Attracting Tomorrow

⬧TDK

A Future Enabled by Sensors

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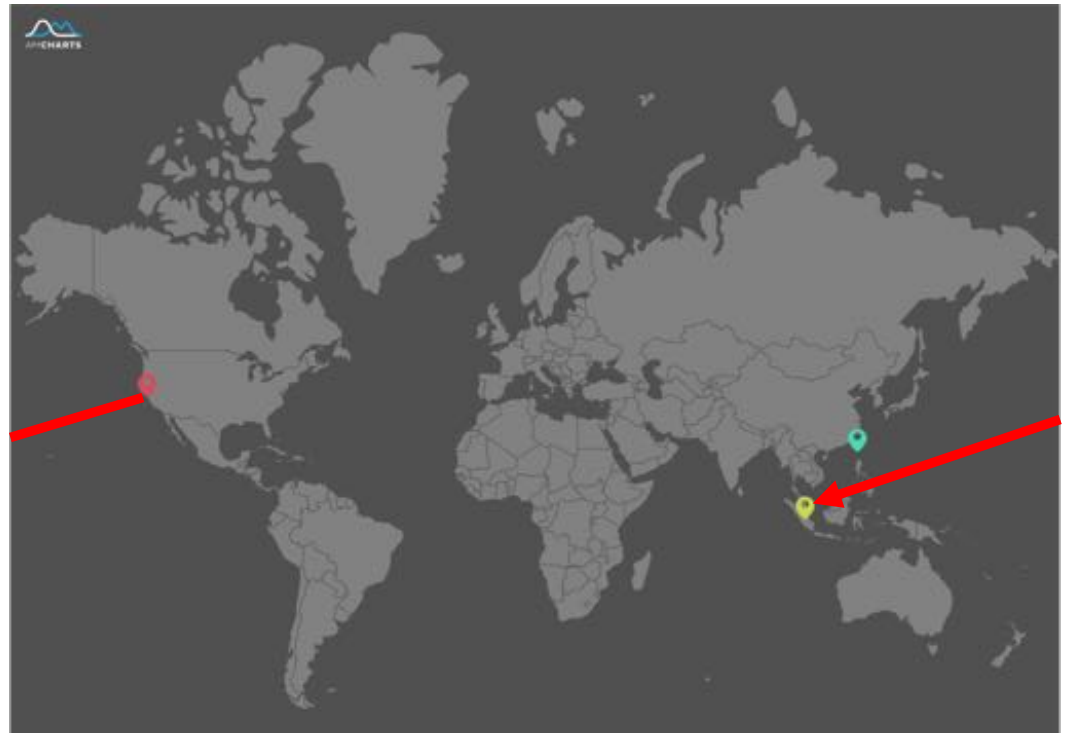
InvenSense
A TDK Group Company
MEMS Sensors Business Group
Sensor Systems Business Company
[9/21/18]

Introduction

- Travel

- Its amazing:
  - ¬ Monday, 5:30pm in San Jose at TDC
  - ¬ Wednesday, 1:30pm in Singapore at PMC
  - ¬ And Friday I will be in Taiwan

  - ¬ What a world we live in.

- And yet, why am I here at all?

So what might the future look like ?

Hologram

- Projected hologram in the room
- Shared augmented reality

Avengers: Infinity War, 2018

Church of the Holy Screen Time

- Live person giving a sermon, but sometimes a video
- Everything simulcast – in church and on the web
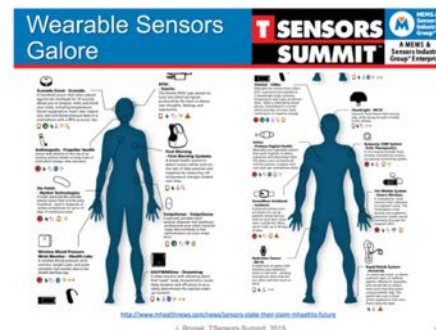- The sound is excellent

Menlo.church

Live entertainment?

- Who goes to live things anymore?
  - ¬ Concerts, theater
- Street performers make us stop
- Magic

- Has video content quality has driven us to a higher standard
- What about science?

- Should I sign off and send you the link to the stream?

