



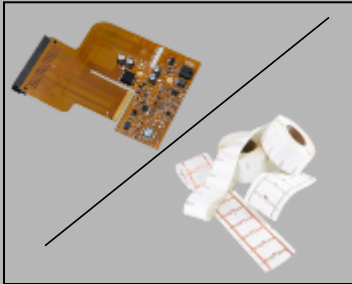
Printed Circuit Solutions

Neal O'Hara
Business Development Manager

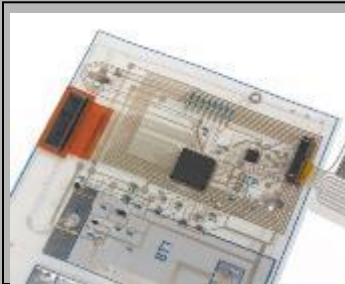
PCS OFFERING



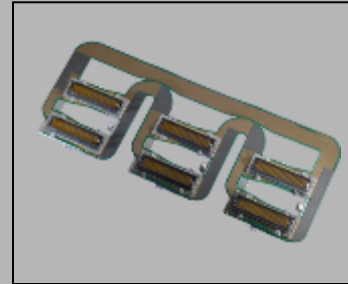
User Interface



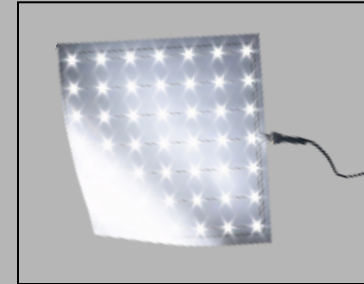
**Flex Circuit
Solutions**



**Sensor
Systems**



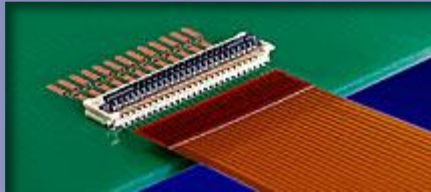
**Multilayer
Copper Flex
Circuits**



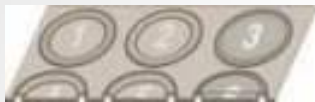
**LED
Lighting**



VERTICAL INTEGRATION



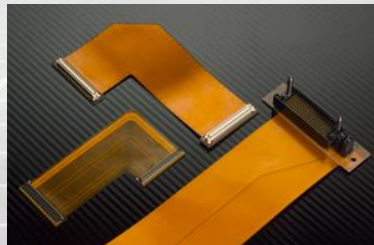
Embossed Graphic Overlay



Metal Dome Foil



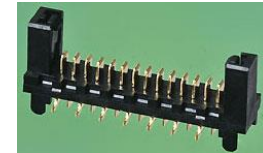
Copper Flex



Picoflex on FFC Cable



Picoflex Header



Silicone Rubber keypad



Rigid PCB



**User
Interface**

Key Markets

**Printed
Electronics**

**Flex Circuit
Solutions**

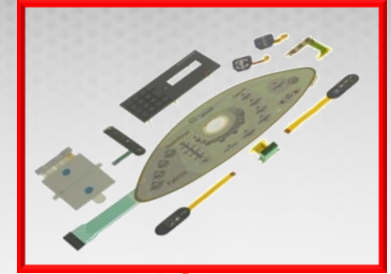
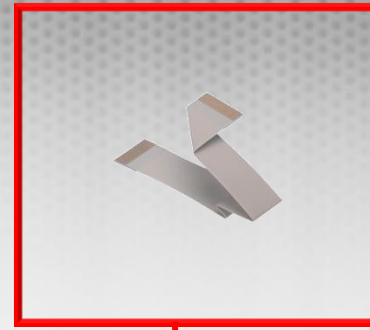
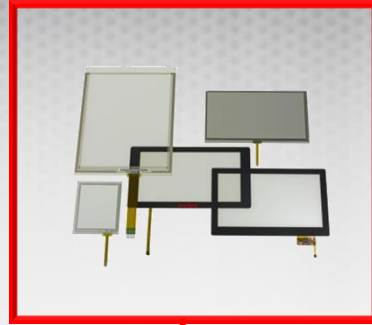
**Sensor
Solutions**

**Copper Flex
Circuits**



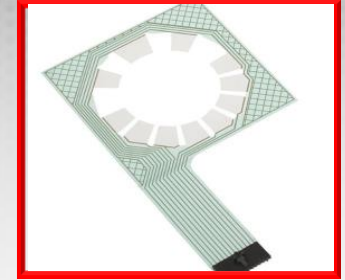
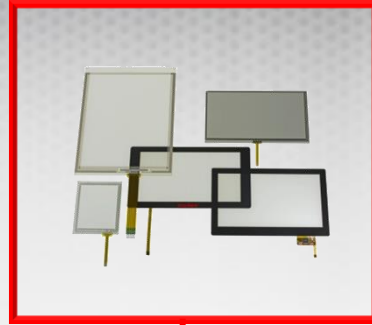
User Interface

- › Huge variety of applications
- › Diverse industries
- › Specialised illumination solutions
- › Custom tooled
- › Solution based product design



UI Products Capabilities

- › **Membrane Switch**
 - Tactile
 - Non-Tactile
- › **LED Indicators**
 - Bonded Assemblies
 - Front Panels
- › **Control Panels**
- › **Capacitive Touch**
- › **Metal Touch**
- › **Fluid Sensing**
- › **Touchscreens**



What is a U.I ?

- › **Transparent electrodes**
- › **LED Indicators**
- › **Membrane switch**
- › **Control Panels**
- › **Capacitive Touch**
- › **Touchscreens**
- › **Eyeball tracking?**
- › **Voice recognition?**
- › **Neural (BCI) (MMI) (BMI)**

**User
Interface**

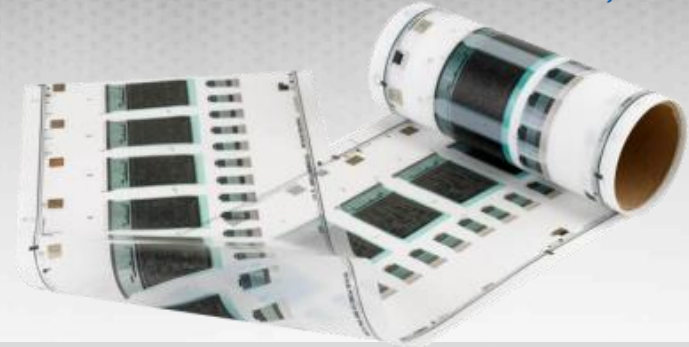
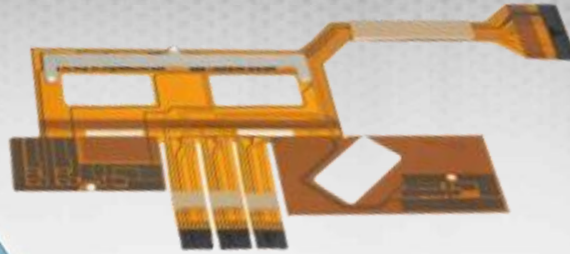
Key Markets

Sensor Systems

**Flex Circuit
Solutions**

**Sensor
Solutions**

**Copper Flex
Circuits**



Flex Circuit Solutions

- › Moving PCB's to Copper Flex Circuits
- › Moving Copper Flex Circuits to Silver Flex
- › Component Attach:
 - Reflow
 - Low Temp Solder
 - Conductive Epoxy
 - Anisotropic Adhesive
 - Hot Bar Solder

