

# Entrepreneurship and the Commercialization of University Research in Engineering

University of Michigan, NSF ERC in WIMS  
January 10, 2006

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Mobius Microsystems, Inc.

# Consider...

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## What is the definition of the word engineering?

**engineering, n**

- the practical application of science to commerce or industry

# Consider...

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## What is the definition of the word research?

**research, n**

- scholarly or scientific investigation or inquiry

# Consider...

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## So what is engineering research?

### engineering research, n

- scholarly or scientific investigation or inquiry into the practical application of science to commerce or industry

# Consider...

## Possible outcomes of engineering research

- Advancement of the field through new discoveries or better understanding of relevant phenomenon
- Determination of concepts, methods, or approaches that have low or little utility (i.e. the null result is a result)
- Determination of concepts, methods, or approaches that have high utility and should be developed for widespread use (i.e. commercialization)

**Engineering research and commercialization are inextricably linked**

# Outline

## About Mobius Microsystems, Inc.

- Technology overview
- History

## New Venture Development

- Overview
- Prototype development, IP protection and licensing, business planning
- Where to begin and university resources
- Challenges

## New Venture Spin-out

- Financing and fundraising
- Infrastructure development and recruiting, M&S for a new technology
- Challenges

## Closing Remarks and Advice

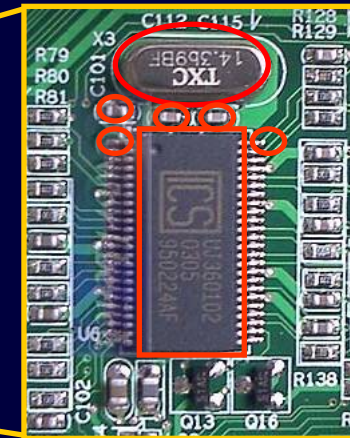
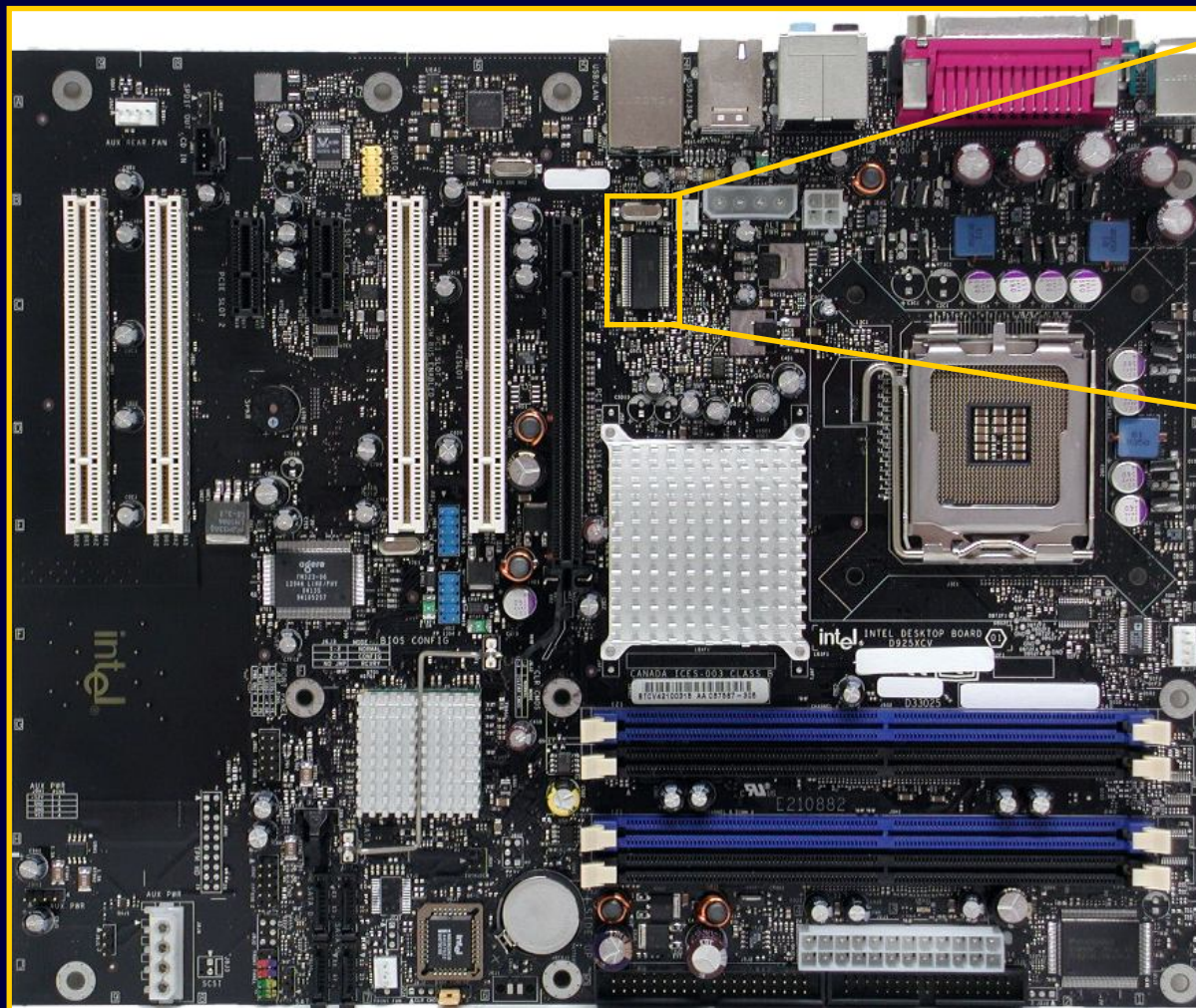
# About Mobius Microsystems, Inc.

