Mobius Microsystems: A Case Study in the Commercialization of Graduate Research in Electrical Engineering

Michael S. McCorquodale, Ph.D.
Founder and Chief Technical Officer
Mobius Microsystems, Inc.
Sunnyvale, CA and Detroit, MI

14th Annual ASEE Conference & Exhibition, Honolulu, HI
June 27, 2007

Overview

- Motivation
- The Development of *Mobius Microsystems*
  - Technology
  - University incubation and seed financing
  - University spin-out and seed stage execution
- Analysis
- Recommendations
  - Academic
  - Local and legislative
- Conclusions

Mobius Microsystems

Motivation

Motivation

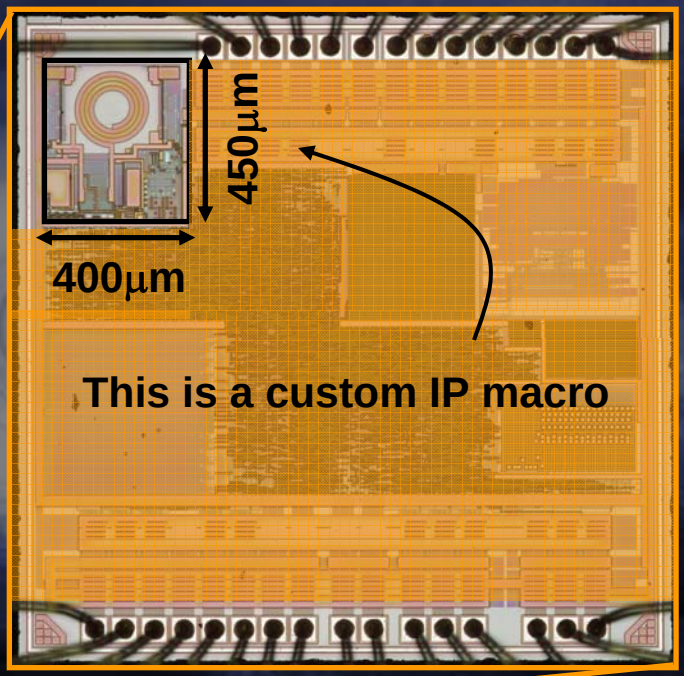
- Bayh-Dole Act of 1980
  - Intellectual property (IP) ownership retained by awarded institution
  - Stimulated technology transfer from academia to industry
- Consequences of the Bayh-Dole Act
  - Tech. transfer centered around IP generating efforts (i.e. research)
  - New tech. ventures typically led by researchers (i.e. IP generators)
  - Tech. transfer can be lucrative for universities, researchers and the local community (though some are better at it than others – why?)
- Status of education in entrepreneurship for engineers
  - Most efforts to date are ad hoc and targeted at undergrads
  - Most do not address the highly linear and analytical sequence of commercializing academic research
  - Most do not address education gaps in commercializing research
- A case study: *Mobius Microsystems*
  - "Start-up" case presented from founding researchers' experience
  - Gaps in engineering education *and* external resources illustrated

Mobius Microsystems

The Development of *Mobius Microsystems*

The Development of *Mobius*: Technology

- *Mobius* is a fabless semiconductor component and IP company specializing in clock/timing products
- Flagship technology: All-CMOS clock generation capable of replacing quartz XTAL frequency references
- IP macro for USB-232 bridge ctrl. shown: shipping @ 200kU/month



[McCorquodale, *et al.*, *IEEE JSSC*, Feb. 2007]

- *Mobius* was the first co. to build a USB-compliant all-CMOS clock
- 9 patents
- 0.18mm² in 0.35µm CMOS