Benefits of Printed & Flexible Electronics

› Many potential advantages, application specific

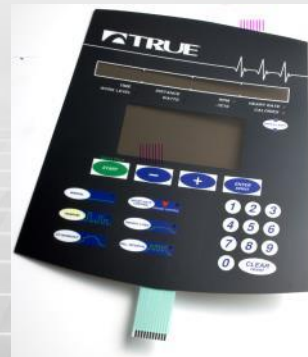
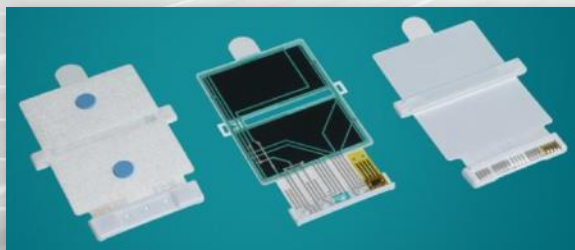
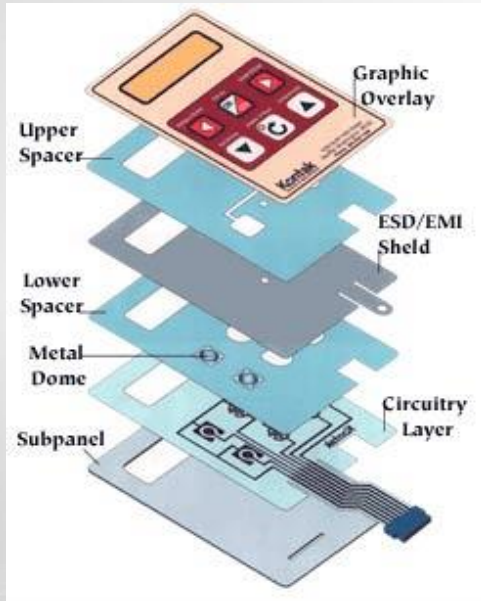
- Putting electronics where they were not possible before
 - New, highly differentiated products
- Form factor improvements
 - Conformal and/or flexible
 - Weight & space reduction
 - Increased comfort
- Increased ruggedness
 - Bend but don't break
- Cost reduction
 - New ways to think about electronics at the system level



Printed & Flexible Electronics

› Genesis of PE: the membrane switch industry, electroluminescent lighting and PCB industry

- Flatbed screen printing
- Silver, carbon, dielectric materials



Printed & Flexible Electronics

› Convergence of new materials, components and manufacturing methods

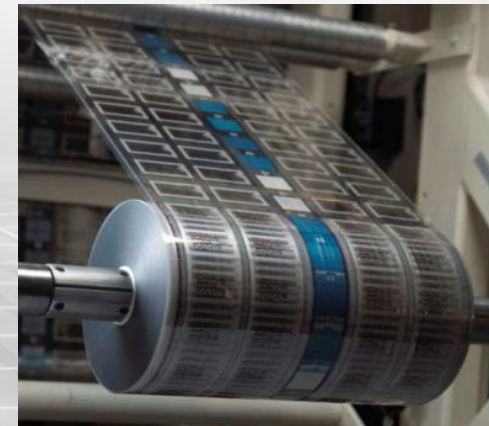
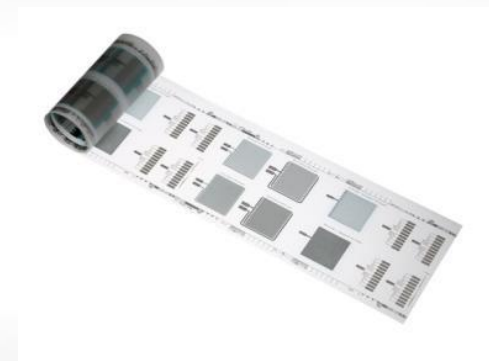
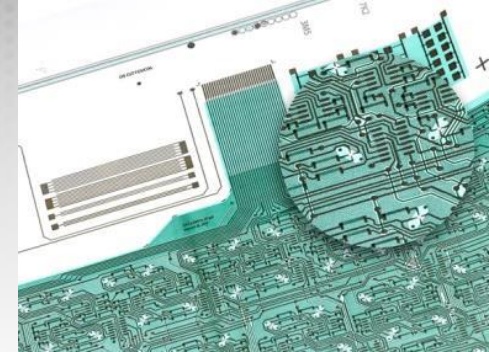
– Materials

- Improved conductors (Ag, carbon, polymers, carbon nanotubes, graphene)
- Dielectrics (UV cure, thermal cure, high/low k)
- Semiconductors (small organic molecules, polymers, carbon nanotubes, graphene, printable inorganic materials – Si, ZnO)
- Specialty materials (batteries, displays, memory, transistors)

– Additive manufacturing of Electronics

- Screen printing, rotary screen, flexo, gravure, direct write (ink jet, aerosol jet, dispense)

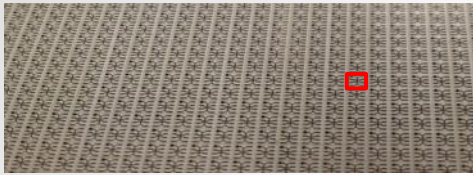
– Printable sensors, displays, batteries, memory, transistors



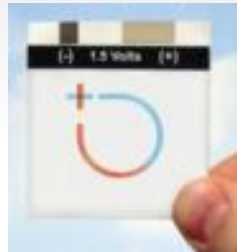
Components

› A few examples...

