



Developing Future Engineers



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To share my experiences in high-tech entrepreneurship to tell you, as students, what you should learn while in university while also telling the rest of you, as educators, where reform is required

- *About Mobius Microsystems*
 - Overview
 - Technology and product
- *Mobius as a case study for developing future engineers*
 - Academic incubation
 - Spin-out
 - Analysis
 - Academic recommendations
- *Thoughts on the future of engineering in the U.S.*
 - Careers in engineering
 - High-tech entrepreneurship
- *Conclusions*

About Mobius Microsystems

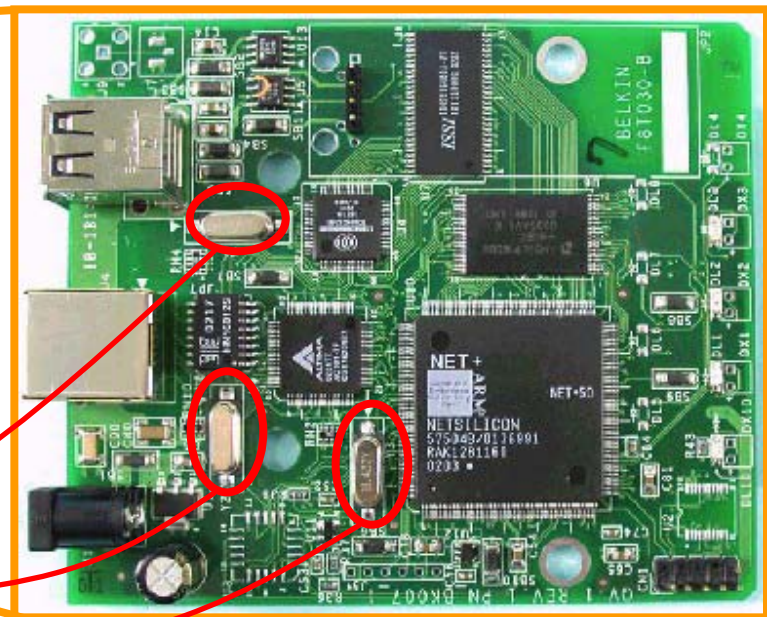
- Founded out of research at U. of Michigan by McCorquodale and Brown
- Flagship technology is an all-CMOS replacement for piezoelectric quartz frequency references
- TAM >\$3.5B; SAM >\$1B
- Fabless business/product model
- Fab, assembly and test partners in Taiwan, Philippines and Thailand respectively
- \$23M in debt and equity financing
- Headquarters in Sunnyvale, CA
- Design center in Detroit, MI

Quartz is one of the last great hold-outs for microelectronic integration



*Belkin Bluetooth/LAN
USB Print Server*

- USB XTAL clock reference
- Ethernet XTAL clock reference
- Processor XTAL clock reference

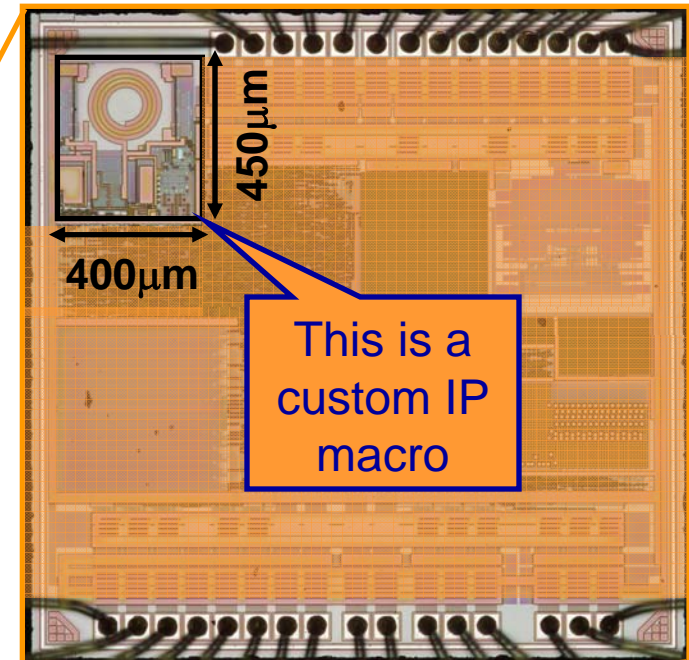


Less large passives, every other component is in Si

- Technology utilizes a compensated *LC* reference and unique architecture to achieve XTAL performance
- *Mobius* launched with an IP business model on \$2M in MI
- IP macro for USB-232 bridge ctrl.: shipping @ 200kU/month