# Technology Overview

**Mobius Microsystems (Mobius) is a semiconductor component and IP company specializing in clock/timing products**

- Flagship technology is high accuracy and low jitter all-Si clock/timing integrated circuitry in standard CMOS
- Tech. based on research in the UMICH NSF ERC in WIMS
- 1 patent issued and 6 pending
- Full custom IC design center in Detroit, MI
- Management, governance, and technical M&S in N. CA

# Entrenched Technology in Typical Application



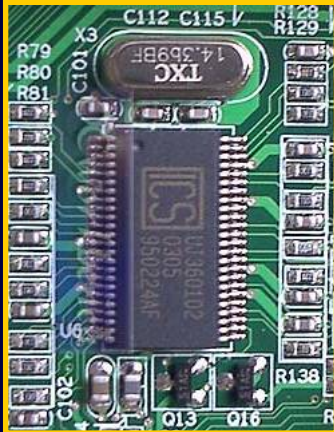
## Master Timing Socket

- ICS95022
- 14.318MHz XTAL
- 2 dedicated pins
- 2 capacitors
- 1 precision resistor
- 5 insertions
- $\pm 300$ ppm accuracy

Intel 925 PC Motherboard

# Entrenched Technology vs. Mobius' Technology

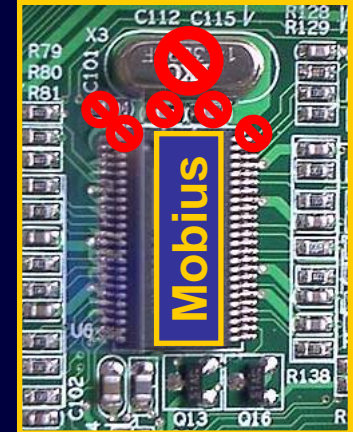
**ICS  
Master  
Timing Clock**



Obviously valuable, but can Mobius demonstrate the required signal integrity without the external frequency reference?

**YES**

**Mobius  
Master  
Timing Clock**

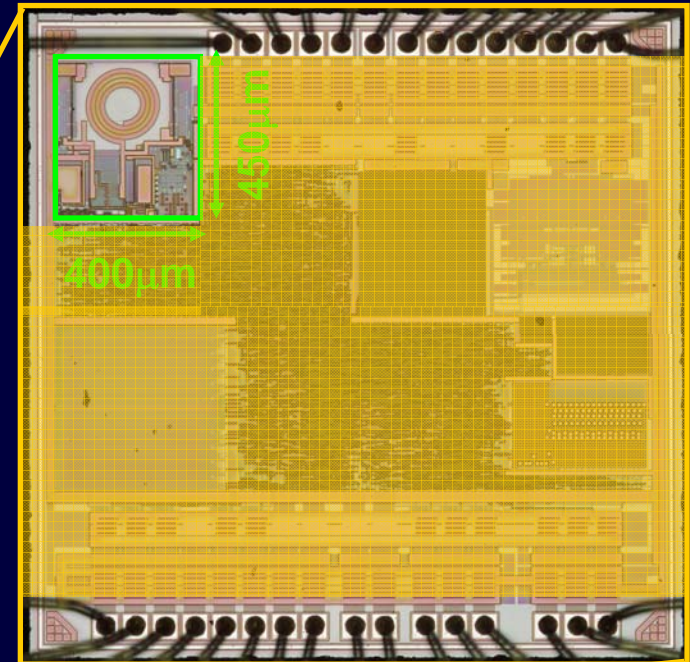


## Mobius all-Si clock generation technology...

- eliminates the XTAL, but retains the required accuracy (as low as  $\pm 150\text{ppm}$ )
- eliminates 2 package pins, 2 capacitors, 1 precision resistor, and 5 insertions
- enables clock start-up latency and scaling in ns, not ms
- can serve applications in harsh environments (high  $T$ ,  $G$ , etc.)