Transistors



Batteries



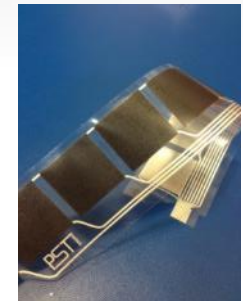
Blue Spark

Display



E Ink

Temperature Sensor



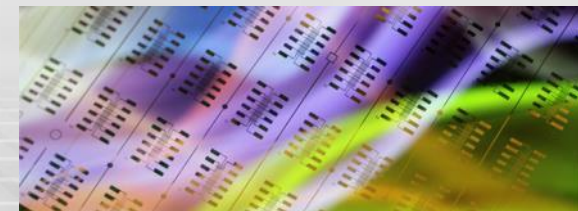
PST Sensors

Pressure Sensor



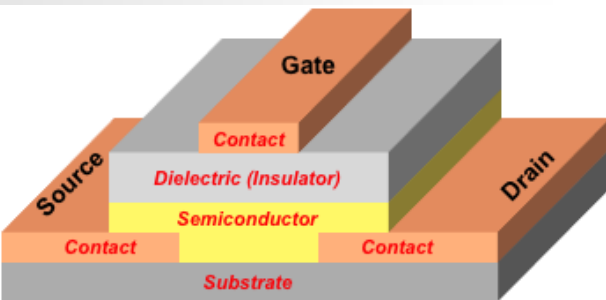
Molex

Memory



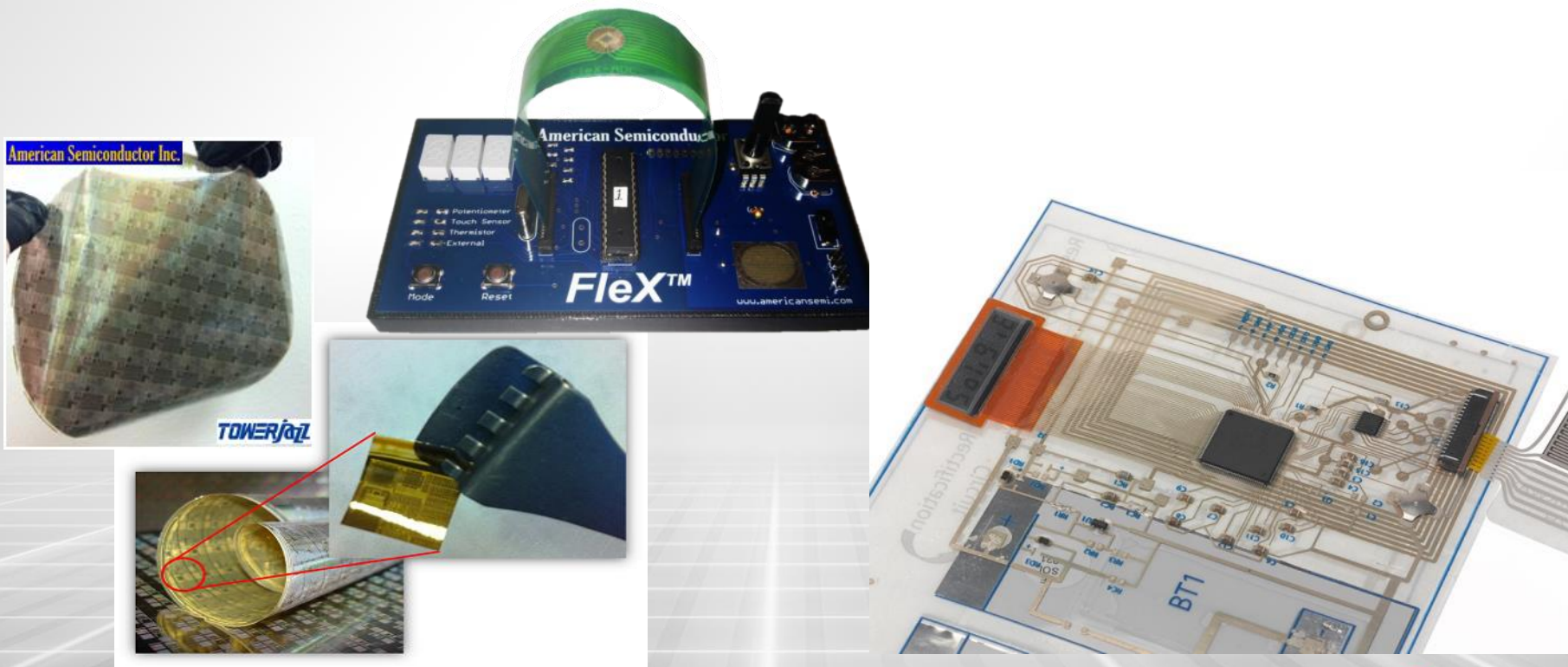
Thinfilm Electronics

Pragmatic Printing

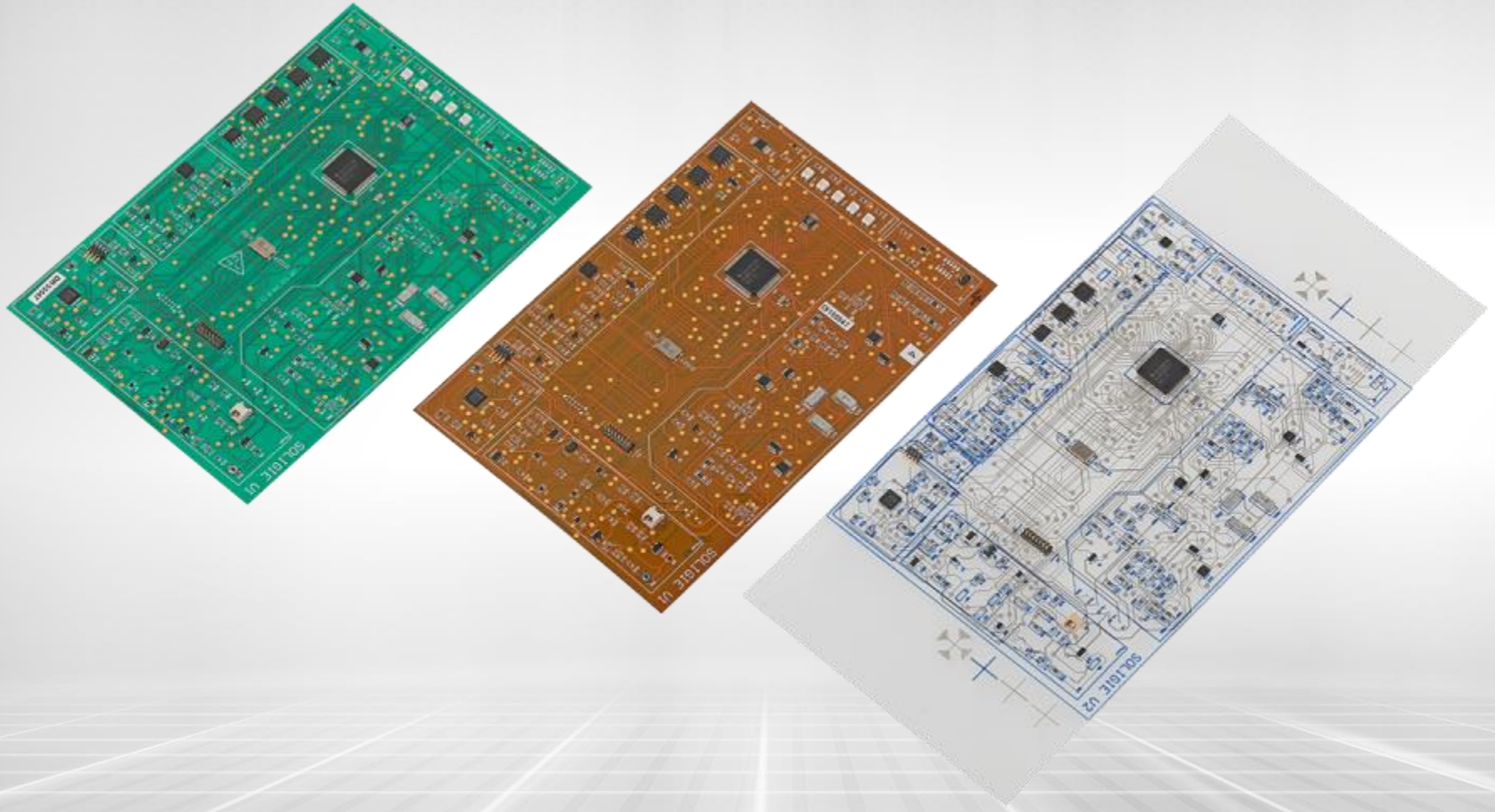


Flexible Hybrid Systems

- A related & complimentary approach to PE
 - Print what you can, attach what you must
- Achieve a high level of functionality while also retaining flexibility



