Commercializing Advanced Science and Technology in Oregon

Robert D. “Skip” Rung, President and Executive Director
Cindy Dahl, VP Operations
Jay Lindquist, Director, Commercialization
Len Blackstone, Director, Technology Labs

collaborative research | technology labs | commercialization
Self-Introduction: Skip Rung

BSEE and MSEE Stanford, 1976

25 years Hewlett-Packard R&D management (semiconductors, inkjet printing, new business)

Co-founder (with UO & OSU) of ONAMI; President and Executive Director

Technical advisor: NW Technology Ventures

Member: Oregon Angel Fund (2012-2014)

Executive Committee and member: Willamette Angel Conference (2010-2014), 2015 Fund Manager

Member: NSF SBIR Advisory Committee
Mercedes Benzene
Agenda

- Oregon’s Signature Research Strategy
  ONAMI case study
- ONAMI Commercialization Gap Fund
  Selected examples
- Funding for commercialization and startups
- Discussion
Signature Research Center Investment Formula

OECD 2002 Study Conclusion: “Multi-scale materials and devices”

Nanoscience & Microtechnologies
Oregon High Tech Manufacturing

Word-leading Industry Assets
Silicon Forest: Hillsboro, Beaverton
WW “Nano Central”?

Intel
FEI
ESI
Triquint
IDT
Genentech
Solarworld
Acrymed
NexPlanar
Voxtel

many more..
Mass production of nano-engineered materials, devices, and systems is being pioneered by the IC industry.

Intel trigate structures for the 32nm and 22nm nodes (left – x-cross section, right – y-cross section). SiGe raised source/drains with strain enhancements in the channel.
TEM, SEM, FIB
Corvallis – HP, microtech cluster
Printing, MEMS and Printed/Molecular Electronics

40nm x 40nm molecular Switch memory devices

www.hpl.hp.com
“Qdots”
If Avogadro calls, tell him to leave his number...
Identified Research Strengths

• **Microtechnology-based Energy and Chemical Systems**

• **Green Nanomaterials and Nanomanufacturing**

• **Nanolaminates and Transparent Electronics**

• **Nanoscale Metrology and Nanoelectronics**
Example of how this is intended to work:

center for sustainable materials chemistry

sustainablematerialschemistry.org
Measuring Success

Look, Mom! Carbon Tetrafluoride!

Report Card

C  F

A  F

History  F

Chemistry  F

Algebra  F

Physical Ed  F
Three-Part Model and Metrics

1. Grow technology and talent at research universities
   • **METRIC:** Federal and private awards and contracts

2. Support research collaboration, industry and start-ups
   • **METRIC:** Number of external clients and revenue

3. Attract capital to Oregon start-ups via a professionally managed commercialization gap fund
   • **METRIC:** Number of FTE employed, leveraged capital investment and grant dollars

State of Oregon Investment in ONAMI:
$53M to-date ($20M capital, $34M operating)
PORTLAND STATE UNIVERSITY ➞ PORTLAND

1. Center for Electron Microscopy and Nanofabrication (CEMN)

OREGON STATE UNIVERSITY ➞ CORVALLIS

2. Electron Microscopy Facility (EMF)
3. Electron Microprobe Laboratory (EMP)
4. Microproducts Breakthrough Institute (MBI)
5. Material Synthesis and Characterization Facility (MaSC)
6. Applied Magnetics Laboratory (AML)

UNIVERSITY OF OREGON ➞ EUGENE

7. Center for Advanced Materials Characterization in Oregon (CAMCOR)
SERVICE BUREAU LABS
You can have one-of-a-kind access to cutting-edge instruments and technical experts at Oregon’s top research universities.

Center for Materials Characterization in Oregon (CAMCOR)  Electron Microscopy Facility (EMF)  Electron Microprobe Laboratory (EMP)  Center for Electron Microscopy and Nanofabrication (CEMN)

COLLABORATIVE RESEARCH LABS
Partnership opportunities abound for groundbreaking research and innovation.