Bigger Story:
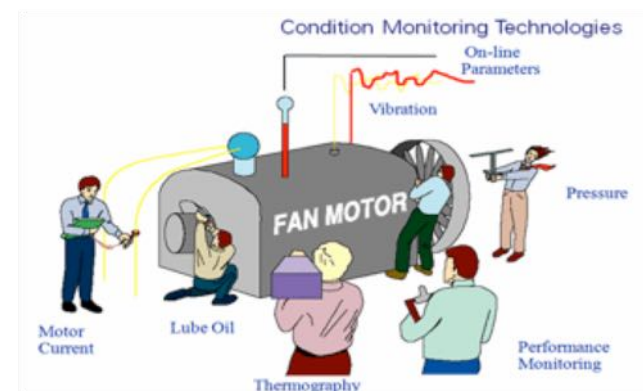# Future enabled by TDK technology
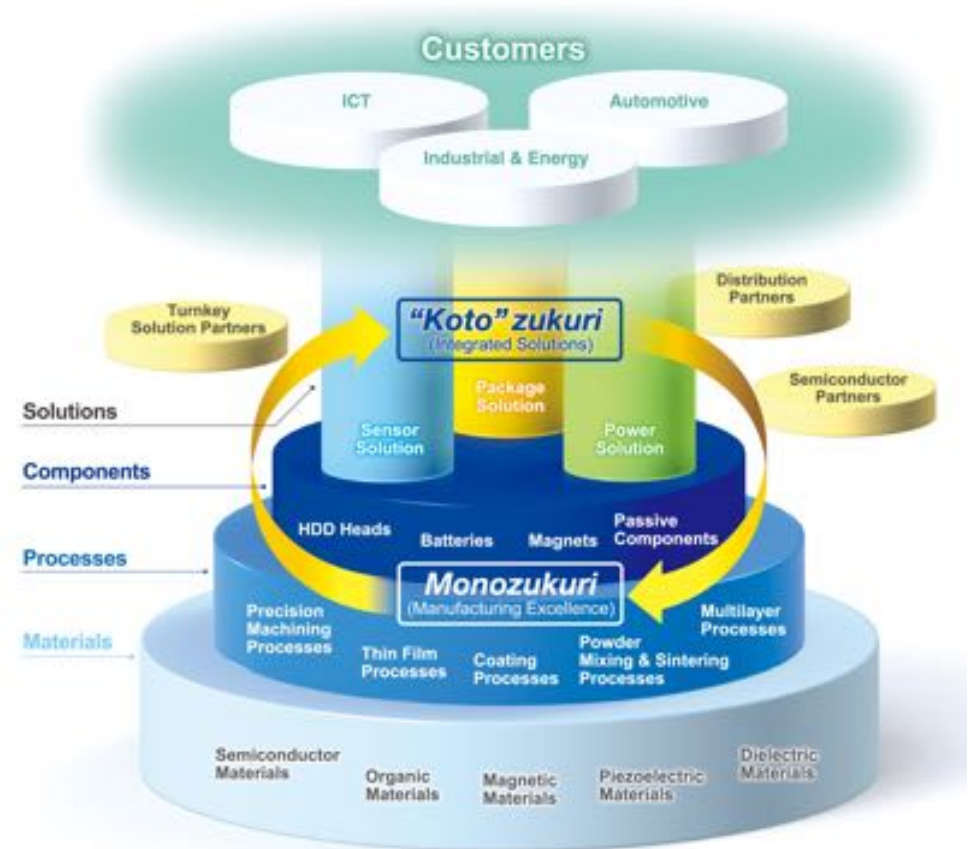
AR / VR

Wellness

Robotics

Next-Gen
Interface

Infrastructure

TDK Solutions

- Sensor
  - ¬ Finger print – authentication / identification
  - ¬ Pressure – altitude, stability, fall
  - ¬ 6 DOF – positioning, relative motion
  - ¬ Ultrasonic – collision detection, position tracking
  - ¬ Magnetic – absolute heading, sensor stability
  - ¬ Silmee – vital signs

- Energy
  - ¬ DC-DC/OBC – efficiency, size
  - ¬ Inverter – compatibility
  - ¬ µPOL – efficiency, size
  - ¬ Li Battery – capacity, size, safety, lifetime
  - ¬ Power Unit – conversion, charging

