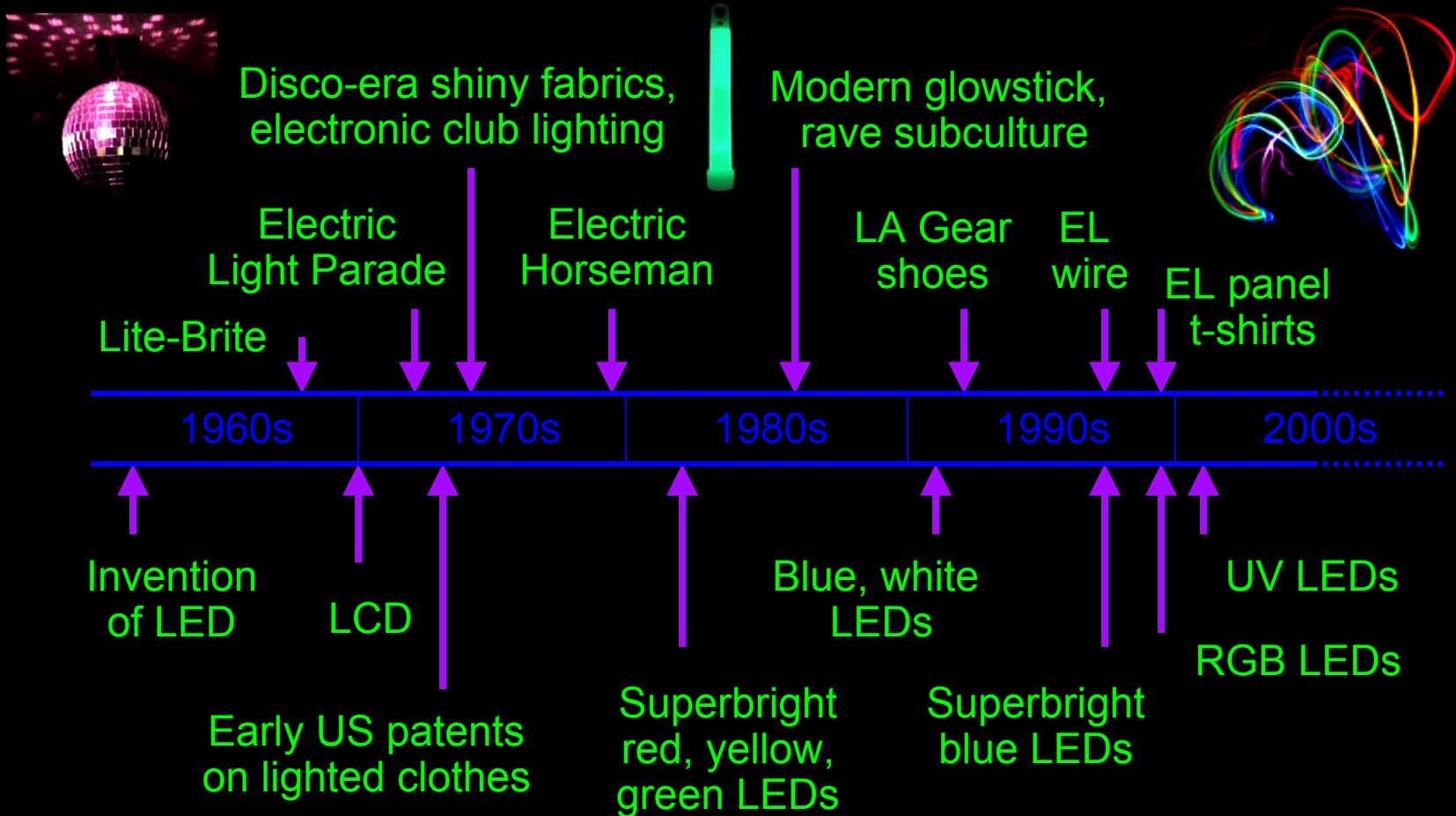


EL wire
and panels



LEDs

Emergence of “flashy” clothes tied to technical developments over time



Light Sources: Incandescent Bulbs



Typical bulb



Disney Electrical Parade



Electric Horseman



DIY costumes with Xmas lights

Advantages

- Inexpensive
- Bright
- Mature technology
- Lights can flash or be sequenced

Disadvantages

- High power consumption
- Fragile
- Limited bulb lifetime
- Heat can pose safety hazard

Light Sources: Reflective, Fluorescent, Phosphorescent, and Chemiluminescent



reflective chemical dress
by cyberoptix.com



glow bracelets



glow-in-the dark/
UV reactive materials



Ingo Maurer
glowstick jacket lining

Advantages

- Inexpensive
- No batteries needed
- Available as dyes, printed design, sewn-on trim

Disadvantages

- Requires external light source, or “charging” with UV, or has limited life (glowsticks)
- Can’t turn on/off, or animate

Light Sources: Electroluminescent (EL) Strips, Panels, and Wires



EL strip bracelet
(MPG, Flixx, others)



EL panel pendant



T-shirt with EL panel
(lightattack.de)



