The Future Unfolds……

What will happen when we put display technology on everything?

For a start, something like this……
The Breakthrough Technology: OLED

Only OLED can enable wafer-thin, feather-light yet super-robust flexible displays that give shape to products that can bend, curve and fold.

**LCD Structure**

1. Polarizer Film
2. Color Filter Glass
3. Color Filter Films
4. Liquid Crystal
5. TFT Array on Glass
6. Polarizer Film
7. Backlight Unit

**OLED Structure**

1. Polarizer Film
2. Encapsulation (Glass or TFE)
3. OLED Layers (RGB)
4. TFT Array on Glass or Plastic

**Applications addressed by YIELDjet**
Flexibility: The New Frontier For Displays

Curved

Rollable

Foldable

Flexibility enables small form factors with large viewable areas
Flexibility: Igniting A Market Trajectory

Plastic and flexible AMOLED

- **Wearable electronics**
- **Automotive & Aerospace**
- **Tablets & Notebooks**
- **Mobile phones**

Source: IDTechEx. OLED Display Forecast 2016-2026
A Key “Flexibility” Enabler: Inkjet Printing
The Inkjet Innovator: Kateeva
Enable low-cost mass production of flexible & large-size OLEDs with **Inkjet Printing** -- a breakthrough & now-proven **Precision Deposition** technology solution
Kateeva: At-a-Glance

• Founded in 2008
• Backed by Venture Capital and Strategic Partners
  - Sigma Partners, Spark Capital, Madrone Capital, Samsung, Veeco, BOE, TCL, New Horizon, GP Capital, and others.
• Rapidly growing global company headquartered in Silicon Valley
  - Growing Headcount: currently ~200 staff (estimate 250 by year end)
  - Regional Subsidiaries in South Korea and China
  - Local Agent in Taiwan; Local Distributor in Japan
  - Newly renovated 75,000 sq. ft. headquarters in Newark, CA
• Supplier of inkjet-based manufacturing solutions for OLED displays
• Serving high-growth OLED markets with the YIELDjet™ Platform
  - In Mass Production: Thin Film Encapsulation (TFE) for Curved/Flexible
  - Next Mass Production Product: RGB Pixel Printing for TV

YIELDjet is trademarked by Kateeva, Inc.
The Path To Mastering Flexible
Flexible Challenge: Thin Film Encapsulation (TFE)

Encapsulation addresses OLED sensitivity to O2 and H2O

- Glass ~ 0.5mm
- OLED Layers ~0.4μ
- Glass Substrate ~ 0.5mm

Standard Rigid

Thin Film Encapsulation needed for thinness and flexibility

- Thin film encapsulation (2μ-10μ)
- OLED Layers ~0.4μ
- Glass Substrate ~ 0.5mm

Thin Rigid

- Thin film encapsulation (2μ-10μ)
- OLED Layers ~0.4μ
- Thin film barrier (2-10μ)
- Flexible Polymer Substrate < 0.2mm

Thin Flexible

TFE requires patterned organic coatings as part of a inorganic-organic multilayer stack
Why Kateeva Inkjet For TFE?

Evaporation: Evolutionary dead-end

Evaporation:
- High Cost
- Slow (thin films); Poor Planarization; Many Particle Defects; Low Material Utilization; Poor Scalability; Difficult Maintenance

Kateeva Inkjet: Precise and efficient material delivery

Kateeva Inkjet:
- Low Cost
- Fast (thick films); Good Planarization; Few Particle Defects; High Material Utilization; Good Scalability; Easy Maintenance
Kateeva YIELDjet™ Differentiation
Keys To TFE Inkjet Mass Production

• “Floating glass” platform – glass floats on N2 (no vacuum chuck)
  - Reduced N₂ enclosure volume
  - Optimal substrate handling to eliminate “chuck mura”

• First-of-its-kind N₂ printer integration with minimal downtime
  - No air exposure for most routine maintenance
  - Fast recovery in rare cases when tool is opened

• Ultra-low particle printing in N₂
  - Specially tuned N₂ flow around printer to minimize turbulence
  - Unique shielding/exhausting technology for head array, cable tray, and other critical printer components

• Unique print algorithms supported by continuous high-speed head monitoring technology and automatic re-calibration
  - Print algorithms are the key to consistent, reliable mura free printing
  - Monitoring and re-calibration occur without down-time (in-between prints)
YIELDjet™ Platform Overview

Product line spans all sizes from R&D, Pilot to full production tools
Kateeva Inkjet: The Bottom Line

• **Thick or thin films at high speed with few defects**
  - Excellent planarization and particle coverage
  - Elimination of shadowmask sharply cuts coating defect rates

• **High uptime, high speed and better scalability ➔ Inkjet CoO much lower than vacuum for each layer**
  - Equipment cost is lower and material efficiency is higher
  - Less maintenance downtime
  - Kateeva inkjet systems scalable today to G10
OLED TV is the “ultimate display” but cost remains too high!
Kateeva’s RGB Inkjet Printing products will enable low-cost OLED TV
Summary