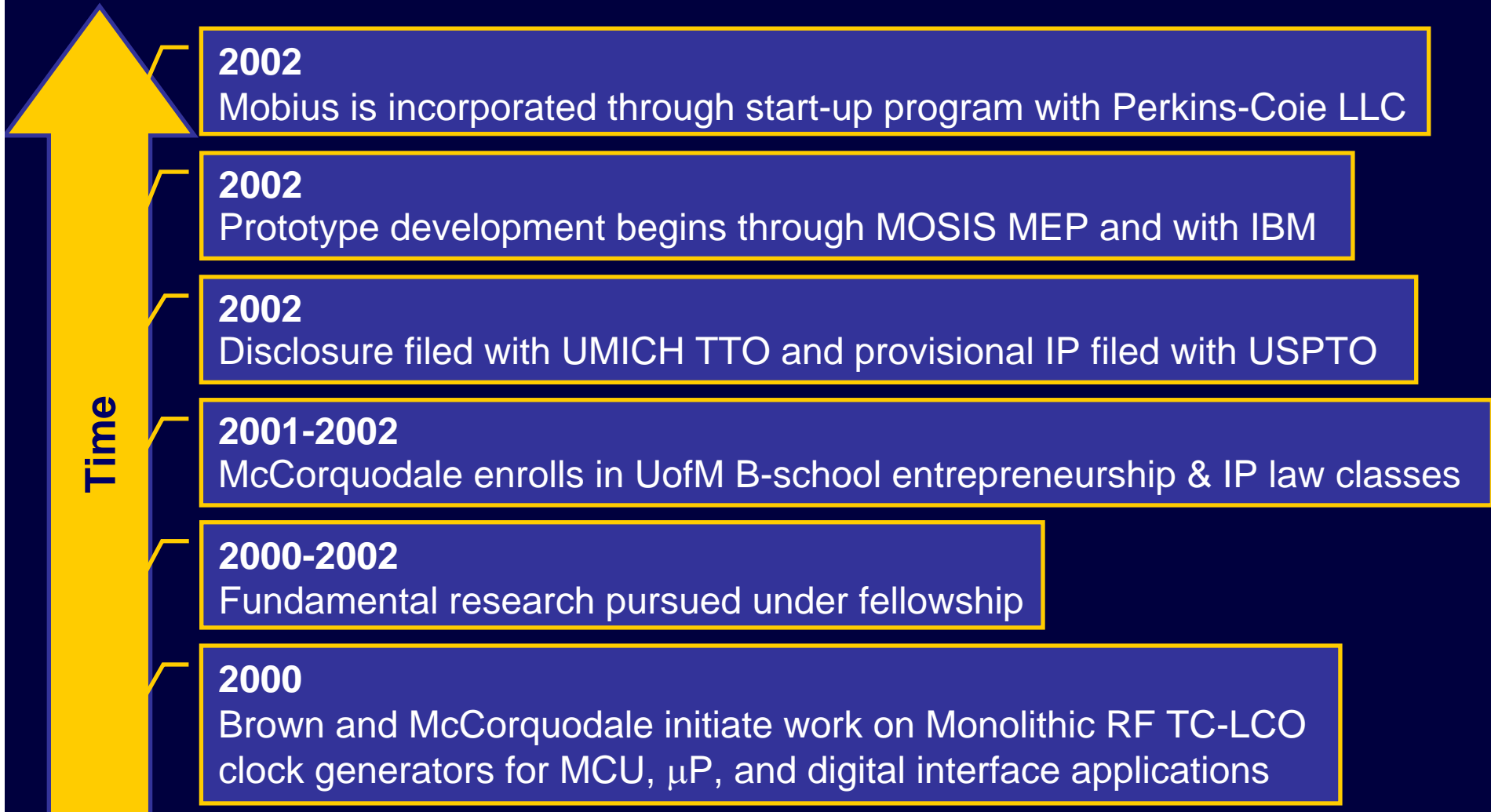
# Mobius Technology

- USB to RS-232 bridge controller for cables and thumb drives
- Mobius replaced the XTAL + PLL with an all-Si clock generator and reduced the clock module cost to pennies and size by over 1,000X
- 2M units/month