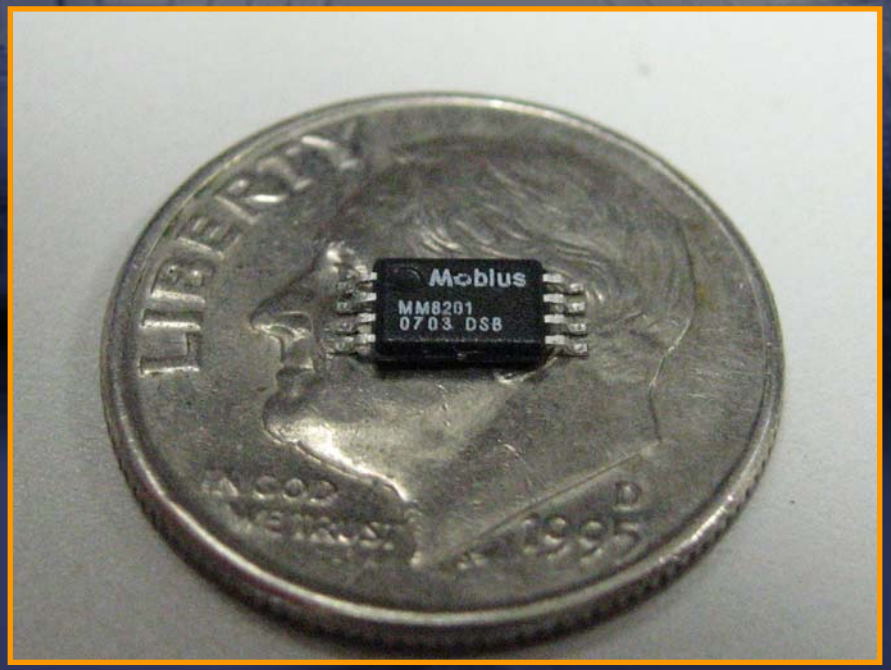
The Development of *Mobius*: Technology

After proven IP implementation, *Mobius* transitioned to component model

Abracon 50MHz 4-Pin Can XO

Technology: Quartz + CMOS

***Mobius*' 12 – 75MHz Programmable TSSOP-8 RF-TCHO™**



Technology: All-CMOS

Development of *Mobius*: University Incubation & Seed Financing

2000-2002
Brown and McCorquodale continue their fundamental research toward monolithic all-CMOS clock generators

2001
McCorquodale and team awarded runner-up at U. of M.'s *Pryor-Hale Business Plan Competition*

2000-2001
McCorquodale enrolls in an MBA business plan development course (despite major admin. challenges) and recruits MBA team

2000
McCorquodale and Brown enter and win 1st round of state-wide business plan competition, *Great Lakes Entrepreneurial Quest*

2000
At U. of M., Brown and McCorquodale (under fellowship) initiate work on all-CMOS clock generators

Development of *Mobius*: University Incubation & Seed Financing

Summer 2003
Mobius' first office established in Ann Arbor with $180k in grants/awards from 8 academic business plan competitions