[McCorquodale, *et al.*, *J. of Solid-State Circuits*, vol. 42, no.2, Feb. 2007.]



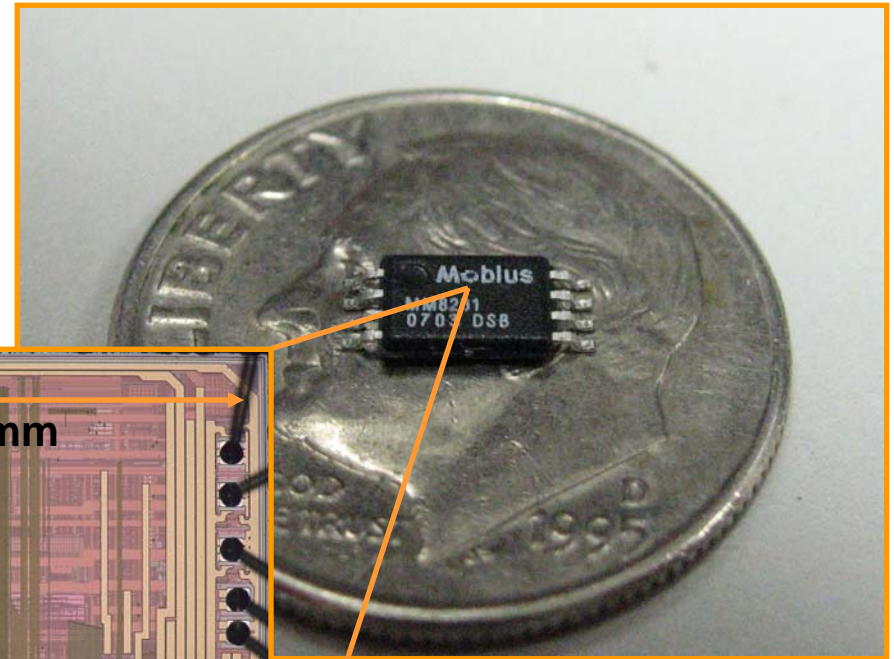
- *Mobius* was the first company to build a USB-compliant all-Si clock
- 0.18mm² in 0.35μm CMOS
- 18 pending/issued patents