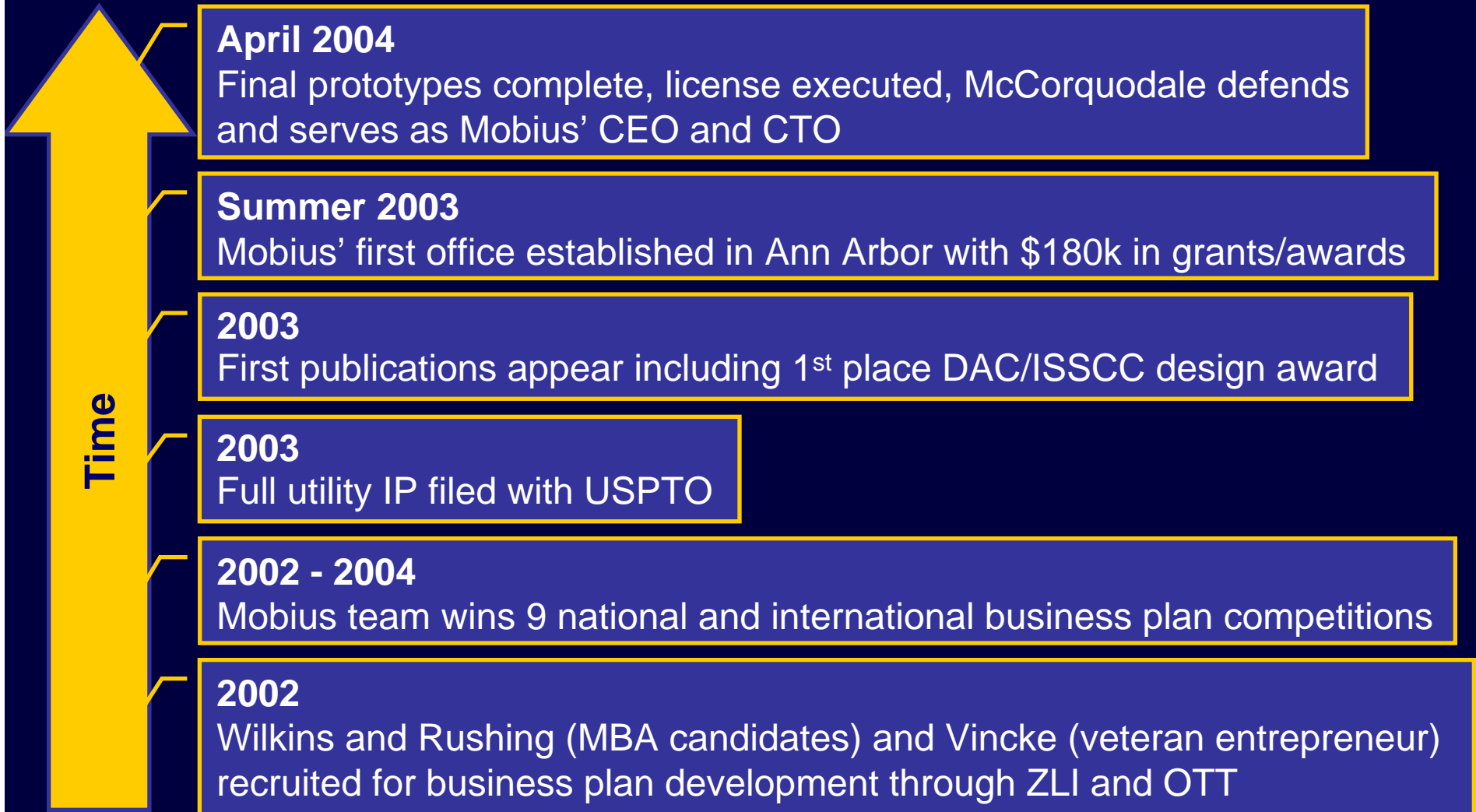


- Mobius is the first to build a USB-compliant all-Si clock
- 0.18mm<sup>2</sup> in 0.35μm CMOS

# History of Mobius



# History of Mobius



# History of Mobius



# History of Mobius

Time

**January 2006**

New members of Mobius' management team hired for next phase

**January 2006**

Mobius' 1<sup>st</sup> customer moves to high volume production

**November 2005**

Mobius raises \$8.1M from tier-1 Si Valley VCs (Foundation and Menlo)

**November 2005**

Mobius 1<sup>st</sup> customer begins sampling of new product in prep. for production

**April-August 2005**

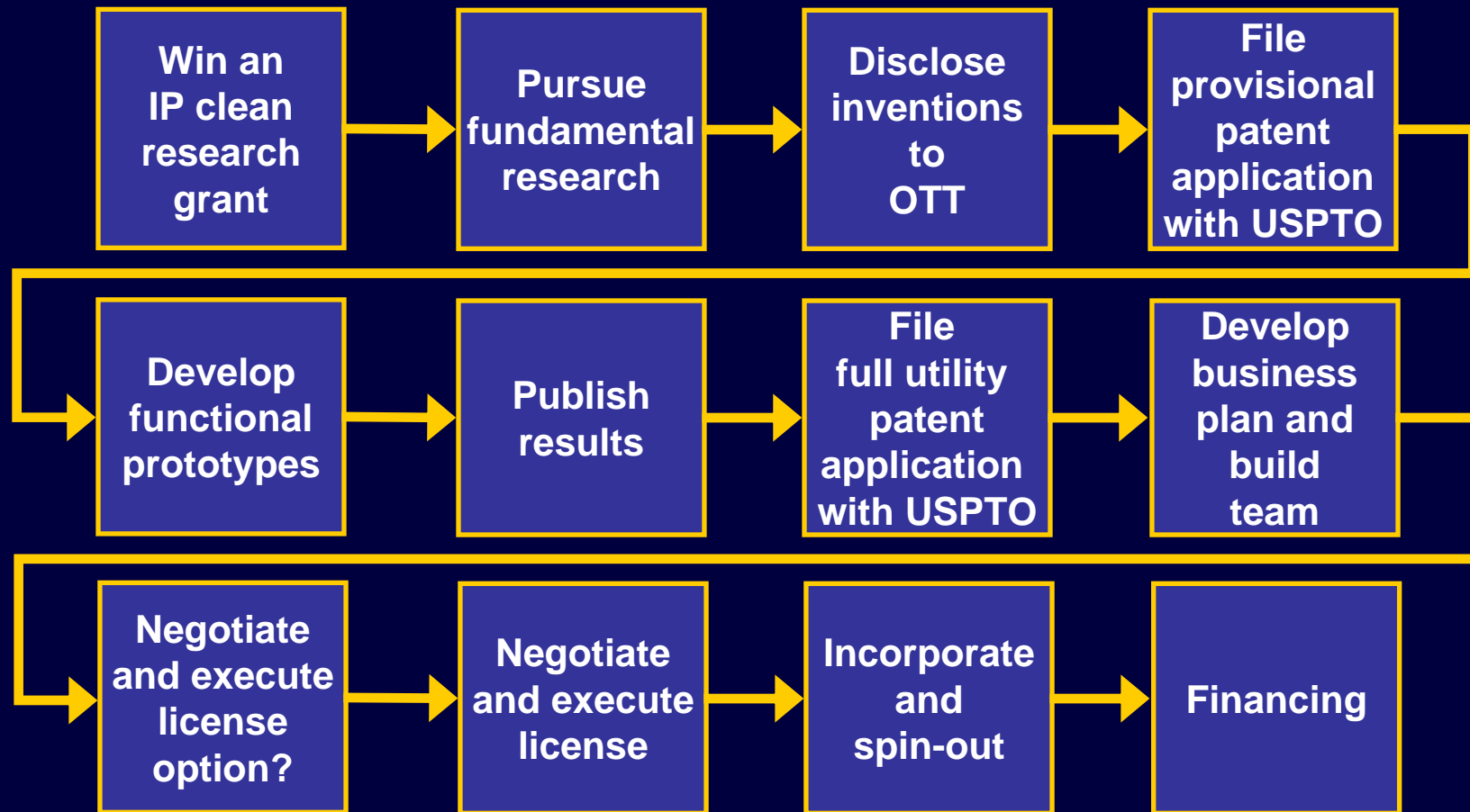
Mobius closes \$1M in additional angel and local VC investment

**August 2005**

Mobius 2<sup>nd</sup> customer project a success and moves to next phase

# New Venture Development

# Overview



Michael S. McCorquodale and Richard B. Brown, "Academic and Professional Resources for Student-Led Technology Ventures," *IEEE Antennas & Propagation*, vol. 46, issue 4, Aug. 2004.