Custom EL wiring
on leather jacket

Advantages

- Inexpensive printing for mass-production
- Uniform illumination of shapes in logos, etc
- Can blink, animate
- Good for creating lines of light

Disadvantages

- Limited brightness (but getting better)
- High voltage (safety issue)
- Noisy
- Fragile
- Relatively short lifetime (<5000 hours)

Light Sources: LEDs



scrolling message hat



"Flyerman" suit



light-up bra



flame pants

Advantages

- High brightness
- Low power consumption & heating
- Range of colors, sizes
- Can blink, animate, integrate with other electronics
- Long life (100,000+ hours)
- Relatively durable

Disadvantages

- Narrow viewing angle for some types
- Point-source lighting (can overcome with light pipes, fiber optics)

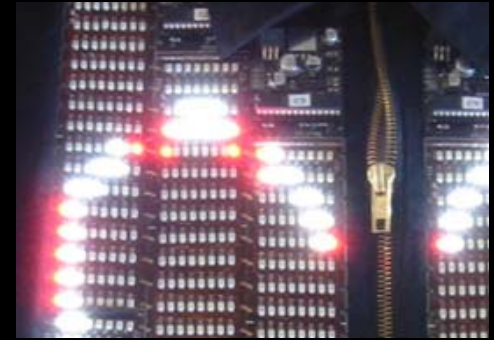
Methods for mounting LEDs in apparel



Grommet in leather



Removable button stud



SM LED on flex board,
sewn to fabric



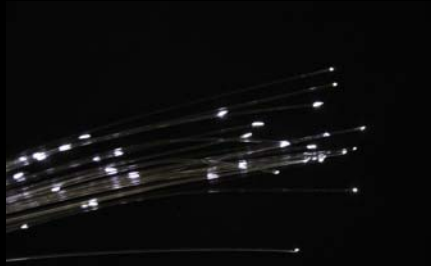
LED folded sideways



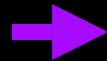
LED normal to surface, board on inside



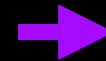
LEDs coupled to fiber optics for other shapes



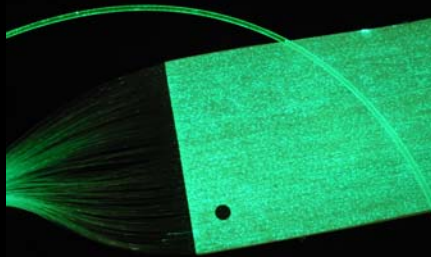
Individual fiber strands



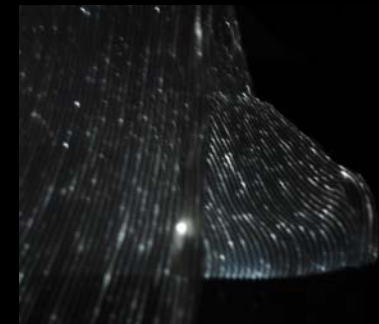
Logo on cap
(identity-links.com)



Applique on jacket
(Animotion)



Leaky fiber optic strand,
Parallel fibers in backlighting
panel (Lumitex)



Fiber optics woven in fabric (Luminex, Italy)

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Markets for light-up clothes: performers



DJs, bands, musicians



theater



performance art,
wearable art



other entertainers



gymnasts, acrobats, dancers
newvisiondancecompany.com



Markets for light-up clothes: promoters



logo on back of a cape



your name in lights



LED message board
on shirt
cyberdog.net



flexible lighted shirt patch



LED "name tag"
StreetTags.com

Markets for light-up clothes: other consumers

clubwear, formalwear, masquerade, holiday,
men, women, children, etc...



examples from
enlighted.com

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Consumer's Wish List for Lighted Clothing

- Durable
- Washable (or removable electronics)
- Long battery life
- Customizable (user control of brightness, light color, etc)
- Easy to use (foolproof switches)
- Stylish
- Comfortable
- Inexpensive



removable lights
cyberoptix.com



light-up bra
enlighted.com



custom message
cyberdog.net

Durability a primary concern for lighted clothing

Options for interconnections:

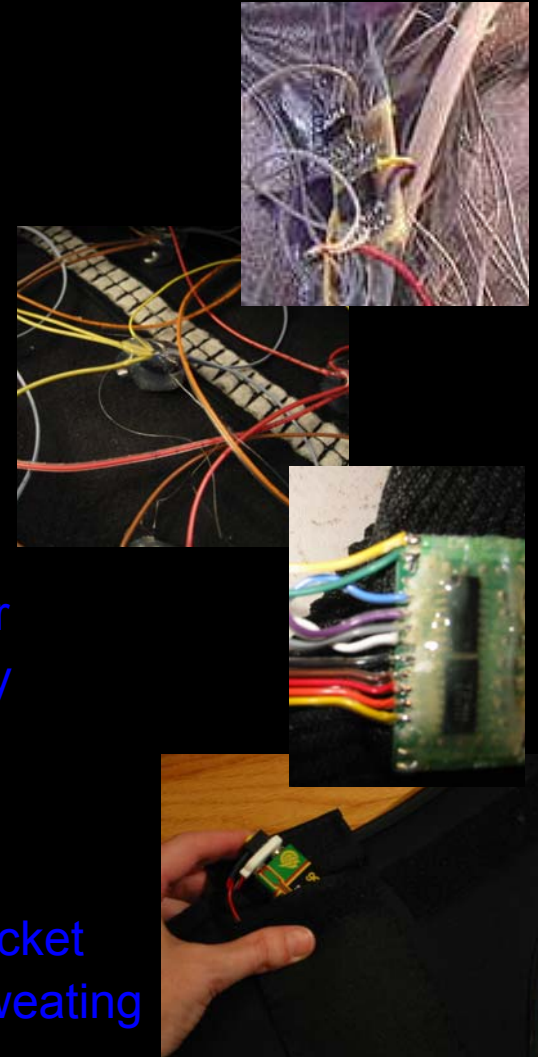
- Rigid circuit board, flex board, **wires**, conductive thread or ink
- Fine stranded wire (~24 GA) best available tech