- High density package
  - ¬ SESub – form factor, parasitics
  - ¬ Passive components – quality, size, integration
  - ¬ Modules / MEC – integration
  - ¬ 5G antenna / BPF – communication (next gen)
  - ¬ WPT – charging anywhere, no down time

Bigger Story:
Future enabled by TDK technology

AR / VR

AR – Augmented Reality

- Industrial application
  - ¬ SOP for workstation tasks
  - ¬ Camera to verify correct procedure, alignment
- DIY
  - ¬ YouTube walk through videos
  - ¬ Voice command for forward, backward pause

- Medical application
  - ¬ Specialist "on demand" with doctor helping with procedure
  - ¬ Haptics, feedback, tele-medicine

- Travel
  - ¬ Directions, recommendations
  - ¬ History – political, celebrity, *personal*

- Solving the "distracted walking" problem
  - ¬ Head not buried in device
 - ¬ Alerts pop up in front of you

VR

- Currently two flavors
  - ¬ 3 DOF -> domed world or spherical world
    - o Oculus Go, Samsung Gear VR, Google Cardboard
  - ¬ 6 DOF -> limited by your room size
    - o   HTC Vive, Oculus Rift, Playstation VR
  - ¬ Tech is there on the viewer – like the early days of TV

- Content genres, conventions yet to be created
  - ¬ From early variety programs (vaudeville) to HBO go and binge watching
  - ¬ IMAX – current experience
  - ¬ What will a movie/show be like?

- Collaborative and Social
  - ¬ Gaming
  - ¬ Good!: watching a movie with people far away
  - ¬ Really?: Family on a couch with headsets

- Its hard to demo VR.

- **Its hard to eat and drink during VR**

VR Vacation
Yosemite and Hetch-Hetchy Valleys
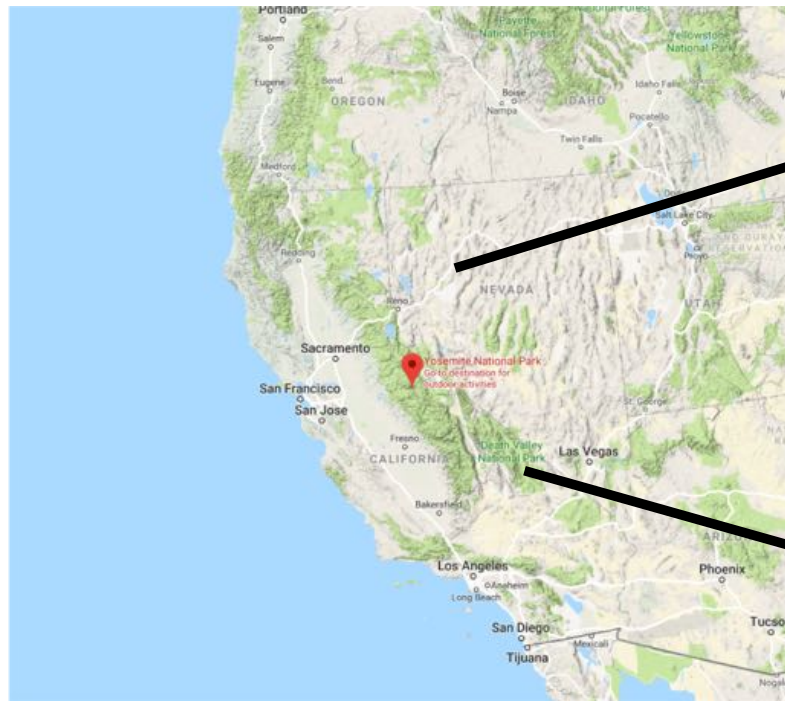
Hetch-Hetchy


California

Yosemite

VR Cultural Exchange
Tokyo Subway

VR Content Creation

- Digital world generation
  - ¬ Merger of gaming and movies

- Capture is the next frontier
  - ¬ **BIG opportunity for sensors**
  - ¬ Camera, motion, freedom of environment
  - ¬ Live interaction vs recorded experiences

- Capture problem
  - ¬ 360 camera – need a lot more pixels – linear
  - ¬ How to capture free-form -> room, objects, positions

- Sports
  - ¬ Point of view: a player, all the players, ref, the ball, the crowd
  - ¬ Commentator
  - ¬ Producer/director