Full Service: FR4, Copper Flex, Silver Flex



PCB, Copper Flex and Silver Flex

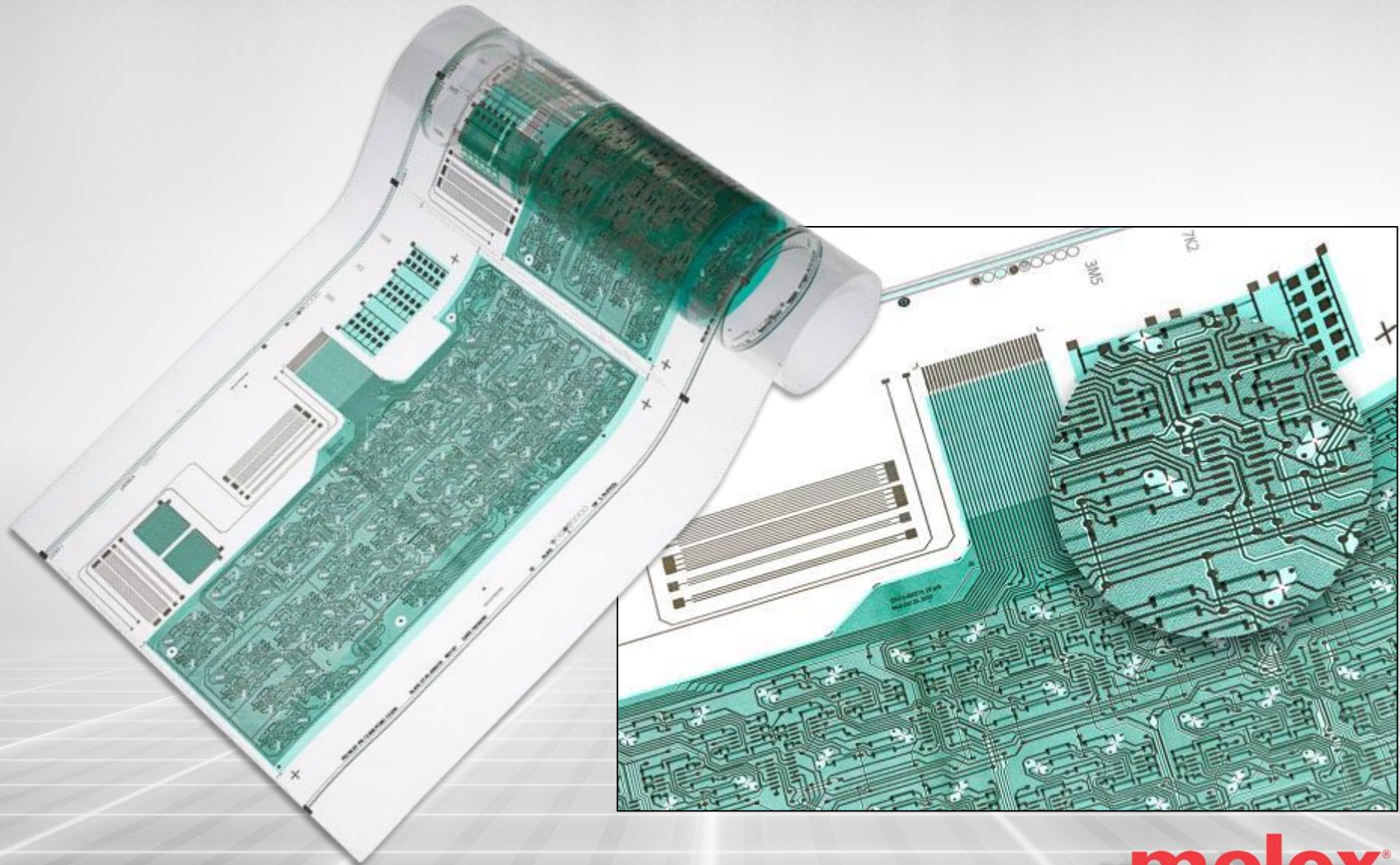


Previous Construction (PCB, Cable Assy, Soldered LEDs)

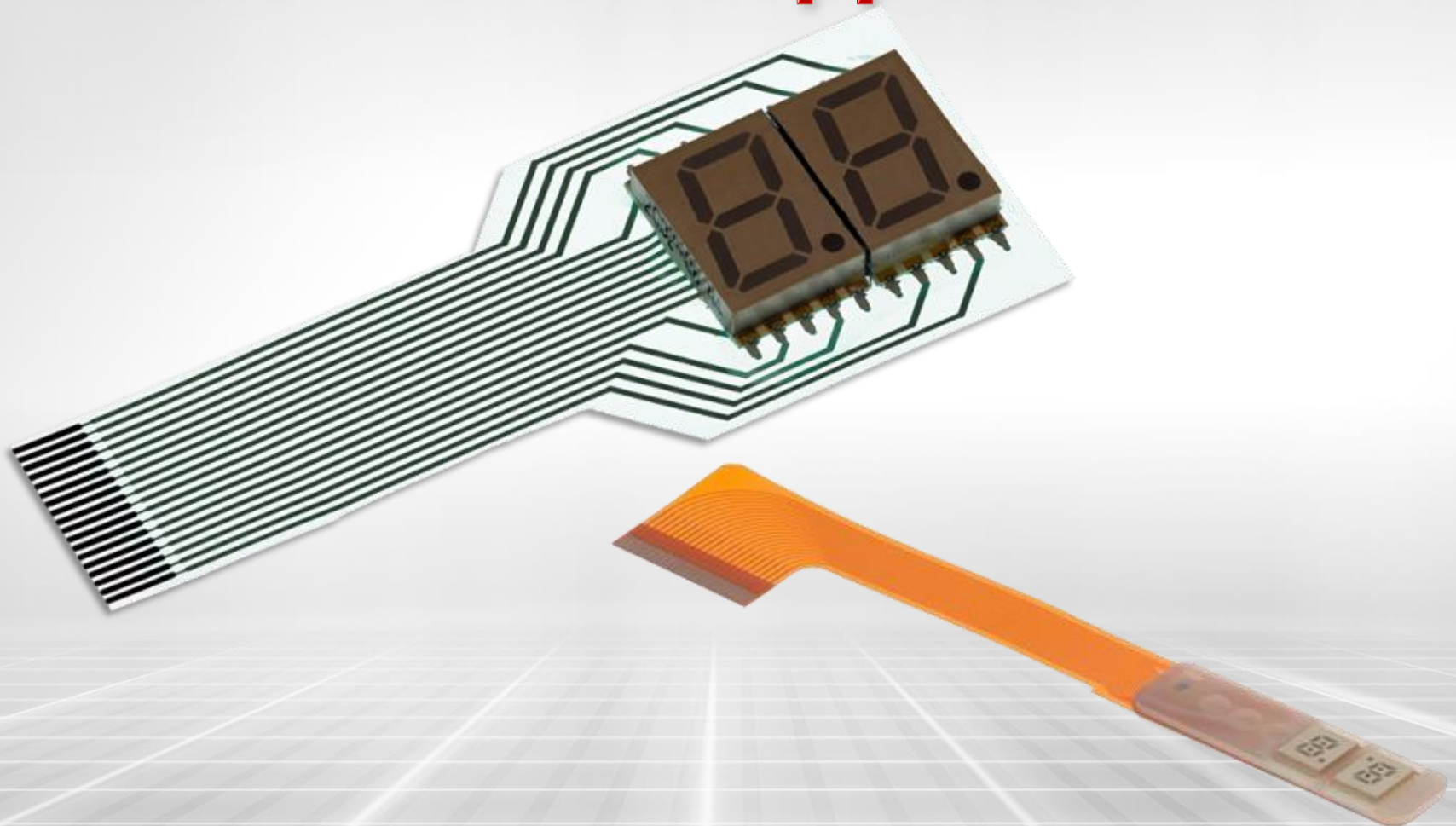


New Construction (Silver Flex, Built In Cable, Bonded LEDs, Easy Assembly)

Moving PCB to Silver Flex



Goal: Optimize Your Substrate Silver or Copper?