2003
Mobius incorporated through start-up program with *Perkins-Coie*

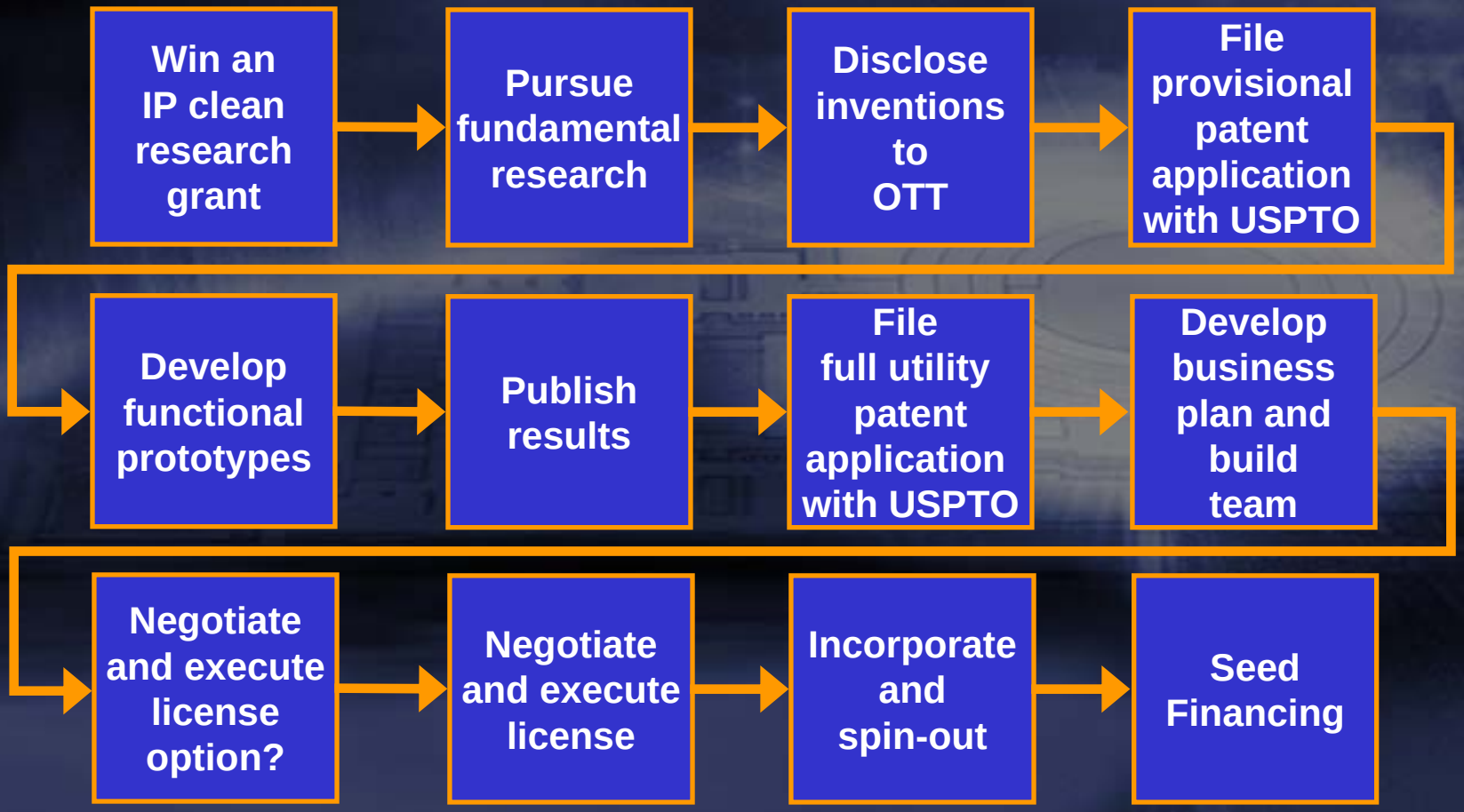
2003
First publications appear including 1st place DAC/ISSCC award

2002
Wilkins and Rushing (MBA candidates) and Vincke (veteran entrepreneur) recruited for business plan development

2002
Technology disclosure filed with U. of M. Tech. Transfer Office (TTO) and provisional IP filed with USPTO

2002
McCorquodale audits Mohammad Islam's new "Patent Law for Engineers" course at U. of M.

Development of *Mobius*: University Incubation & Seed Financing



Michael S. McCorquodale and Richard B. Brown, "Academic and Professional Resources for Student-Led Technology Ventures," *ASEE National Conference*, Nashville, TN 2003.

Development of *Mobius*: Spin-out & Seed-Stage Execution

Q4 2004
Founding team focuses on executing business plan and builds a design team while seeking managers with domain expertise

Q3 2004
Founding team secures 2 design wins with only 2 months on the market and despite little to no experience in such endeavors

April 2004
Final prototypes complete, license executed, McCorquodale defends and serves as *Mobius*' CEO and CTO while Wilkins and Vincke fill out the founding management team at *Mobius* and Brown retains a board seat. An additional $700k is raised.

Q4 2003
$300k in equity financing is raised through a network (MI, IL and OH) of angel investors and local VC firm (*Waypoint Ventures*) as well as U. of M.'s business school venture fund (*Wolverine Venture Fund*)

Development of *Mobius*: Spin-out & Seed-Stage Execution

June 2005
McCorquodale moves to N. CA to focus on fundraising and steps aside from CEO position and upon his recommendation D. Sikes (industry veteran) takes over CEO role