***Abracon* 50MHz
4-Pin Metal Can XO**

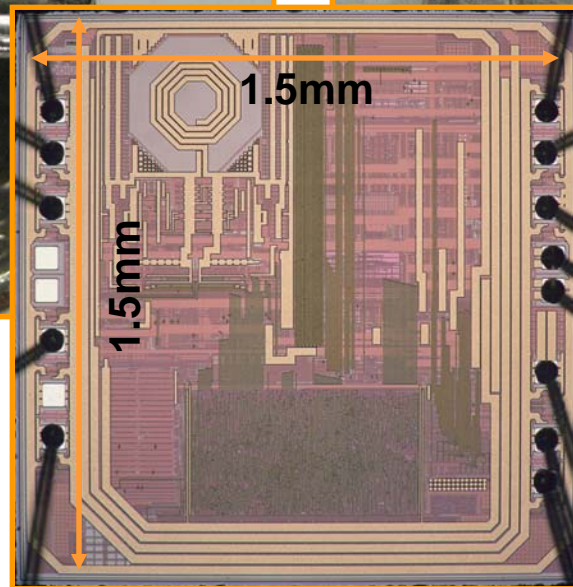


Tech.: Quartz + CMOS

***Mobius*' 0.5–480MHz
Programmable TSSOP-8 CHO™**

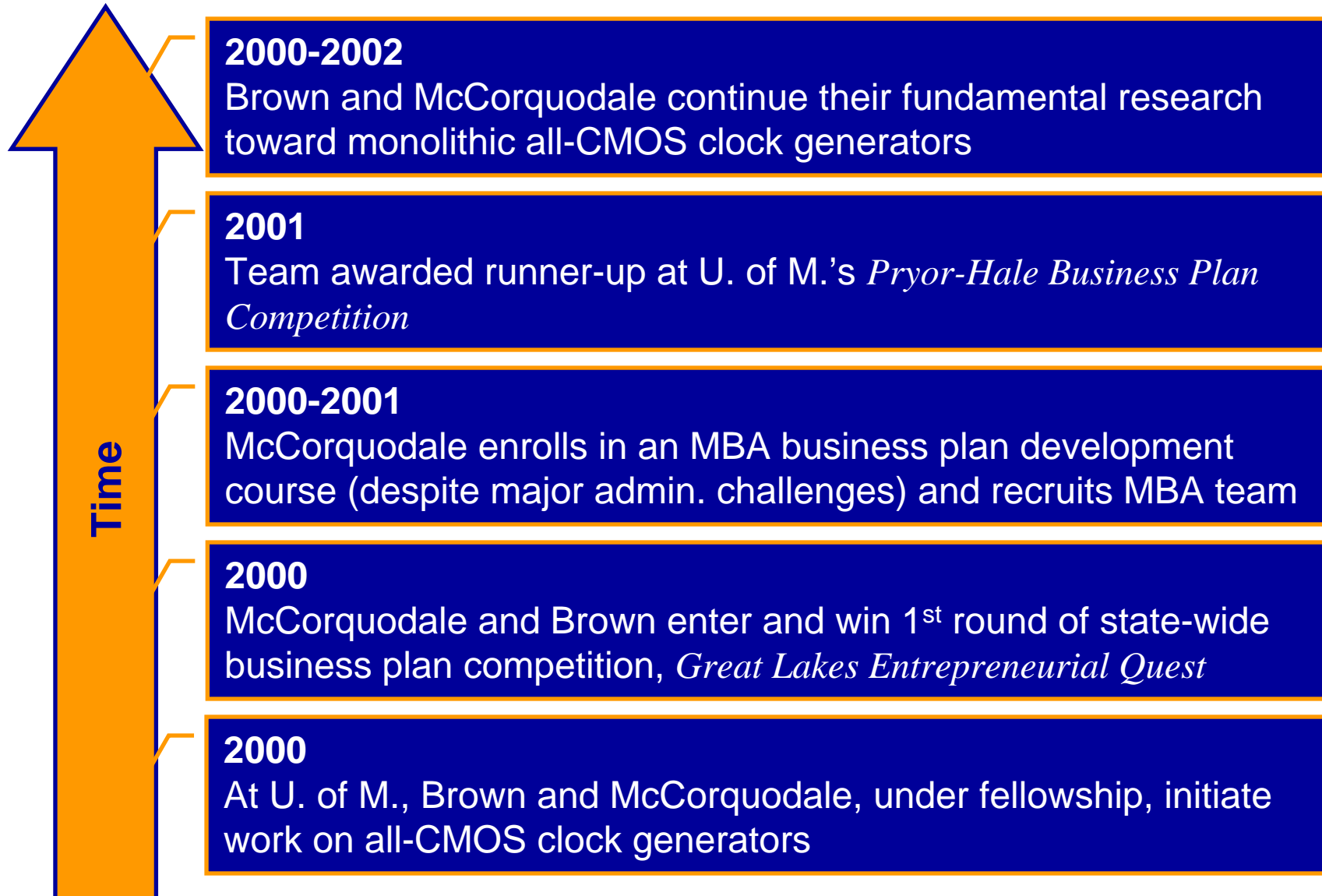


Tech.: All-CMOS



[McCorquodale, *et al.*, to be presented at the *Int. Solid-State Circuit Conf.*, Feb. 2008.]