Poor Opportunities for Silver Flex

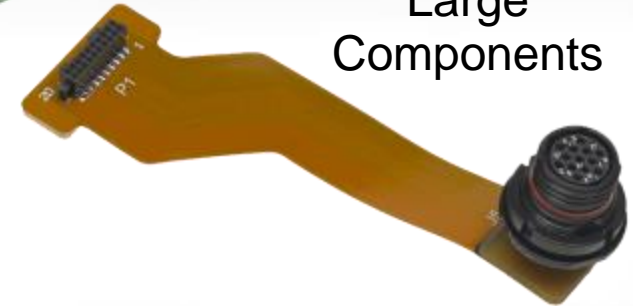
Densely
Populated



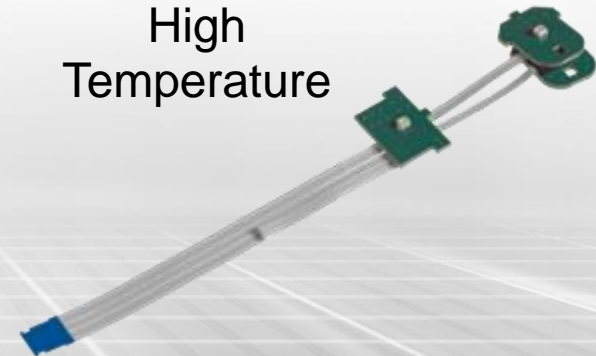
High Power



Large
Components



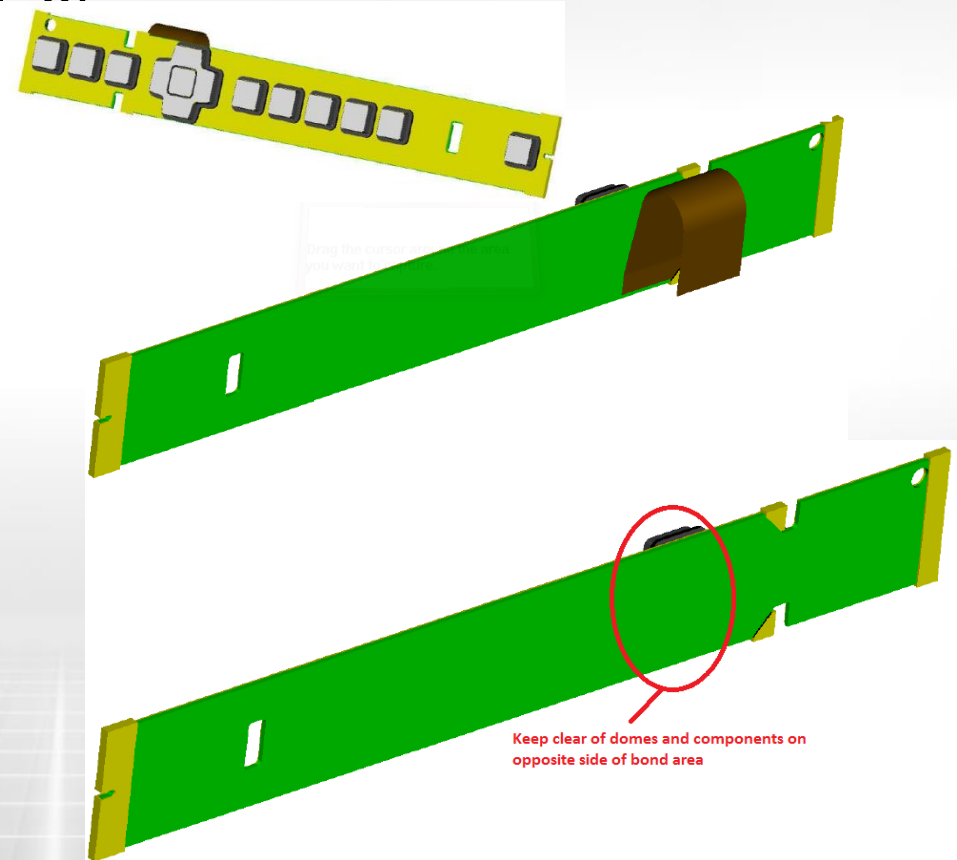
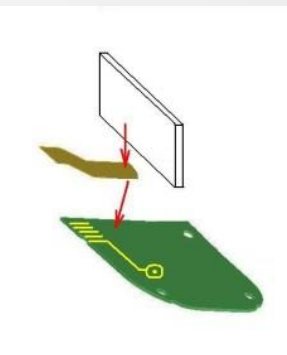
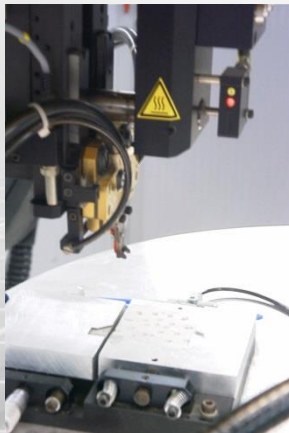
High
Temperature



Hybrid solution

› FPC+ PCB using HotBar process

- Lower cost than RigidFlex
- Keep area in front clear of domes or components



New Cost-effective Flex Solution

› Previously no fine-pitched ICs on PET

- Regular solder melting point is too hot for polyester
- Silver epoxy does not wick to closely spaced contacts
- We use PCB but it is not flexible
- We use FPC polyimide but it is expensive

› New solution: Low-temp solder on PET

- Screen print silver ink
- Screen print low-temp solder paste
- Pick-and-place components
- Reflow
- Dispense protective encapsulant
- UV cure