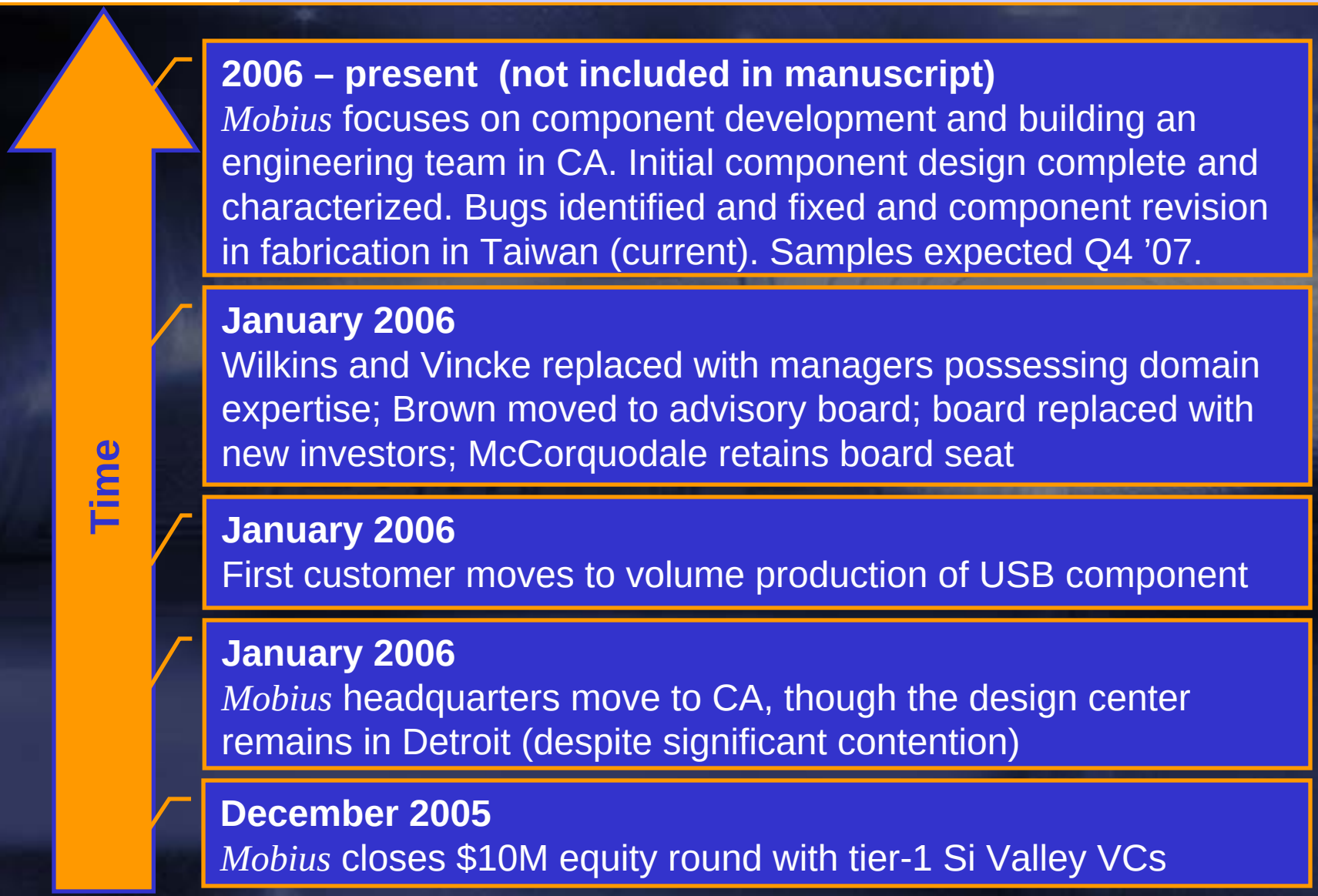
May 2005
McCorquodale has visited nearly every single equity investor in MI, OH, IL, IN and WI and to no avail because of round size (too large), stage (too early) and space (semiconductors)

March 2005
First customer project completes USB qualification

Q1 2005
McCorquodale and founding team seek $5-10M institutional round to move from IP to component business model

Q4 2004
Mobius awarded MI's *High-Tech MEGA* tax abatement to move from Ann Arbor to Detroit

Development of *Mobius*: Spin-out & Seed-Stage Execution



2006 – present (not included in manuscript)
Mobius focuses on component development and building an engineering team in CA. Initial component design complete and characterized. Bugs identified and fixed and component revision in fabrication in Taiwan (current). Samples expected Q4 '07.