  - ¬ Off the ball action

  - ¬ Will people stop going to game?
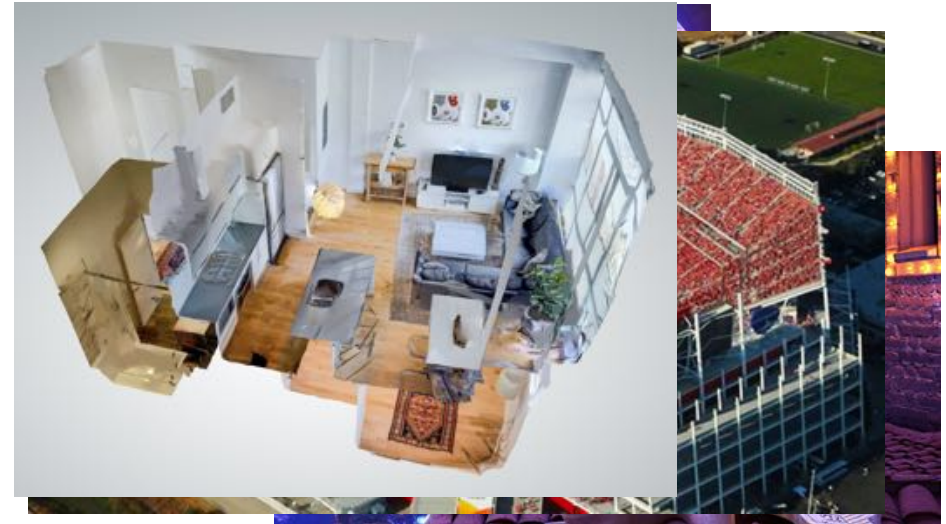
2006 WorldCup

AR/VR needs

- Sensors
  - ¬ Motion – (headset, controllers): noise, latency, bias stability
  - ¬ Ultrasound – triangulation – relative position and angle, wide field
  - ¬ Microphone – interface, social, environment
  - ¬ Pressure – height, fall
  - ¬ Cameras – 2D/3D

- Energy
  - ¬ Batteries – weight, lifetime
  - ¬ Efficiency - DC/DC conversion

- Packaging
  - ¬ **Paradigm shift to enable stealth glasses**
  - ¬ Wireless power transfer – no connectors

- SW Fusion – drive a complete solution
 - ¬ Sensors reduce computation load, latency

Bigger Story:
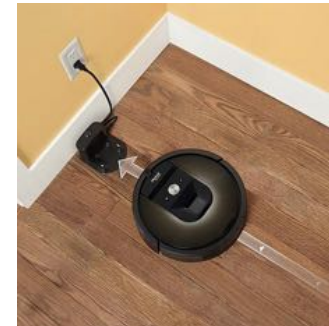# Future enabled by TDK technology

Robotics

Robots

- Roomba
  - ¬ Simple concept, simple software got the job done
  - ¬ Now a mapping service… data is king

- Alexa, Siri, Hey Google
  - ¬ Tethered assistant – need one per room
  - ¬ Why wasn't your phone enough? What did Echo change

- Drones
  - ¬ Package delivery – last mile

- Autonomous Vehicle
  - ¬ Local driving is hard – so many variables
  - ¬ Long haul is way easier
    - o Limited exits, similar speed, no bike/ped/animals
    - o Autonomous lanes – check in, check out
    - o Similar to railroad, but partitioning existing infrastructure
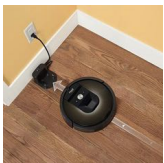
Robot needs

- Sensors
  - ¬ Motion – position, dead reckoning, orientation, stability
  - ¬ Ultrasound – object detection, collision avoidance
  - ¬ (multiple) Microphone – interface, noise canceling, beam forming
  - ¬ Pressure – altitude
  - ¬ Vision
  - ¬ Location (GNSS) – with IMU for outage

- Energy
  - ¬ Batteries – weight, lifetime
  - ¬ Efficiency - DC/DC conversion

- Packaging
  - ¬ Robust, lifetime
  - ¬ Wireless power transfer – no connectors

- SW Fusion – drive a complete solution
  - ¬ Position and location services
  - ¬ Attitude stability (flight)

