Enabling Technologies and Processes for Wearable Displays

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Evolution of wearables
Wrist-worn devices dominate wearables market today, but growth is expected in several other form factors.

<table>
<thead>
<tr>
<th>Head Mounted</th>
<th>Watch</th>
<th>Clothes</th>
<th>Accessory</th>
<th>Bioelectronics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incorporates users' vision, speech and hearing</td>
<td>Voice/text message interface</td>
<td>Maintains appearance of normal clothing, but can warm up the body and/or provide simple electronic functions</td>
<td>Fashionable functionality, usually in the shape of a ring, bracelet, belt, headband or ring</td>
<td>Combines electronics and biotechnologies e.g. electronic skin, subcutaneous devices, ingestible devices</td>
</tr>
<tr>
<td>Serves as a display screen in the form of glasses or visor</td>
<td>Smartphone app extension</td>
<td>Health &amp; location monitoring</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Basic functions**

**Some products currently on the market**

- Google Glass; wearable cameras, Oculus Rift
- Apple Watch; Moto 360; Samsung Gear; Pebble; Sony
- Under Armor E39
- Jawbone Up, Nike +
- EKG Heart monitor

Data Source: Yuanta
Triple-digit growth highlights growing interest in wearables market from both end-users and manufacturers.

**Worldwide Wearables Shipments**

- **Units (M)**
  - 2014: 100
  - 2015: 200
  - 171.6% YoY growth

**2015 Market Share**

- **Fitbit**: 35%
- **Xiaomi**: 27%
- **Apple**: 15%
- **Garmin**: 15%
- **Samsung**: 15%
- **Others**: 4%
- **Others**: 4%

*Data Source: IDC*
Spotlight On: Smart Watch

Smart watch category could reach 100 million devices by 2019

Units (M)

200
150
100
50
0


Growth regions: Far East & China, North America

Data Source: Juniper Research
## Spotlight On: Smart Watch

**Compare and contrast: heirloom timepiece vs. smart watch**

<table>
<thead>
<tr>
<th></th>
<th>Timepiece</th>
<th>Smart Watch</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functions</strong></td>
<td>Time, date, pressure, altitude</td>
<td>+Health monitoring, notifications, apps extension, location</td>
</tr>
<tr>
<td><strong>Design</strong></td>
<td>Wide range of fixed material choices, customized features</td>
<td>Customize digital face Choice of fixed materials</td>
</tr>
<tr>
<td><strong>Battery Life</strong></td>
<td>Years - unlimited</td>
<td>1-3 days</td>
</tr>
<tr>
<td><strong>Lifetime</strong></td>
<td>Generations</td>
<td>3-5 years</td>
</tr>
<tr>
<td><strong>Durability</strong></td>
<td>Sapphire face, metal housing</td>
<td>Glass or sapphire face, metal housing</td>
</tr>
</tbody>
</table>
Requirements for wearables

1. Surface material achieving arbitrary shapes, forms and finishes
2. Display with flexibility / conformability
3. Adequate battery life
Requirements for Wearables:

Surface material achieving arbitrary shapes, forms and finishes

Challenge

Designers want the freedom to choose shape, form and finish without sacrificing the damage resistance and image clarity of existing mobile device screens

Innovation

Supply chain is emerging to offer shaped glass parts, custom finishes and custom decoration process

Example: Vibrant™ Corning® Gorilla®Glass
## Requirements for Wearables:

**Display with flexibility / conformability**

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<tr>
<th>Challenge</th>
<th>Innovation</th>
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<td>Low cost, high-yield manufacturing of thin, light, flexible displays capable of arbitrary form factors</td>
<td>Advantaged carrier glass is key to enabling PI OLED process</td>
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**Example:** Corning Lotus™ NXT Glass as a carrier for PI-OLED Displays

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Requirements for Wearables:

Adequate battery life

**Challenge**

Extend battery life of wearables from days to weeks

**Innovation**

- Power efficient displays & chipsets
- Conformable batteries
- Advanced reflective displays process

Example: Corning through-glass via packaging solutions

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Summary

- Wrist-worn wearables are not heirloom devices, but we still expect them to look good and function well.

- Future requirements for wrist-worn wearables push further on traditional values for mobile devices:
  - sunlight readable, low power, thin & light
  - form fitting and attractive design

- Corning is partnering with industry leaders to bring:
  - cost effective solutions for conformable and decorative surface materials and flexible displays
  - substrates and materials for more efficient displays and components