# Prototype Development

**For any venture to be financed from university research the technology must be demonstrable**

## Prototype development pertinent to WIMS

- Prototypes from the MNF
- MOSIS MEP

## Grant programs funding prototype development

- Engineering Technology Development (GAP) Fund
- Office of the Vice President for Research (OVPR)

# IP Protection and Licensing

## Patent application overview for the researcher

1. File formal IP disclosure with OTT
2. OTT reviews interest in IP (e.g. is there a corporate or start-up licensee for the technology?)
3. Work with university IP attorney to develop and file provisional or full utility application with USPTO
4. File with PCT and choose nationalization strategy
5. Wait for review, amend claims, resubmit
6. USPTO grants patent to research institution
7. Research institution can license IP (Bayh-Dole Act, 1980)

# IP Protection and Licensing

## Patent licensing overview for the entrepreneur

- License option
  - Licensee is granted limited time rights to IP for exploratory purposes
  - IP unavailable to other interested licensees during option period
  - Licensee has “option” to execute formal license
- License
  - IP is licensed to a specific company under a specific set of terms
  - Terms vary from agreement to agreement

**A business plan is required for any license**

# Team Building and Business Planning

## Difficult to move a venture forward without a team

- Faculty + student
- Researcher + local professionals
- Leverage resources and network to source teammates
- Mobius sourced local professionals through OTT and MBA students through ZLI, business development courses, and MBA student groups

## Business planning

- Technology venture concepts can be presented to MBA students in business plan writing courses for development
- For students, business plan competitions provide an excellent resource for deadline-oriented plan development and critical feedback (e.g. local competitions include GLEQ and Pryor-Hale)

# Where to Begin and University Resources



## Office of Technology Transfer

- IP development support
- Business development support
- Grants: GAP, OVPR, MUCI, MI TTC
- Licensing



## Zell Lurie Entrepreneurial Institute

- Prep./sponsorship for business plan competitions
- MBA internship program (Marcel Gani)
- Business development support
- Dare to Dream grant program
- Pryor Hale, Michigan Innovators competitions

# Academic Courses

## UMICH Ross School of Business

- 23 entrepreneurial courses
- Business plan writing course particularly useful
- Entrepreneurial Multidisciplinary Action Project (EMAP)

## UMICH CoE

- No courses on entrepreneurship for graduate credit
- Challenges electing business school courses
- EECS 495: Patent Fundamentals for Engineers

# Student Organizations

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## UMICH Ross School of Business

- Entrepreneur and Venture Club (EVC)
- High Tech Club (HTC)
- Wolverine Venture Fund (WVF)

## UMICH CoE

- Michigan Entrepreneurs (UME)

# Challenges

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## The UMICH CoE...

- does not have academic offerings in entrepreneurship
- does not have student-led organizations in entrepreneurship
- is decoupled from the UMICH Ross School of Business
- does not have an entrepreneur-friendly culture
- has a poor track record in research commercialization
- does not have access to sufficient professional business development resources