Microproducts Breakthrough Institute (MBI)  Applied Magnetics Laboratory (AML)  Materials Synthesis and Characterization (MaSC)
Agenda

Oregon’s Signature Research Strategy
ONAMI case study

ONAMI Commercialization Gap Fund
Selected examples

Funding for commercialization and startups

Discussion
There are really TWO gaps:
1. Technology/product maturity
2. Transition from Technology Push to Market Pull
Entrepreneurs in Residence

• Veteran CEOs

• Team, Network, Market and Sales Assistance

Augie Sick
Chemistry
Nanomaterials
Life Science

John Brewer
Semiconductors
Electronics
Optics

Michael Tippie
Biomedical
Pharma
Nanomedicine
Advanced Materials
Amorphyx
CSD Nano
Dune Sciences
Inpria
Microflow CVO
OnTo Technology
OrCal
Pacific Light Technologies
QE Chemical
Voxtel Nano/SEMI
Supra Sensor Technologies
(Diatomix)

Energy
Applied Exergy
Element One
Energy Storage Systems
Mtek Energy Solutions
NWUAV
Perpetua Power/Thermogen
Polaris Battery Laboratories
Trillium FiberFuels

Water
Crystal Clear Technologies
Mtek Desal
Puraiytics
ZAPS Technologies

Bio and Health Care
(Artielle)
Cascade Prodrug
DesignMedix
Floragenex
Flash Sensor
Home Dialysis Plus
Northwest Medical Isotopes
NemaMetrix
PDX Pharma
Valliscor
Tomegavax
(Stratus)
(AbSci)
(Neuramedica)

>$190M leverage to date

281 FTE estimated job impact

20 of 33 ONAMI Gap Fund Portfolio Companies have been SBIR/STTR Awardees
Selected Portfolio Company Examples
Applications

Display Backplane TFT Materials

Lithography Materials

Thin Film PV

Materials And Processes

Printed Electronics & Lighting

Window Coatings
Inpria raises another $1.57.3 million for new semiconductor production technology

This time, though, it's arriving four months after Inpria's big industry financial partners. Samsung Venture Investment Corp., Intel Capital and equipment maker Applied Ventures put $7.3 million into the Corvallis company in February.
REINVENTING THE DISPLAY BACKPLANE THROUGH ELIMINATING SEMICONDUCTOR CONTENT
SIMPLIFYING MANUFACTURING, REDEFINING COST
ADVANCING ULTRA-HIGH RESOLUTION, INCREASING ENERGY EFFICIENCY, INTEGRATING TOUCH, AND ENABLING FLEXIBLE SUBSTRATES

OUR MISSION
Amorphyx is an innovator at the intersection of materials science and electronics for the display market. We leverage our expertise in amorphous metals and the creation of high-quality thin films in developing the Amorphous Metal Nonlinear Resistor (AMNR) device, subpixel circuit, and PECVD-based manufacturing process. The AMNR simplifies backplane processing and reverses the trend of increasing display complexity and cost.

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+1.503.453.2765
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Amorphyx
Simple. For a Change.

Complexity
Backplane
Increasing
a-Si LTPS IGZO

SIMPLE DEVICE HIGH PERFORMANCE
LOW COST FLEXIBLE TOUCH
Amorphyx Overview

• Breakthroughs in manufacture and use of amorphous metals
• Revolutionize manufacturing of flat-panel display backplanes while enabling the future of flexible displays

Replaces complex Thin Film Transistor with simpler Amorphous Metal Electrode Thin Film Diode

Roughly 3x capacity increase in TFT Array manufacturing facilities using existing tooling

• License AMTFD Process into FPDs
• Develop Reference Plant for Flexible

Convert $Bs in annual FPD industry losses into profits by redefining backplane manufacturing throughput

Generation 8 glass panel patterned with six backplanes for 52” Samsung televisions. Previous generation glass panels are seen to lower left.
Why Energy Storage?
- Peak period energy costs are 400% higher than low-cost nighttime rates in many areas.
- $7.5B market for energy storage in California.

The ESS Advantage:
- Reduce electricity expenditures by 33%.
- Increase energy reliability and maintain operations through power outages.
- Fully amortized system cost of $270/kWh vs. >$1000/kWh for commercially available systems.

$1.725 ARPA-E SBIR Awarded August 2, 2012
$3.5M Series A financing, March, 2015
SSL Bulbs Today Reduce Electricity Usage by:
• 80% vs. Filament Bulbs (But initial price is 2-3x too high)
• 10-20% vs. Florescent (Not sufficient)

PLT’s High Efficiency QD Down Converters Will:
• Reduce Cost by Reducing Number of LEDs (20-50%)
• Reduce SSL “Florescent” Electricity Usage by another 20-50%
• Improve Stability of Color (no objectionable CFL color “shifts”)

Pacific Light Technology
*efficient lighting through engineered nanomaterials*
* Moth-eye structure (<100nm) with polymer hard coat

* Average 5.85% increase across 400nm-750nm
  (3rd party measured, 12 Eagle 2000 solar cover glass)

* Excellent broadband and angle of incidence performance without extra film layers

Percent Transmission (%T)

100% is PV cell with no glass cover, ATSM 1.5 curve normalized
**Tri-Optical:**
The LiquID™ made by ZAPS Technologies, Inc. is the only early warning system that can apply a variety of analytical techniques; absorption, fluorescence and reflectance measurements, with the same machine. The LiquID™ uses novel flow-cell and optical arrangements to manage the light more efficiently than any other optical detection system. This patented innovation together with its unique analytical capabilities makes the LiquID™ a powerful event detection system.