January 2006
Wilkins and Vincke replaced with managers possessing domain expertise; Brown moved to advisory board; board replaced with new investors; McCorquodale retains board seat

January 2006
First customer moves to volume production of USB component

January 2006
Mobius headquarters move to CA, though the design center remains in Detroit (despite significant contention)

December 2005
Mobius closes $10M equity round with tier-1 Si Valley VCs

Mobius Microsystems

Analysis

Analysis: University Incubation & Seed Financing

- There is nothing particularly unique about *Mobius* and its incubation or spin-out (other than it has succeeded)
- The case study presents the typical protocol for the development of research-based technology ventures
- The challenges should be clear and include
  - Academic shortcomings
  - Local and legislative shortcomings

Analysis: University Incubation & Seed Financing

- Incubation is highly linear and analytical, though few academic programs address this
- It is difficult for engineering students at many institutions to elect entrepreneurship courses
  - Often such courses are not within the college of engineering
  - Sometimes such courses are not offered at all anywhere
  - Most courses are too broad because they are taught in the MBA program (e.g. U. of M.'s course does not address IP at all)
- MBAs play a supportive role, but cannot hold sustainable roles with a new technology venture w/o specific domain expertise
  - MBAs can facilitate the development of a seed-stage business plan
  - MBA business plan competitions provide incentives to develop plans
  - But, professional managers will always replace MBAs
  - Why is entrepreneurial education often owned by the MBA program? Isn't an MBA incongruent with entrepreneurship? Think about it.

Analysis: Spin-out & Seed-Stage Execution

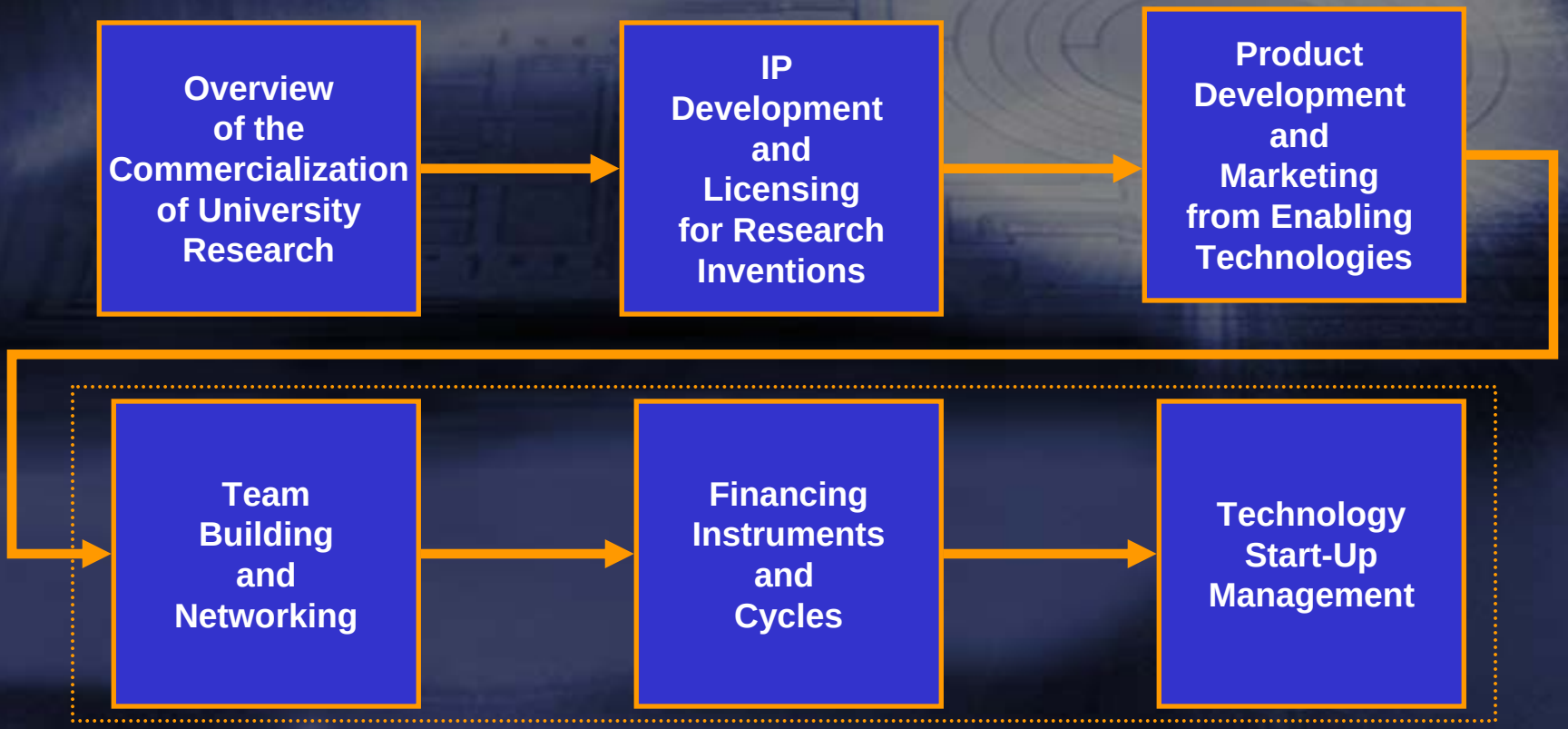
- Like incubation, “spin-out” is highly linear and analytical, though few academic programs address this either
- Financing is **required** to constitute a high-tech venture
  - Venture capital (equity financing) is the best resource for high-risk technology ventures which are capital intensive and w/o collateral
  - Only CA, MA and TX have significant VC industries
- Professional managers with relevant domain expertise are required for success
  - Such managers will inevitably replace MBA students, particularly after an institutional round
  - Founding engineers w/o significant management experience will be taken out of leadership roles – lost opportunities for engineers
- Local incentives are generally ineffective
  - Few programs truly serve the needs of new ventures
  - Local organizations are decoupled from commercializing research