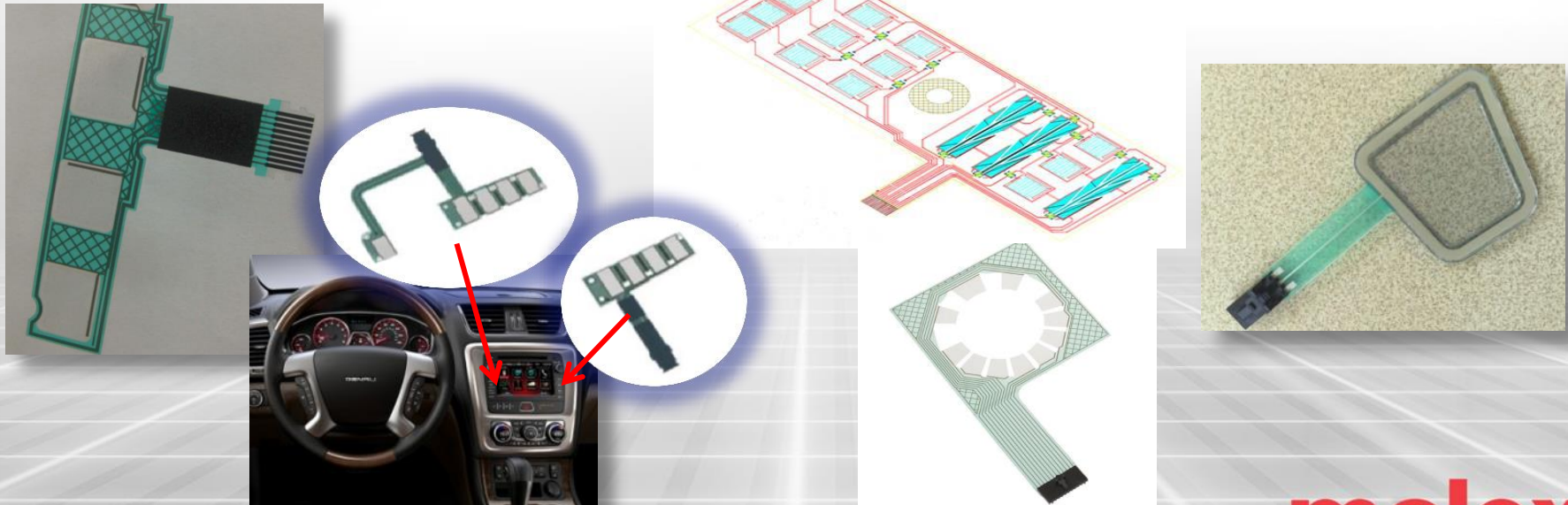
PEDOT

› Transparent conductive ink

- Screen printable, additive process
- Transparency allows external backlighting of keys

› Lower cost than ITO

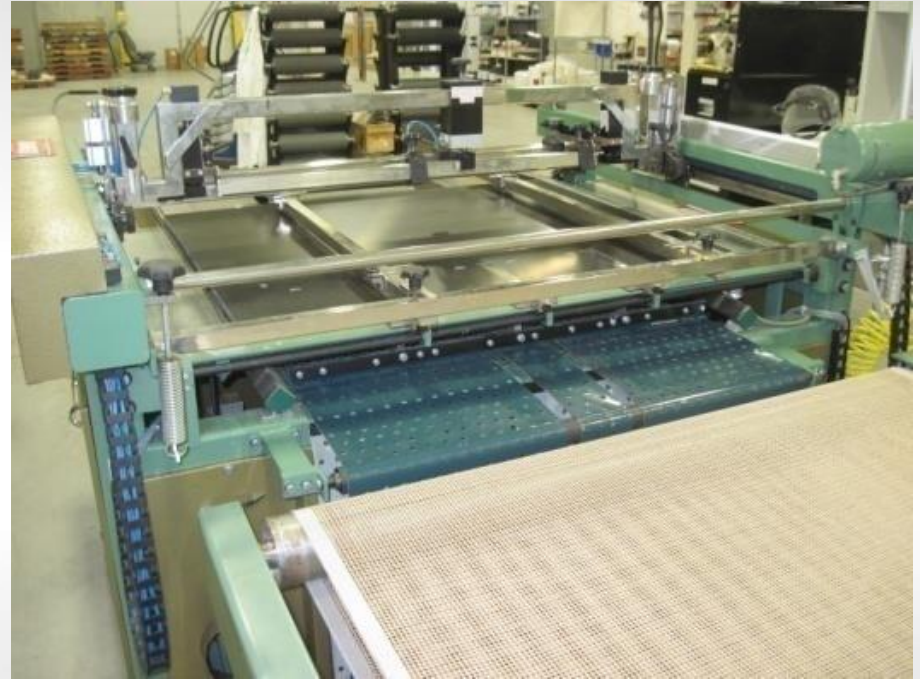
› Applications include appliances and automotive



PRINTING



Roll-to-roll printing



Sheet based printing

CONVERSION

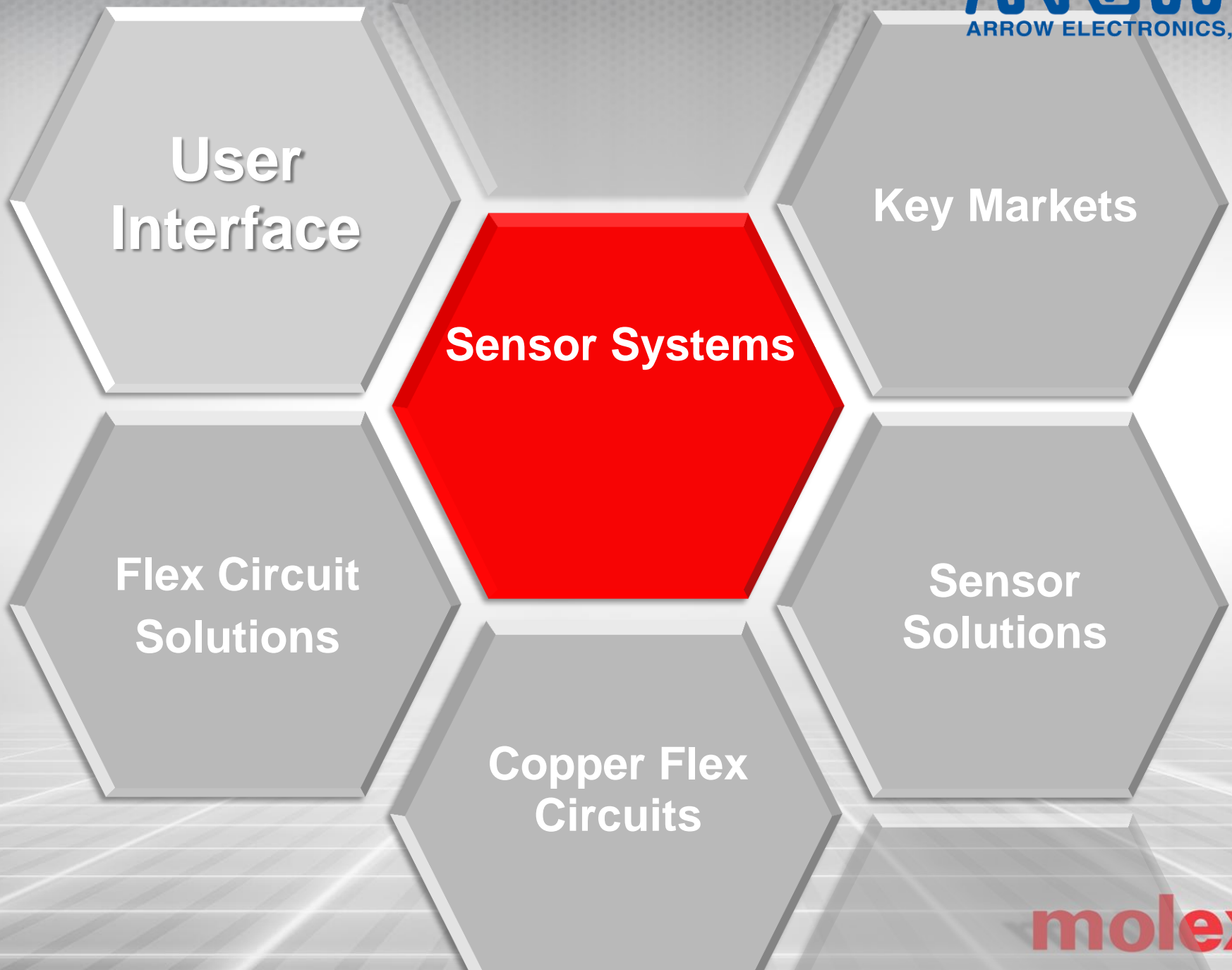
› Roll to Roll converting

- Medical Adhesives
- Transfer Tapes, Foam
- Rotary Diecut Tooling
- Slitting, Kiss Cuts, Tabs
- Laminating (5+ layers)