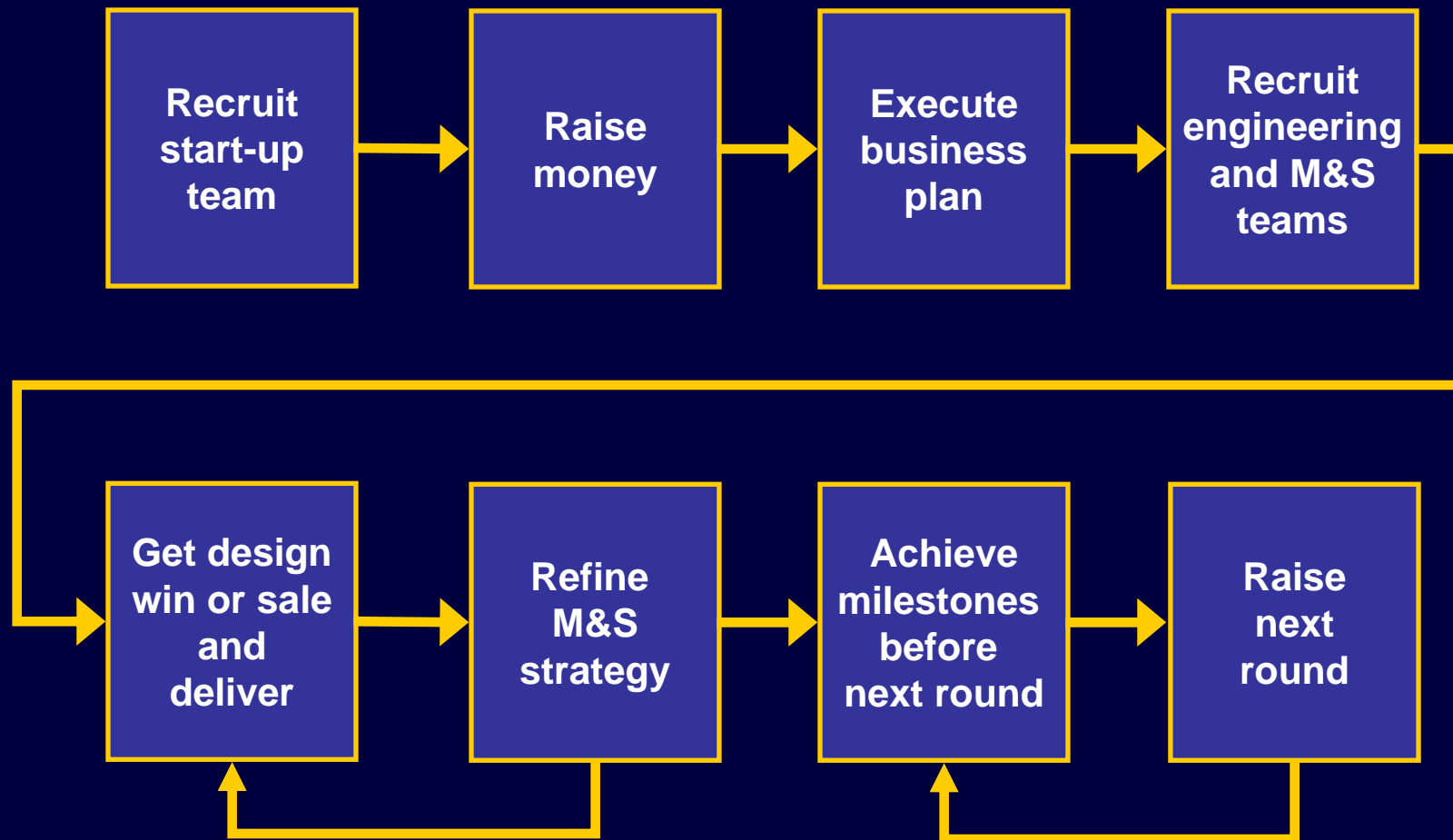
# Addressing Challenges

## The UMICH CoE...

- students can drive demand for better access to entrepreneurial education and resources
- can create organizations or leverage existing organizations
- can work more closely with the Ross School of Business
- students and faculty can improve the entrepreneurial culture
- can focus faculty searches on those with entrepreneurial experience
- can develop incentives for faculty and students to pursue entrepreneurial interests

# New Venture Spin-out

# Overview



# Non-Equity Financing Sources

## Government programs

### ■ SBIR/STTR

- Grants through federal agencies (e.g. NSF, DoD) for new research only
- 2-phase award (~\$100k + ~\$1M) with long review cycle
- Marginally successful
- Decreasing in popularity with both legislators and awardees

### ■ Congressional “Defense adds”

- Direct additions to defense budget for any project
- Requires direct lobby in D.C. to congressional representative and senators
- Requires a defense agency champion; not a review process like SBIR
- Amounts to ~\$1-5M “added” as pork to the defense budget
- Now very popular, but award cycle tied to defense budget cycle

### ■ Local loan and grant programs

# Non-Equity Financing Sources

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## Banks

### ■ Collateralized loans

- Must have collateral (unlikely for a new technology venture)
- Difficult to secure loans for high-risk ventures
- Difficult to secure sufficient capital
- Great resource for subsidizing capital equipment expenditures

### ■ Personal credit

- High personal risk associated with default
- For the “confident” or “crazy”; you decide

# Equity Financing Sources

## Private accredited investors or angels

- Difficult to source without close personal relationships
- Substantial legal overhead to manage several individual investors
- Becoming very common (nearly mandatory for technology ventures) as VC moved to later stages post-bubble
- Some now organized into networks (e.g. Great Lakes Angels)

## Professional equity investors

- Venture capitalists
- Private equity funds

# Comments on Financing Sources

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## Non-equity financing

- Government financing cycles are too long and are riddled with red tape
- Bank financing can be difficult and is high risk for the entrepreneur
- Founders maintain ownership of the company, though it may be worthless

## Equity financing

- The typical route for a technology venture
- Amounts to selling ownership of the company to investors

# A Typical Equity Financing Cycle

## Angel and founder round or seed round

- Sources: private accredited investors and founders
- Size: ~\$100k - \$1M
- Typical milestones: development of a commercially viable prototype, customer references or letters of intent
- Goal: attract professional investors

## Series A round

- Sources: professional venture funds
- Size: ~\$2M - \$10M
- Typical milestones: management team, final product development, design wins, first few customers
- Goal: maximize valuation for next round

# A Typical Equity Financing Cycle

## Series B round

- Sources: professional venture funds
- Size: ~\$10M - \$20M
- Typical milestones: Growth, ramp sales rev., increase GM, profitability
- Goals: Ramp sales and possibly achieve profitability

## Series C round

- Sources: professional venture funds and financial institutions
- Size: >\$20M
- Typical milestones: Continued growth and profitability
- Goals: IPO or acquisition

# The Art of Fundraising

## Not all technologies are appropriate for venture backing

- The entrepreneur must determine this prior to proceeding

## Key parameters VCs consider in a new tech. venture

- Proven and demonstrable technology with significant differentiation to entrenched technology (e.g. 10X power, form factor, cost reduction)
- Technology addresses a TAM >\$1B
- Served market is attractive (e.g. large CAGR, not disrupted recently)
- Barriers to entry: Patents, trade secrets, etc.
- Competent or replaceable management team
- Large potential ROI

## Financing decisions are analytical, not subjective

# The Reality of Investment Capital

## <sup>1</sup>Top 10 Colleges of Engineering in the U.S. in 2006

1. Massachusetts Institute of Technology (MIT)
2. Stanford University
3. University of California Berkeley (UC-Berkeley)
4. Georgia Institute of Technology (Georgia Tech.)
5. University of Illinois at Urbana-Champaign (UIUC)
6. University of Michigan (UMICH)
7. University of Southern California (USC)
8. California Institute of Technology (Cal. Tech.)
9. Carnegie-Mellon University (CMU)
10. Purdue University

**3 in the Midwest, 2 in N. Cal., 2 in S. Cal.**

1. "America's Best Graduate Schools 2006," *U.S. News and World Report*, 2005.

