BSAC's Impact on Startups: From Device Engineering to Entrepreneurial Excellence, Illustrated by UltraSense Systems

Hao-Yen Tang
Co-Founder/CTO, UltraSense Systems
# BSAC Alumni from Prof. Boser & Horsley’s Group

<table>
<thead>
<tr>
<th>Prof. Bernhard Boser</th>
<th>Prof. David Horsley</th>
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<tr>
<td>Burak</td>
<td>Qi Wang</td>
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<td>Joshua</td>
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<td>Hao-Yen</td>
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<td>Igor</td>
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<td>Mitchell</td>
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Chirp MicroSystems – Role Model!

TDK to acquire Chirp Microsystems, aiming for leadership in ultrasonic sensing solutions

- TDK to acquire Chirp Microsystems, Inc., a developer of high-performance ultrasonic 3D-sensing solutions.
- Acquisition to enhance TDK’s existing technology in fingerprint sensors, MEMS sensors, and Piezoelectric transducer product lines.
- TDK aims to be the leader in the ultrasonic MEMS sensors and solution market.


Company Confidential & Proprietary
And More..

- Prof Liwei Lin (Iota Bioscience)
- Prof Michel Maharbiz (Iota Bioscience)
- Sina (UltraSense)
- DJ Seo (Neuralink)

Astellas Completes Acquisition of Iota Biosciences

Oct 30, 2020

TOKYO October 30, 2020 - Astellas Pharma Inc. (TSE: 4503, President and CEO: Kenji Yasukawa, Ph.D., "Astellas") announced today that it has completed the acquisition of Iota Biosciences, Inc. ("Iota"), a start-up company focused on the bioelectronics field, located in Berkeley, California, and Iota has become a wholly owned subsidiary of Astellas as of U.S. Pacific Time October 29, 2020.

Under the Merger Agreement executed between Astellas and Iota shareholders, Astellas paid approximately US$127.5 million to acquire all of the outstanding equity in Iota that was not previously held by Astellas (Astellas through a U.S. subsidiary, was an investor in Iota through its previous Series A Preferred Stock offering). In addition, Iota’s former shareholders (other than Astellas) will be eligible to receive additional payments of up to a total of approximately US$176.5 million upon achievement of predetermined milestones by Iota within certain timeframes after completion of the transaction.
Back to this Nobody...
What Did We Do in BSAC?

**Architecture**

- **Sensor Architecture**
- **Wafer-bonding**
  - PDMS: 1.5-µm Si
  - 0.2-µm electrode (Mo)
  - Ta or AlN
  - 0.2-µm electrode (Al)
  - 2.35-µm Vacuum
- **Readout Timing Diagram**
  - Sample to Measurement
  - AD Completion

**Verification**

- **Robust**
  - Capacitive Fingerprint Sensor
  - Proposed Ultrasonic Fingerprint Sensor
- **Secure**
  - Fake Finger on our Sensor
  - Resulted Image
- **3D Imaging**
  - Epidermis Fingerprint (Surface Layer)
  - Dermis Fingerprint (Inner Layer)
What Did We Do in BSAC?

**MEMS Design**

- **Wafer-bonding**
  - PDMS
  - 1.5-μm Si
  - 0.5-μm electrode (Mo)
  - 1-μm AlN
  - 0.2-μm electrode (Al)
  - 2.35-μm Vacuum
  - CMOS

- **MEMS Fabrication**
  - (a) IrO$_2$
  - SiO$_2$
  - Pt
  - Si(100)
  - (b) Au/Pt/Cr
  - Al$_2$O$_3$
  - (c) Au
  - Sacrificial PR
  - (d) XeF$_2$ etching

**Sensor Architecture**

- **Cross-section**
  - Finger
  - Pad
  - PDMS
  - Epoxy
  - Eutectic bond
  - CMOS
  - 10 μm
  - 2 μm

- **Readout Timing Diagram**
  - Top Electrode (TX/GND)
  - Bottom Electrode (GN/GND)

- **Die Shot (CMOS)**
What Did We Do in BSAC?

Architecture

Sensor Architecture

Circuit Design

Circuit Layout
What Did We Do in BSAC?

- PCB Design
- FPGA/Micro-controller Coding
What Did We Do in BSAC?

**Verification**
- Finger with sweat
- Robust
- Proposed Ultrasonic Fingerprint Sensor
- Capacitive Fingerprint Sensor

**Secure**
- Fake Finger on our Sensor
- Resulted Image

**3D Imaging**
- Epidermis Fingerprint (Surface Layer)
- Dermis Fingerprint (Inner Layer)

**Software**

**Algorithm**
- Digital image of the fingerprint pattern
- Distinguishing features of the fingerprint
Knowledge Spectrum

Physics  Sensors/Actuators  Circuit  System  Software

- Single PhD Student handle the whole project
Where UltraSense Started

# how many pitches a VC need to hear per year?
Learning

• “As broad as you can!”

• Capability of building a demo is the key to start your startup journey.

• Corporate: one guy do one thing all the time to make it perfect.
  Startup: one guy do multiple thing with 60% “good enough”.
Startup/ Product with Piezoelectric Transducers/MEMS

- Chirp Microsystems
- InvenSense’s Fingerprint Sensor (UltraPrint)
- UltraSense
- Iota Bioscience

- eXo imaging
- xMEMS Microsystems
- Frorre Systems
Sensitivity to Process Control

- MEMS Gyroscope
e.g. InvenSense

- MEMS Resonators (fbar)
e.g. SiTime
Sensitivity to Process Control

- PMUT Fingerprint Sensor Example
- UltraSense’s Example (2019 fabout, 2021 MP, >95% yield)

Ref: https://ieeexplore.ieee.org/abstract/document/7579196/
Learning

• Variation for a MEMS process take long time to be mature --especially for new stuff!