› Clean Room Capabilities

- Class 10K for clean room medical applications



Sensor System Considerations

SAMPLING OF TECHNOLOGY CHOICES

Customer
Needs



Display:

- E Ink
- LCD
- LEDs

uController:

- Epson
- TI
- ASI

Power:

- Li battery
- C/Zn battery
- Supercap

Sensor Types:

- Temperature
- Humidity
- Pressure
- Vibration
- Shock
- Glucose
- Lactate
- Methane
- Nitric Oxide

Wireless:

- Bluetooth
- NFC
- WiFi

Energy Harvesting:

- Solar
- Thermal
- RF



Custom
Commercial
Products

Sensor Development Focus

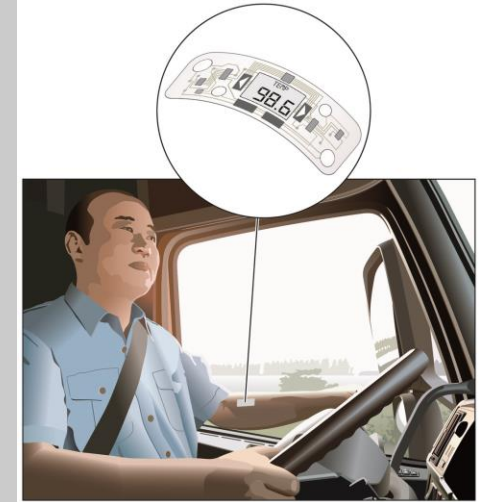
Temp, Shock, Vibration



Shock Measurement



Biomarkers



Health and Fitness









Smart Label



Smart Cards



Flexible Automotive Electronics

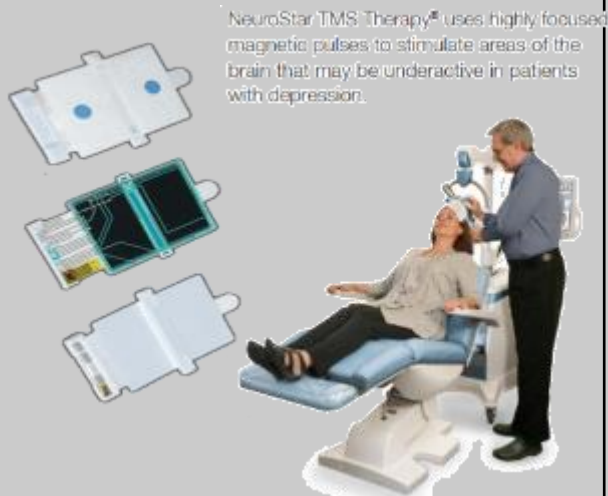
| | | |
|--|---|---|
| <p>Flexible Seat Heaters</p>  | <p>Capacitive User Interface</p>  | <p>Visor Vanity</p>  |
| <p>Pedot Map Lighting</p>  | <p>Pedot Backlit Switches</p>  | <p>Exterior Lighting</p>  |

Medical Applications

Wound Care



Transcranial Therapy



Disposable ECG



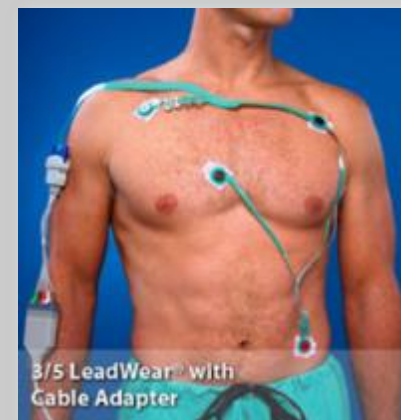
Kinesiology



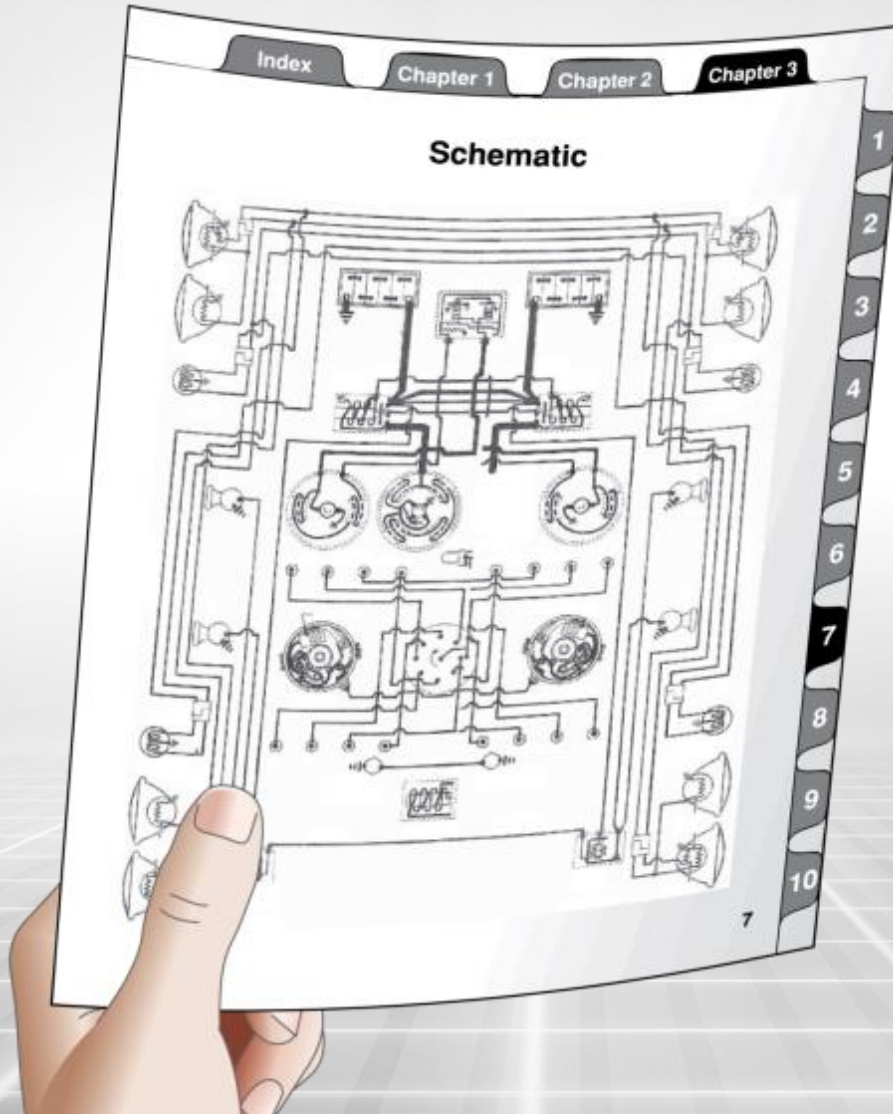
Medical Electrodes



Disposable ECG



Critical to Program Success: Early Program Engagement



Critical to Program Success: Focus on Functional Requirements and Use Case Scenario

› Functional Requirements – including...

- Power requirements
- Voltage, Current and Resistance requirements
- Communication protocols

› Use Case Scenario – including...