Mobius Microsystems

Recommendations

Recommendations: Academic

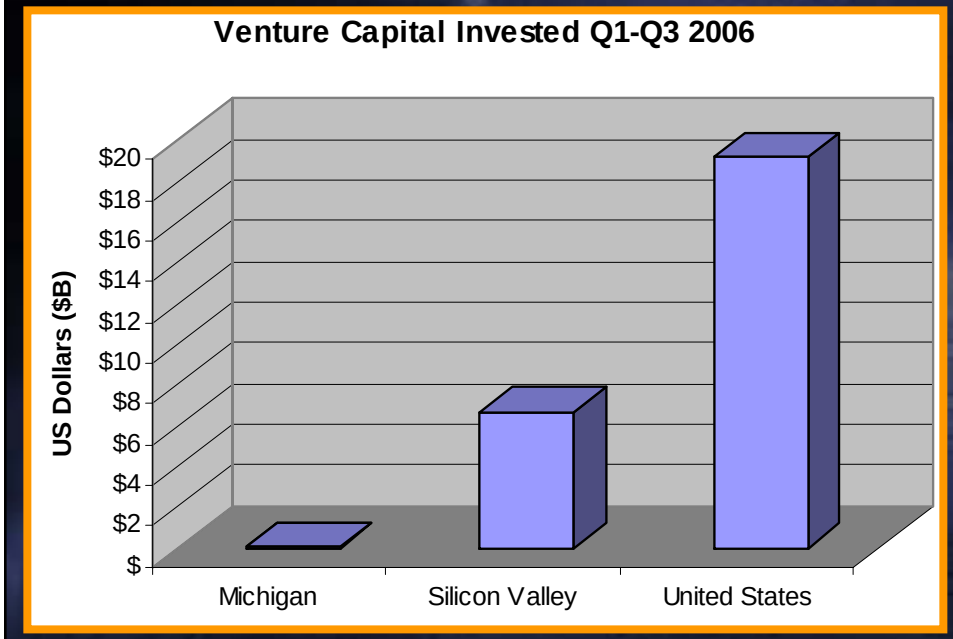
- Move entrepreneurship education into engineering programs
- Propose the development of an academic program/curriculum focused on linear sequence of commercializing engineering research



Recommendations: Local and Legislative Challenges

- Management Team
  - Challenge: limited access to management pool with relevant domain expertise
  - Consequence: often start-ups relocate
- Venture Capital
  - Challenge: limited access to early-stage capital for high-risk technology ventures
  - Consequence: venture is never constituted due to undercapitalization (i.e. technology never sees the light of day) or it relocates