Broken wire failure

- Insufficient slack (must consider fabric stretch)
- Poor strain relief at junction with LED or controller
- Heavy components (like batteries) swinging freely

Battery-related failure

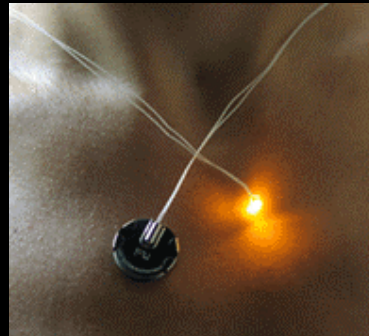
- Shorting 9V contacts with keys, coins in same pocket
- Corrosion of battery contacts due to excessive sweating



Light-up Jewelry & Accessories



Color-changing gem
FUZE by flipo.com



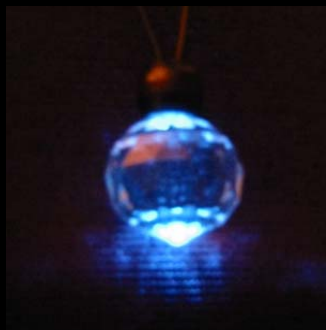
“Moi” LED accessory
moinewyork.com



LED bracelet
(various)



LED blinkers for
hair, earrings,
bellyrings, etc



LED pendant
(various)



EL panel bracelet
(various)



EL pin/pendant
(various)

Light-up Shoes



Motion-activated LED
kids' shoe (various)



Motion-activated LED
in platform heel (various)



Custom LED modification
enlighted.com



Motion-activated LED
LA Gear (discontinued)



EL panel sandals
atomicproducts.net



Glowstick in sole
Soul Fusion Shoes

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Designer's Wish List for Lighted Clothing

- **Continued improvement in available materials**
 - low-profile thru-hole LEDs, SM modules
 - washable fabrics with embedded fiber optics
 - low-profile washable switches, quick disconnect plugs
- **Improved consumer education**
 - etiquette for wearing lighted clothes in public
 - realistic technical expectations
- **Pay attention to physiological effects of blinking lights**
- **Better integration of lighting with the shape and function of a garment**



Blinking lights affect your mental state

Visual effects:

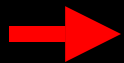
- Rapid change between bright and dark is irritating (depends on ambient light level)

Blinking may interact with rhythmic brain behavior in various states:

- 0.5-4 Hz Delta Deep sleep
- 4-7 Hz Theta Drowsiness
- 7-13 Hz Alpha Relaxed but alert
- 13-40 Hz Beta Highly alert



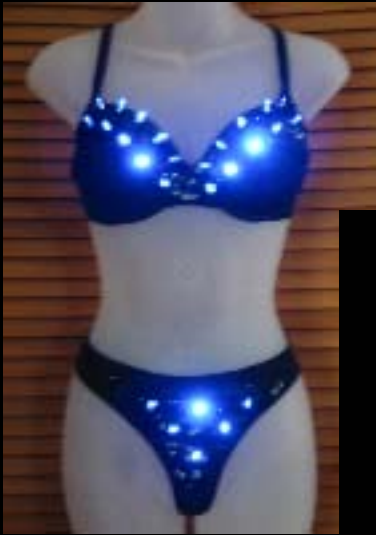
Photosensitive epilepsy can be triggered by certain flashing frequencies (approx 5-30 Hz, depends on the person)



Too many novelty light-up accessories have obnoxious blinking patterns!



Lights accentuate flattering shapes



Curved bustline,
no lights at waist



Wider light placement at
shoulders in men's jackets

Lights can also create unflattering shapes



Twisted legs?



No heads?



Where's the body?



TV on a t-shirt,
as reported on
nature.com



Suggestive of
another character
with TV belly

Closing thoughts

- High brightness LEDs are, by far, the most suitable form of lighting for clothing
- Early adopters have been performers, promoters, clubwear enthusiasts
- Mainstream consumers have seen novelty lights, are hungry for real quality and style
- Apparel is a huge industry, with lighting applicable to a wide range of categories