**Multi-Parameter:**
LiquID™ optically monitors diverse processes from drinking water to waste and industrial fluids. ZAPS Technologies' patented Multi-Parameter Technology™ allows for real-time measurement of numerous fluid quality indicators in a single station.

**Real-Time Detection, Analysis and Control:**
The LiquID™ system is accessible via a web-based user interface allowing for a comprehensive view of the entire region. A layered Observation system such as Regional, System, Site, Machine, Parameter, diagnostic, calibration and even control activities can be observed and acted upon from anywhere in the world.
Award-Winning Power Pucks®

Life-long, renewable battery for powering Wireless Sensor Networks

• Renewable energy from waste heat
• Eliminates batteries
• Like a battery – constant voltage
• Easy installation
Mission Statement: To be the world’s premier producer of fluorinated intermediates for pharmaceutical and specialty chemical applications.

Value Proposition: Valliscor has invented a process for the production of bromofluorohydrocarbons (BFC’s) of significant industrial utility that is cost efficient and minimizes waste and highly reactive impurities. The lead compound in this process for Valliscor is bromofluoromethane (BFM).

<table>
<thead>
<tr>
<th>Metric</th>
<th>Valliscor</th>
<th>Competitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single step</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>No toxic waste</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Avoids problematic methyl bromide impurity</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Low raw materials cost</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Small physical footprint</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Rapid response to market demand</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>High operating margins</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>BFC / Custom synthesis synergy</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Cash flow positive after first BFM sale</td>
<td>Yes</td>
<td>N/A</td>
</tr>
</tbody>
</table>

BFM is used to make fluticasone propionate - with $8B in sales as the active ingredient in Advair® and Flonase®.

Please contact Rich Carter for more info:
4033 NW Princess St
Corvallis, OR 97330
Tel: 541-250-9034
Email: rich.carter@valliscor.com
Concept Works: We are already delivering the highest purity material on the market in kilogram levels to customers.

Our Site: We are located in the Microproducts Breakthrough Institute on the Hewlett-Packard Campus in Corvallis, OR.

Future Directions: We are actively working towards expanding manufacturing capacity and broadening our product portfolio. We view bromofluoromethane (BFM) as an entry point for the broader bromofluorocarbon (BFC’s) market. BFC’s are widely used in the pharmaceutical, agrochemical & polymer markets. We see significant upside potential for this business model.

The Team:
- Rich G. Carter, Ph.D. (Co-founder and CEO) Current Professor and Chair, Department of Chemistry, Oregon State University. Expertise in multi step organic synthesis and reaction development.
- Mike Standen, Ph.D. (Co-founder and COO) Currently Chief Technology Officer at Lacamas Labs. Formerly Director of Technology, Synthetech, sold to W.R. Grace.
- Raj Lingampally, Ph.D. (Employee #1, Lead Scientist) Currently Research Associate, Rich G. Carter laboratory, Oregon State University.
Products & Services

Photodetectors and Detector Arrays
- InGaAs (InAlAs/InP) PIN and APDs
- Silicon

Photoreceivers and Rangefinders
- InGaAs PIN and APDs
- Integrated uLRF Receivers
- uLRF ROICs

Readout Integrated Circuits (ROICs) & Focal Plane Arrays
- Radiation Hard Silicon Imagers
- Wavefront Sensors
- Active/Passive Imagers
- LIDAR/LADAR sensors

Photon Counting Detectors and Instruments
- InGaAs linear mode and Geiger mode (GM) APD
- Silicon GmAPD and SiPM
- Time-of-flight (TOF) ROICs and electronics
- Photon Counting and TOF ROICs
Shoei Electronic Materials, Inc. is a provider of tailored nanocrystalline quantum dots (NQDs) and nanoparticles (NPs). We provide high quality, mono-disperse NQDs and NPs that are tailored to meet our customers’ specifications. Using our proprietary processing capability, we produce these custom materials at low cost with high batch-to-batch reproducibility.