- How will the product be used?
- Expected life in use
- Shelf life requirements
- Regulatory requirements

Printed Electronics

› Design Engineering & Manufacturing Services

- Problem solvers & solutions providers
- Design, prototype and development services
- Fabrication capabilities & path to volume manufacturing
- Established partnerships both materials & technology
- Leveraging existing operational excellence at Molex

› Quality

- ISO Certifications: ISO 9001 and ISO 13485
- FDA Registered
- ITAR Registered

**User
Interface**

Key Markets

Sensor Systems

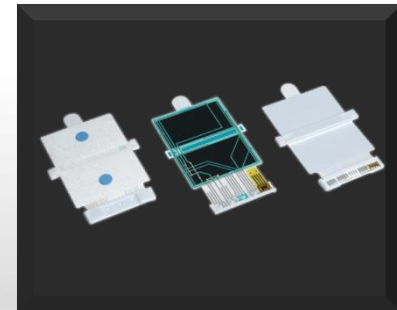
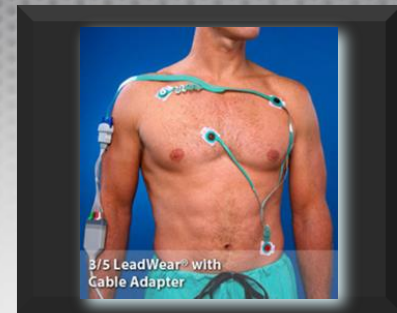
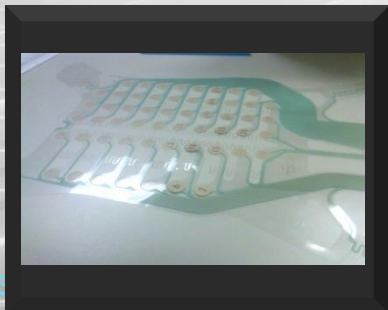
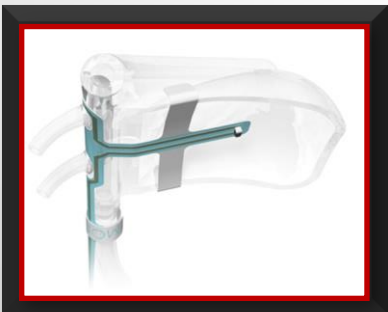
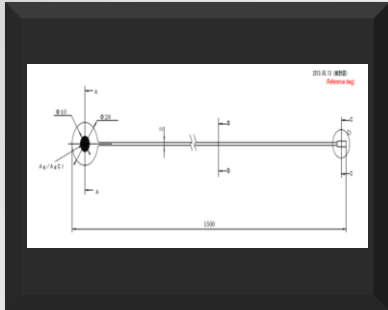
**Flex Circuit
Solutions**

**Sensor
Solutions**

**Copper Flex
Circuits**

GLOBAL MARKET FOCUS: MEDICAL

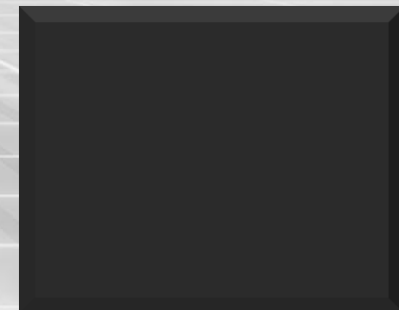
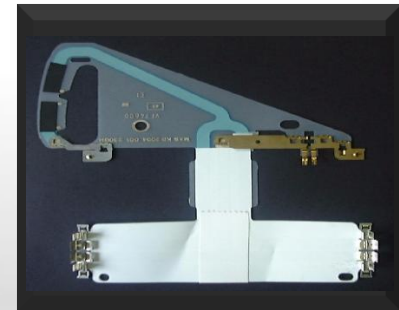
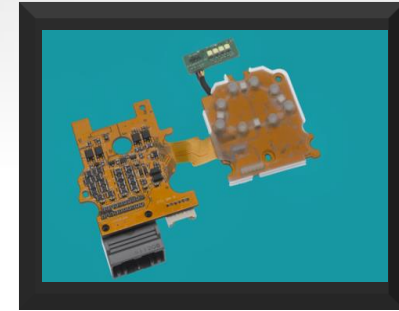
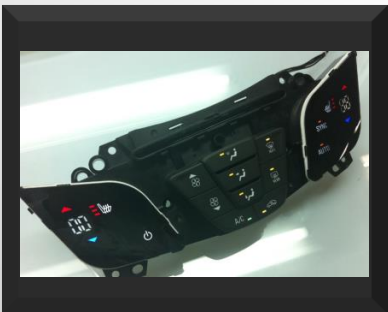
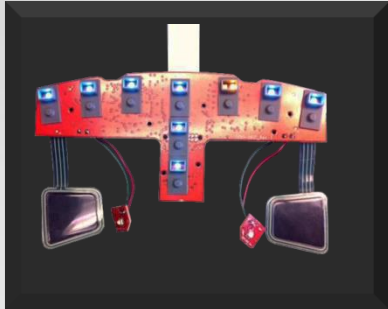
- › U.I
- › Flex
- › Medical Disposal
- › Sensors
- › Printed Electronics
- › Hydrogels



GLOBAL MARKET FOCUS:

Automotive

- › U.I
- › Flex
- › Touchpanel
- › Sensors
- › Printed Electronics



AUTOMOTIVE INTERIOR

- **Transparent PEDOT electrodes**
- **Excellent backlighting**

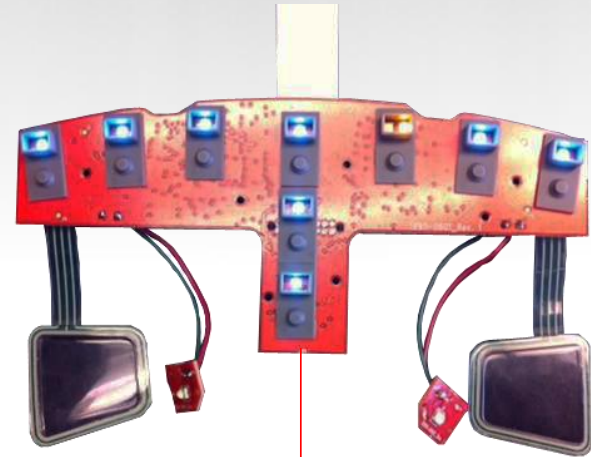


Plastic
Circuit
Diffusing inks



molex®

AUTOMOTIVE INTERIOR



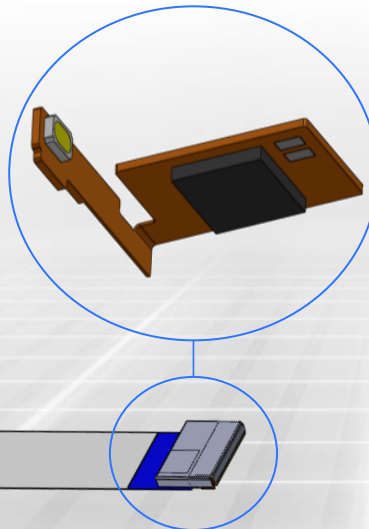
AUTOMOTIVE INTERIOR



Ultra-flexible light
guide film

Uniform glow

Efficient flex light
insertion system and
integrated PCB



Neal O'Hara

European Business Development Manager

Printed Circuit Solutions