Bigger Story:
Future enabled by TDK technology

Next-Gen
Interface

Next gen interfaces

- Keyboard is 140 years old

- Voice is natural
  - ¬ My son just uses Siri

- Need interfaces designed for voice
  - ¬ The PowerPoint problem
  - ¬ iOS / Android were designed for touch

- Voice interfaces
  - ¬ Ordering at the drive thru
  - ¬ How to know what's possible?
  - ¬ Magic Door

- Gestures, attention
  - ¬ Which device in a room of many

- Feedback, haptics
  - ¬ Virtual button
  - ¬ Scrolling a list

Interface needs

- Sensors
  - ¬ Motion – Gesture
  - ¬ Ultrasound – proximity, gesture, occupancy
  - ¬ (multiple) Microphone – direction, noise canceling, beam forming
  - ¬ Vision - attention

- Energy
  - ¬ Haptics – feedback, size, power

- Packaging
  - ¬ integration

- SW Fusion – drive a complete solution
  - ¬ attention

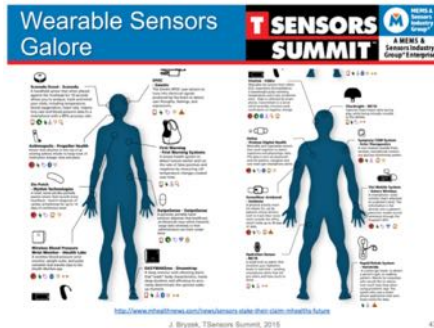|	根据指尖碰触表面时的场所进行反应	按下开关时的信号
响应	配合指尖灵敏度 做出舒适反应（振幅）	明确反应（振幅）
用途	·智能手机 ·可穿戴设备 ·触控板	·汽车导航仪 ·控制器的显示屏

Bigger Story:
Future enabled by TDK technology

Sensors
- Vital signs

Energy
- Wearable
- Continuous operation

Packaging
- New form factors
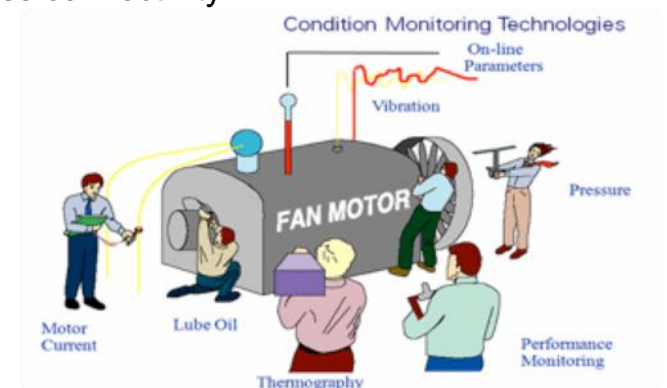- Integrates with Lifestyle
- Wireless charging

Wellness

Sensors
- Equipment condition
- Vibration, sound

Energy
- Energy harvesting
- Continuous operation

Packaging
- Wireless connectivity

Infrastructure

Summary

- Sensors bridge between digital and real worlds
  - ¬ Humans into virtual world
  - ¬ Robots into real world

- Beyond sensors, TDK brings
  - ¬ Breakthrough Energy and Packaging technology

- Call to action
  - ¬ Must do (it's a business), can do (enabling, adjacent), should do (philanthropy)
  - ¬ IoT for climate change
  - ¬ Air quality education for people who only have a phone
  - ¬ New device: **IoT World Portal**
    - ○ light, battery, PV, connectivity, charger, air quality sensor, assistant …

As essential as:
Food, shelter, family

⬢TDK

www.invensense.com

- Preso for Dev Conf

- A Future Enabled by Sensors.
- Peter Hartwell, PhD, CTO, InvenSense

- CTO Peter Hartwell will present a vision of the future where sensors are the bridge between the human and digital experience. The advancements are plenty and converging. Robots are moving into the world that we have tailored for humans over many centuries. People are digitizing that world – to preserve, archive, share, model, understand, and continue to improve, all while striving to reduce our impact. And the interfaces between us and our digital devices is beginning to evolve at a dramatic rate. At the lowest level, at the very core, are sensor advances in performance, power, cost, and size, allowing the measurement of physical parameters needed to form the bridge. In the end, the sensors disappear into the background and all that is left is new experiences, vibrant, natural, and inspiring.