• Best Case: the application make the device inherently insensitive to process variation. --PMUT fingerprint example:
  (1) Relatively high bandwidth (low Q) $\rightarrow$ insensitive to resonance frequency variation
  (2) Care about amplitude but not resonance frequency
  (3) Care about relative amplitude
UltraSense Systems is elevating the automotive touch experience.

By replacing mechanical buttons with intuitive Smart Surfaces.
A team that has done it before

Mo Maghsoudnia
Founder / CEO
Head of technology and manufacturing at InvenSense & NetLogic

Hao-Yen Tang, PhD
Co-Founder / CTO
Lead ultrasound fingerprint designer at Qualcomm and InvenSense

Sina Akhbari, PhD
Co-Founder / Chief Sensor Architect
Design expert in piezo ultrasonic transducers at InvenSense

Mo Li, PhD
Vice President Products/System Architect
Sensor System Architect at Apple, Autonomous Driving Architect at Nio

Daniel Goehl
Co-Founder / CBO
Founding team InvenSense & Head of Sales, GM TDK Sensor Sales Grp; founding member of 6 startups

Hema Sankar
Vice President, Customer Engineering
Asst Customer Engineering Head for InvenSense, Motorola software

UltraSense Systems - Crunchbase Company Profile & Funding
Team in place/starting date: 07/16/2018
24M USD raised
Lead Investors: Aritman Venture, Bosch Venture
One Technology Three Solutions

UltraSense TouchPoint HMI Controllers

UltraSense InPlane Sensing Solutions

UltraSense Solid-State Interface Module
Bringing Smart Surfaces to the automotive experience

2025 Hyundai Genesis
GV80 EV

Door
Steering wheel
Center console
Overhead console
Pillar
Frunk / trunk
Handles
Charge port
Multimode: Ultrasound + Strain Sensor on the Same Chip

Ultrasound Sensor: Detects object (finger) on the button

Strain Sensor: Detects deformation of the button region

Finger **on** the button + Finger **press** the button
Enough Bright Part, Now Let's Look at Dark Side..

"UNLUCKY REALLY"

**LG TO CLOSE MOBILE PHONE BUSINESS WORLDWIDE**

*Stepping Away from Phone Manufacturing and Sales Enables Company to Focus on Growth Sectors Including EVs, IoT and B2B Solutions*

SEOUl, South Korea, April 5, 2021 — LG Electronics Inc. announced that it is closing its mobile business unit. The decision was approved by its board of directors earlier today.

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What We did

Minimalistic Design for EVs
Challenge

- Temperature Spec: -20~65 \rightarrow -40~105 (AECQ100)
- Automotive functional Safety: “ASIL”
- Automotive Customers are looking for a “full solution”: --Mechanical Assembly --Back-lighting --Haptic Feedback

Calibration Robot

Haptic Feedback

Backlight Uniformity
UltraSense Steering Wheel demo

Converts to center console demo
Shytech / dead front demo

Secret-Until-Lit
Touch Experience Demonstrator
UltraSense Button Bar demo
Solid State Interface (SSI) for multiple use cases

Features
- Press-activated – door cover or button cap
- Programmable force thresholds to open (e.g. 5N)
- Multi-color (RGB) & pattern programmability
- Operable with gloves
- Factory calibrated for plug & play assembly
- Waterproof, IP65
- Integrated LIN comm bus Interface
- Customizable to any form factor (square)

Use cases
- Charge port door “e-lid” opener
- Frunk / trunk button / lifgate opener
Solid State Interface (SSI) for overhead lights

- Press exceeds force threshold to power on/control LED
- Configurable force thresholds for power on/off/intensity
- HMI Controller’s internal PWM directly controls LED
- No complex attachment of capacitive film
- No extra MCU required to control LED
Now..
Learning

• Q*U*I*C*K
• Don’t be afraid of jump out of comfort zone to learn new stuff
  --Refuse to say “I don’t know”: Try googling. Try asking, Try anything you could!
  --Nothing worse than phd!
• Ride the Tide!
Finally..

• Connection
  --50% of technical team recruited by myself
  --Majority of problems I got first answer from friends
  --So, please add my LinkedIn if possible, let's connect 😊
  Hao-Yen Tang | LinkedIn

• The other 70% of the story:
  “YC's essential startup advice” from Y Combinator”
  --This is a Bible..!
  --Don’t quite understand what it’s talking about? That’s normal. Check it out:
  YC's essential startup advice : YC Startup Library | Y Combinator

The Pocket Guide of Essential YC Advice

• Launch now
• Build something people want
• Do things that don’t scale
• Find the 90 / 10 solution
• Find 10-100 customers who love your product
• All startups are badly broken at some point
• Write code - talk to users
• "It's not your money"
• Growth is the result of a great product not the precursor
• Don’t scale your team/product until you have built something people want
• Valuation is not equal to success or even probability of success
• Avoid long negotiated deals with big customers if you can
• Avoid big company corporate development queries - they will only waste time
• Avoid conferences unless they are the best way to get customers
• Pre-product market fit - do things that don’t scale: remain small/nimble
• Startups can only solve one problem well at any given time
• Founder relationships matter more than you think
• Sometimes you need to fire your customers (they might be killing you)
• Ignore your competitors, you will more likely die of suicide than murder
• Most companies don’t die because they run out of money
• Be nice! Or at least don’t be a jerk
• Get sleep and exercise - take care of yourself