# The Reality of Investment Capital

University	Region	CoE Research Expenditures
Stanford	N. CA	\$178M <sup>2</sup>
UC-Berkeley	N. CA	\$110M <sup>3</sup>
<b>Total</b>		<b>\$288M</b>

University	Region	CoE Research Expenditures
UMICH	Midwest	\$132M <sup>4</sup>
UIUC	Midwest	\$214M <sup>5</sup>
Purdue	Midwest	\$130M <sup>6</sup>
<b>Total</b>		<b>\$476M</b>

2. *Annual Report*, Stanford University, School of Engineering, 2005.

3. *Facts 2005*, University of California-Berkeley, College of Engineering, 2005.

4. *Annual Report*, University of Michigan, College of Engineering, 2005.

5. *2005-2006 Guide to Expertise, Programs, Departments*, University of Illinois, College of Engineering, 2005.

6. *Research and Entrepreneurship*, [engineering.purdue.edu/Engr/Research](http://engineering.purdue.edu/Engr/Research), Purdue University, College of Engineering, 2005.

# The Reality of Investment Capital

<sup>7</sup>Total U.S. post-bubble VC investment from Q1/02 – Q3/05  
\$79B and 11,060 deals

<sup>7</sup>Si Valley  
**\$27B** and 3,189 deals

- Emerging  
\$4.86B and 479 deals
- Semiconductors  
\$3.6B and 339 deals
- Emerging semiconductor  
\$686M and 102 deals

<sup>7</sup>Midwest  
**\$2.9B** and 636 deals

- Emerging  
\$473M and 186 deals
- Semiconductors  
\$147M and 41 deals
- Emerging semiconductor  
\$27M and 12 deals

7. "MoneyTree™ Survey," Pricewaterhousecoopers/Thomson Venture Economics/National Venture Capital Association, 2005.

# The Reality of Investment Capital

**7Total U.S. post-bubble VC investment from Q1/02 – Q3/05  
\$79B and 11,060 deals**

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- Emerging semiconductor  
\$686M and 102 deals

**7Michigan  
\$363M and 75 deals**

- Emerging  
\$25M and 21 deals
- Semiconductors  
\$39M and 7 deals
- Emerging semiconductor  
\$2.8M and 4 deals  
(Mobius is \$2M of this)

# Mobius' Financing Experience

## Capital requirements

- Mobius launched in '04 with SIP model to prove tech. on minimal capital
- By '05 Mobius required >\$5M to grow and move to component model

## Midwest investors

- Mobius raised a nearly unprecedented \$2M from over a dozen angels and 2 local VCs (Waypoint and WVF)
- Spoke with nearly every single Midwest VC over 6 mo. and could not raise next round due to size (>\$5M), space (semis.), and stage (early)

## Si Valley investors

- Mobius received multiple term-sheets and raised over \$8M in just a few months after engaging only a few VCs in CA
- Headquarters to move to CA due to recruiting and governance

# Infrastructure and Recruiting

## Office Establishment

- Proper consideration of resources needed and recruiting is mandatory
- Difficult balance between growth opportunities and cash
- Possibly consider some local incubators and accelerators
- Consider local incentives: Mobius only start-up ever to receive MEGA
- Mobius started in Ann Arbor and moved to Detroit

## Recruiting and compensation

- Very difficult to recruit without sufficient capital
- Founding technologists and team likely to be grossly underpaid at first
- Determine capitalization table sooner rather than later
- Mobius hired many personnel already known or referred

# The Art of Securing the First Customer

## Must solve a very “painful” problem

- Mobius’ first customer was won in a bloody price war
- Mobius’ other customers were won with customer’s performance challenges (e.g. power)

## Credibility and transparency critical to tech. M&S

- Competency of the customer’s application builds credibility
- Transparency of the technology provides comfort and increases the likelihood that a customer will take a risk on a small company

# Regional Challenges

## Lack of investment capital

- Only \$25M in MI in emerging business for the past 4 years
- Poor local and state leadership to recognize this as a problem
- Local entrepreneurial initiatives off in tangential directions

## Recruiting

- Difficult to build a management team with tech. start-up experience
- Difficult to recruit engineering talent due to concerns over lack of other local opportunities if the venture fails
- Midwest engineers tend to be risk adverse

# Regional Challenges

## **N. CA is a success as an entrepreneurial region**

- Technology from the East Bay (Berkeley) to the Peninsula (Stanford)
- Financial institutions from SF to Sand Hill Rd.
- Companies throughout the entire region from SJ to SF to Livermore