• Inkjet essential for high-performance, low-cost OLED

• Today’s technology, vacuum evaporation, has reached an evolutionary dead end
  - High Cost: Slow; Many Particle Defects; Low Material Utilization; Poor Scalability; Difficult Maintenance

• Inkjet printing is vacuum’s successor for TFE organic coating and for RGB patterning (our next product)
  - Low Cost: Fast; Few Particle Defects; High Material Utilization; Good Scalability; Easy Maintenance

• Kateeva’s YIELDjet platform realizes the full & superior potential of IJP, providing an ideal mass-production solution for TFE and RGB
Lessons Learned
(And some humble advice for fellow entrepreneurs)
Be Audacious
Solve Difficult (High-Impact) Problems

OLED was invented in 1984. Yet in 2008 the market was still tiny due to high manufacturing costs and low yields.

At the same time, inkjet was considered a loser after failing as a replacement for photolithography for LCD color filter.

So were we CRAZY to start Kateeva in 2008?

After the LCD failure, incremental solutions were not the answer. But if we made it work, inkjet printing would be a breakthrough.

Rebuilding an existing technology from the ground up with a entirely new approach was hard, but that was the answer.
Be Absolutely Necessary To Your Customer

In our industry, the customer is fundamentally risk averse.

You had better be solving an “impossible” problem.

Just to lower cost a little, or improve specs a little will not cut it!

Would you risk a 1B+ USD FAB investment on a new company’s “bright idea” if you had an alternative?

Probably more than anything else, our success has come from helping customers solve core problems with no other solutions; that’s why they are willing to take a risk on Kateeva.
Persevere
Never Stop Fundraising

2008-2016 was a very bleak funding environment for science-based hardware startups.

But the capital is there.

It was not easy, but we found the $200M we needed.

First, look for “Patient Capital”
Kateeva’s first (and enduring) investors always had a keen awareness of the $s and timelines required to build a company innovating complex, transformative HW.

Then, go worldwide to find investors with synergistic priorities
Samsung led Kateeva’s Series D round (Sep 2013)
Kateeva’s $88M Series E (May 2016) drew funds from China (where OLED is considered strategic), including money from VCs and electronics giants BOE and TCL.
We started with one idea for our first product. But we pivoted rapidly when customers told us to focus on a different problem.

TFE was not on our roadmap when we started. But when our customers told us that TFE was the first-priority problem, we wasted no time in aggressively changing course.

Thus, the YIELDjet FLEX became Kateeva Product #1.

Product #2 will be a YIELDjet system for RGB OLED.

A small company’s greatest strength will always be its agility. And the best pivots are about responding to your customer.
Social Capital Is Developed In The Darkest Times

Our Culture develops Social Capital. Shared values and understanding, trust, reciprocity, and cooperation with a sense of mission. We always know “why” we do what we do.

This trust makes conflict safe, more vigorous and open. For a young company that routinely confronts risk and change, this kind of social capital catalyzes innovation.

Social capital is a strong ally in times of high stress – your team stays with you, protecting core expertise and know-how.

And in good times it’s a talent magnet.
Be Humble
Clearly Distinguish Between Brains And Luck

Introducing an industry-leading product can give one a big head. But you need some luck along with the hard work.

Example: Our TFE product came to market so quickly because the customer already had an ink material ready.

The instant retrofit onto our inkjet was luck. But we were prepared because of the 6 previous years we’d spent developing our inkjet platform (for another application).

Louis Pasteur: “Luck favors the prepared mind”. Recognize and acknowledge the lucky shifts. This keeps us humble.

And reminds us: without the customer we would not exist.
Resist Urge To Over-Promote

Achieving technical breakthroughs and enabling dramatic technology transitions is cause for celebration. But over-promoting can hurt you – creating distraction, wasting money, and angering customers or partners.

Kateeva employs PR solely to support key business objectives, like driving sales, boosting valuation and recruiting top talent.

We focus our PR on typical items: technology innovation and leadership; product positioning and branding; customer messaging; competitive positioning, and executive leadership. But we scrutinize every PR action to ensure that it’s necessary and maps to a clear business objective.
Inflection points: Expand Team And Seek Help

Fall 2013:

Beta projects confirm inkjet as winning solution for TFE. Sets inkjet on runway for take off. Kateeva needs to transform itself FAST from R&D to full commercialization.

Kateeva Co-Founder & CEO (me) spearheads search to replace himself with an experienced executive to build the sales/support organization and take over fund-raising and finances.

I put all my focus on driving the internal operational transformation and further building out the team.

This felt risky at the time (even though our rationale was sound). In retrospect, it was essential. When it’s time to execute, don’t let fear or pride prevent you from getting help when the job is too big (or stretches too far beyond your core competencies).
When Building Your Dream Team
Look For Shared Vision And Shared Culture