**Areas of Expertise:**
- **Photophysics:** active/passive materials
- **Surface Modification:** ligand chemistry
- **Materials Development:** novel materials and optical properties
- **Matrix Incorporation:** films, solvents and polymers

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Shoei Electronic Materials, Inc. tailors nanoparticles, through manipulation of the core material, shell configuration, and surface modification to meet our customers’ requirements and to enable use in specific applications with improved performance:

- **Displays:** enhanced color, reduced cost of fabrication, increased lifetime.
- **Photovoltaics:** flexible form factor, enhanced absorption, reduced energy losses.
- **Security:** increased complexity of information input, increased security and product protection.
- **Thermoelectrics:** ease of production/manufacture.

SHOEI Electronic Materials
We create solutions for your unique application
I LOST AN ELECTRON!

ARE YOU POSITIVE?
LEDs excite a nanotechnology coated mesh which destroys germs and chemicals

4 Patent Apps Filed, 3 Grants, Field tests successful
The “Field Nutrient Sensor™” (FNS™) approach allows for a snapshot of the current nitrate levels in a field, and works in tandem with current soil moisture probes. Our N-measurement modules communicate wirelessly with the existing network, and report nitrate-N on demand (up to 200 times a day) for the duration of the growing season. This autonomous measurement of field-moist soil avoids the need for expensive and time-consuming soil sample collection, and enables data-guided fertigation.
Need, Market, Opportunity and Impact

**Need:** Today’s tools leave a large gap between testing and actionable data in monitoring the 12.29M tons of nitrate fertilizer applied annually in the US. Growers need precise reports of nitrate levels in order to optimize farm efficiency in input, labor and regulatory costs

**Value Proposition:** Wireless, *in-situ* monitoring of nitrate in soil with accuracy equaling standard laboratory testing

**Market Opportunity:** Decreasing the 30% of wasted fertilizer input on our 442M acres of farmland would save growers an average of $8/acre

**Impact:** Mitigation of water quality degradation in lakes, streams and oceans, and increased cost of living due to rural well-water fouling due to nitrate non-source point pollution

Technology and IP Position

**Technology Description:** The core technology is a chemically-modified field-effect transistor (CHEMFET) sensor incorporating a novel, patent-protected nitrate-selective receptor. The sensor is enclosed in a wirelessly reporting module that can be housed in existing soil moisture monitoring probes.

**IP Position:** There is an issued patent that covers the innovation in this technology SupraSensor has an exclusive license to this and future related patents.

Company and Business Model

**Company:** SupraSensor Technologies is a start-up company formed for the commercialization of this University of Oregon-held intellectual property. The company was started through the NSF Innovation Corps program at Stanford University, where they won “Best Team”.

**Business Model:** SupraSensor Technologies will develop, manufacture and sell *in-situ* sensor components and systems business to business with an eye on future home and garden, drinking and wastewater markets.

**Objective:** SupraSensor is seeking additional partners for integration and manufacturing scale-up of this Oregon-based technology venture.
Agenda

- Oregon’s Signature Research Strategy
  ONAMI case study
- ONAMI Commercialization Gap Fund
  Selected examples
- *Funding for commercialization and startups*
- Discussion
Early Considerations

- Protect intellectual property, get IIP help
- Define first market opportunities (TAM, SAM, specific customers)
- Networking: begin relationships with those who may fund you or may join your team
- “Business model” and detailed financial assumptions
  - Key to understanding and selling your business

* http://www.pdx.edu/research/innovation-intellectual-property
Non-dilutive funding

- University resources: UVDF, core facilities, interns, etc.
- Business plan competitions
- STTR, SBIR grants (NSF, NIH, DoD, DoE etc.)
  - Not the same thing as “more funding for my research”
- Signature Research Center (ONAMI, BEST, OTRADI) commercialization gap grants or in-kind assistance
  - Leveraged private investment and Oregon job creation expected
- Sales/customer funding
Basics for an “Investable”* Business

- **Market opportunity**
  “I look at the last page first, if the numbers are big, I read the rest of the plan”

- **Winning and unique product**
  “Game changer” required to start. Manage risk from there.

- **Management Team**
  - “Given the choice between an A idea with a B team and a B idea with an A team, I’ll pick the A team every time”

- **Financial return to investors**
  - “How do I get my money back – with an acceptable risk multiple (e.g. 10x)?”

*Most new businesses aren’t in this category, which means they must self/family/friend-fund to viability, after which lower risk bank financing may become possible*
Early stage investment sources

• “Skin in the game” – time and money
• 3 F’s: Family/Friends/Fools
  • be careful about downstream complications
• Angel Investors – product completion and early business growth, not research
  • OEN, Willamette, Bend angel conferences
  • Portland Seed Fund
  • Oregon Angel Fund – largest early stage investor in OR
  • Super angels
• Venture capital firms – generally prefer to fund business growth, not product development
• Key issues: valuation, control, investor exit, liquidation preferences
What investors talk about when you are not in the room