## **SE MI lacks regional cooperation and proper leadership**

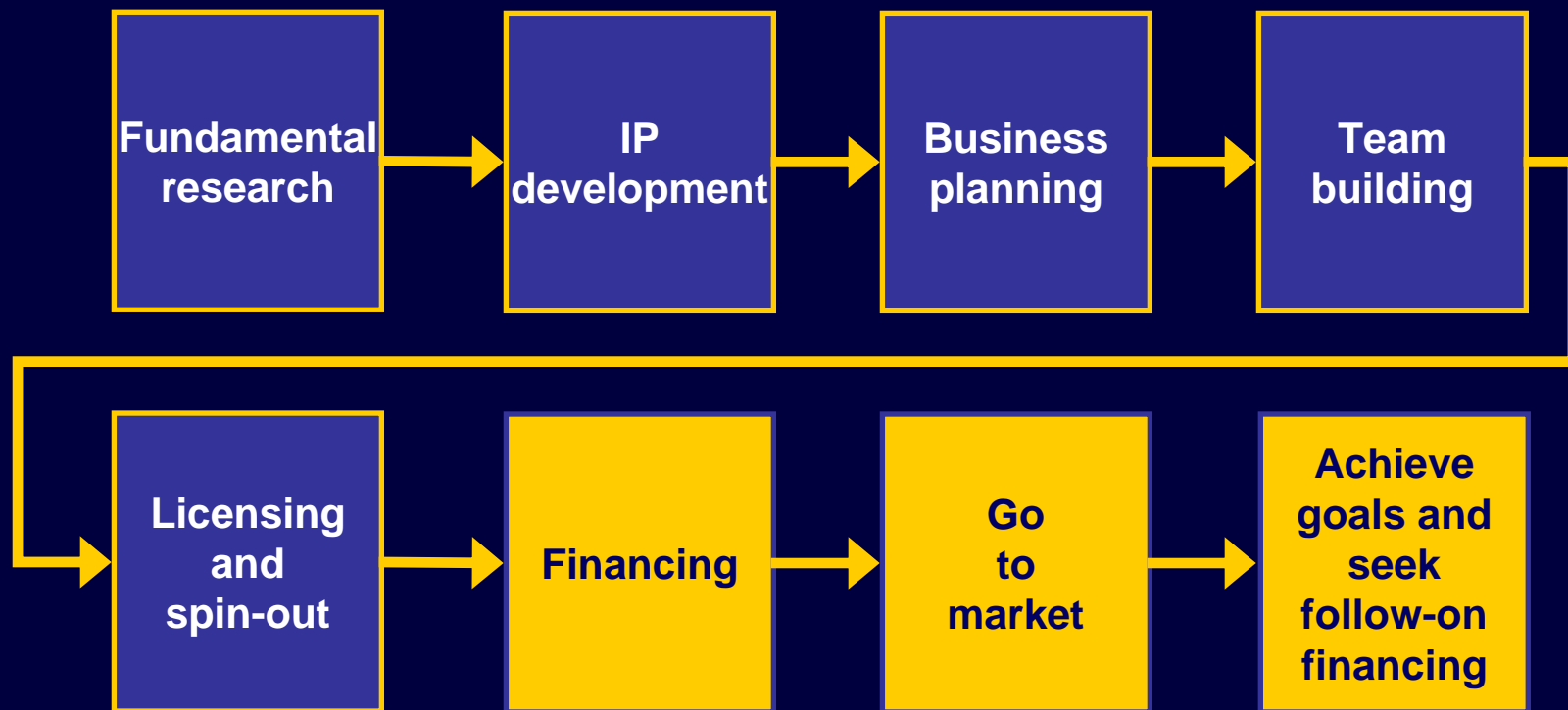
- Ann Arbor: Spark and IT Zone
- Detroit: TechTown
- Oakland County: Automation Alley

## **What SE MI needs**

1. Capital
2. Capital
3. Entrepreneurial leadership from its premiere research institutions (i.e. you)
4. Better leadership that understands the importance of tech. to the economy

# Closing Remarks and Advice

# Putting the Pipeline Together



# Putting the Pipeline Together

**The next  
successful  
technology venture**

# Common Questions

## Was launching Mobius easy?

- It was the hardest endeavor I have ever pursued in my life
- Prof. Brown and others provided endless encouragement
- MI made the endeavor unnecessarily challenging

## Was it worth it? Would I do it again?

- Absolutely; it has been the greatest experience of my professional life

## For what do I aspire in the future?

- That Midwest research institutions (e.g. UMICH, UIUC, Purdue) become synonymous with successful technology start-ups
- That the Midwest becomes a technological leader in the private sector
- That the economies of the great Midwest cities (e.g. Chicago, Detroit) diversify through a focus on new technologies

# Closing Thoughts

## **Commercialization of research is a simple pipeline**

- Follow the protocol, leverage university resources, succeed

## **Midwest entrepreneurs face formidable challenges**

- Large gaps in the commercialization pipeline
- Limited educational and professional resources
- Poor culture and enthusiasm
- Dearth of capital
- Lack of regional cooperation and proper leadership

# Advice

## **Prudent for Midwest entrepreneurs to leave the region**

- Remaining in the region delays inevitable fundraising challenges
- Infrastructure/personnel in the region are expensive/difficult to relocate
- Small workforce with start-up management experience

## **Generally steer clear of local entrepreneurial orgs.**

- For those not in university, education through orgs. may be useful
- Else if it is not helping you raise money or win customers, it is useless
- Stick to UMICH resources: Only CoE, OTT, and ZLI ever helped Mobius

## **MI and Midwest still offer opportunities**

- Cost is substantially lower than VC-rich regions of the U.S.
- Quality of life in Midwest perceived as high
- Large skilled workforce in science in engineering
- Substantial research resources at world class institutions

# Acknowledgements

## **UMICH WIMS Student Leadership Council**

- Ruba Borno
- Neil Welch

## **UMICH Office of Technology Transfer**

- Karen Studer-Rabeler

## **UMICH Zell Lurie Entrepreneurial Institute**

- Dr. Tim Faley
- Prof. Tom Kinnear
- Paul Kirsch
- Tim Petersen

## **Investors**

- Waypoint Ventures
- Wolverine Venture Fund

**Questions welcome**