Recommendations: Local and Legislative

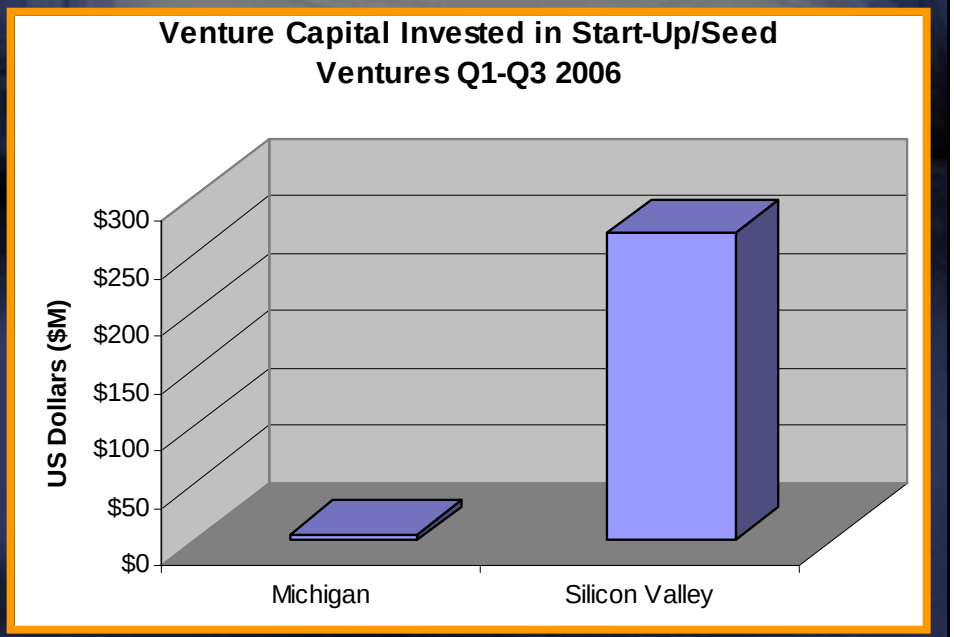


Total VC: Q1-Q3 '06

- MI: $72M
- Si Valley: $6.7B
- US: $19.2B

Start-Up VC: Q1-Q3 '06

- MI: $6M
- Si Valley: $269M
- Si Valley:MI = 45



Recommendations: Local and Legislative Challenges

But is it an issue of research expenditures or capital? (not in manuscript)

University	Region	CoE Research Expenditures
Stanford	**N. CA**	**$178M[1]**
UC-Berkeley	**N. CA**	**$110M[2]**
Total		$288M

University	Region	CoE Research Expenditures
UMICH	**Midwest**	**$132M[3]**
UIUC	**Midwest**	**$214M[4]**
Purdue	**Midwest**	**$130M[5]**
Total		$476M

1. *Annual Report*, Stanford University, School of Engineering, 2005.
2. *Facts 2005*, University of California-Berkeley, College of Engineering, 2005.
3. *Annual Report*, University of Michigan, College of Engineering, 2005.
4. *2005-2006 Guide to Expertise, Programs, Departments*, University of Illinois, College of Engineering, 2005.
5. *Research and Entrepreneurship*, engineering.purdue.edu/Engr/Research, Purdue University, College of Engineering, 2005.

Recommendations: Local and Legislative

- The example of the State of Michigan
  - Incubators and “enablers” receive substantial state funding including: TechTown (Detroit), Spark (Ann Arbor) and Automation Alley (Oakland Co.)
  - Is “enabling” really a challenge based on the case study?
- What are the real challenges in Michigan?
  - Education – need to educate researchers to take IP to market
  - Access to management with specific technology domain expertise
  - Access to capital, particularly early stage
  - Enabling is NOT a challenge
- How can these challenges be resolved?
  - Education: new curriculum development in colleges of engineering
  - Management: subsidies for commuter-managers; “parachute” grants for those who relocate
  - Capital: tax breaks for tech investment (in MI legislature now)
  - Certainly many more – these are just a few ideas

Mobius Microsystems

Conclusions & Acknowledgements

Conclusions

- Entrepreneurship education has not focused sufficiently where Bayh-Dole have created an incentive
  - Need to focus efforts on commercialization of research (i.e. IP)
  - Need to focus on educating researchers (i.e. IP generators)
  - Pipeline is highly linear and analytical (i.e. appropriate for edu)
- Most significant challenges in the “spin-out” stage of commercializing engineering research
  - Lack of sufficient education for researchers-turned-entrepreneurs
  - Access to management expertise
  - Access to capital
- Academic and external challenges can be addressed
  - Academic: move center of gravity of entrepreneurship education into engineering, curriculum dev., collaborate w/ ext. resources
  - Local and Legislative: increase risk capital in market, drop funding of local organizations/incubators, focus on university resources, create incentives for experienced managers to commute/relocate
- The presented case study is extensible (regions/disciplines)


Questions Welcome