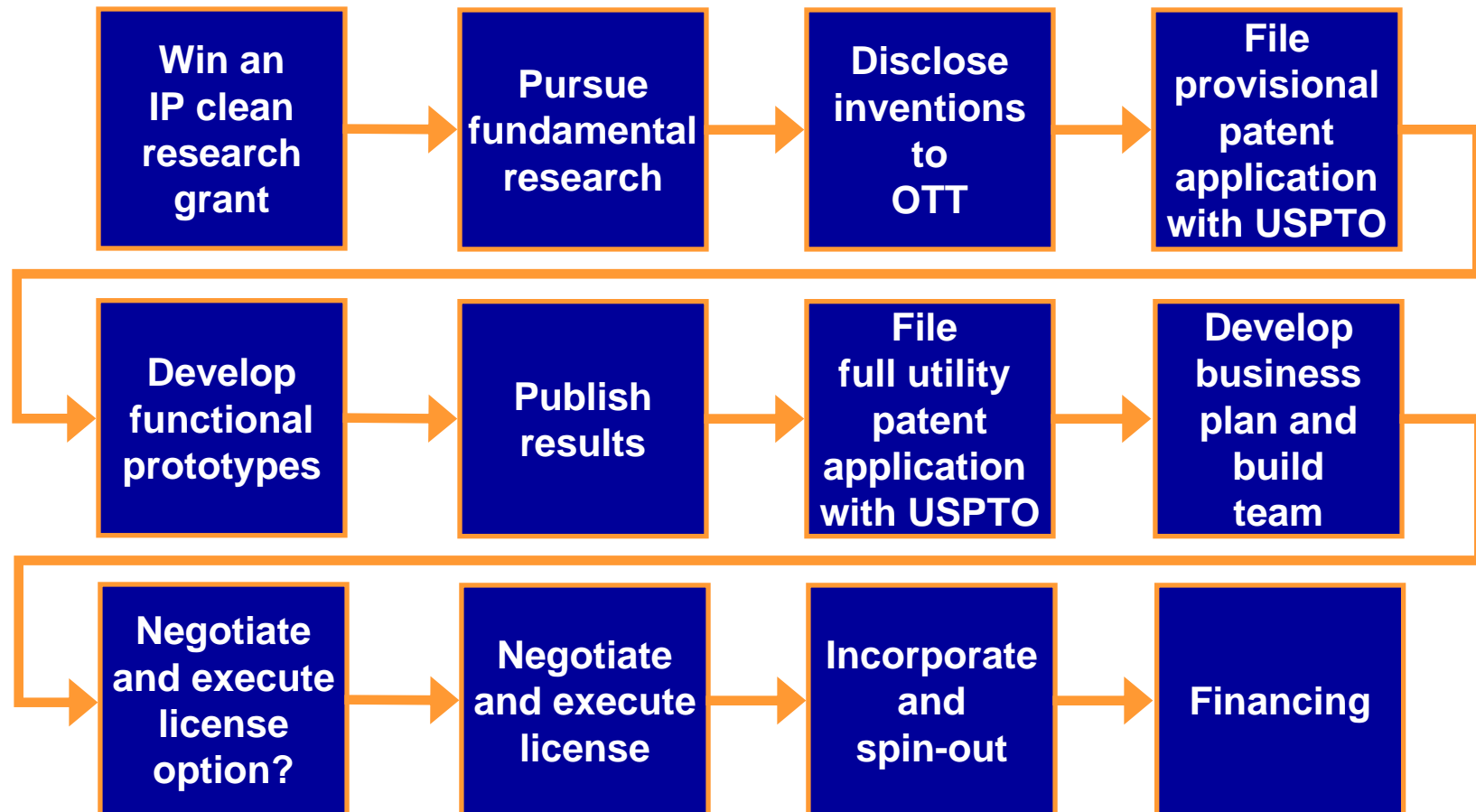
Mobius as a case study for developing future engineers



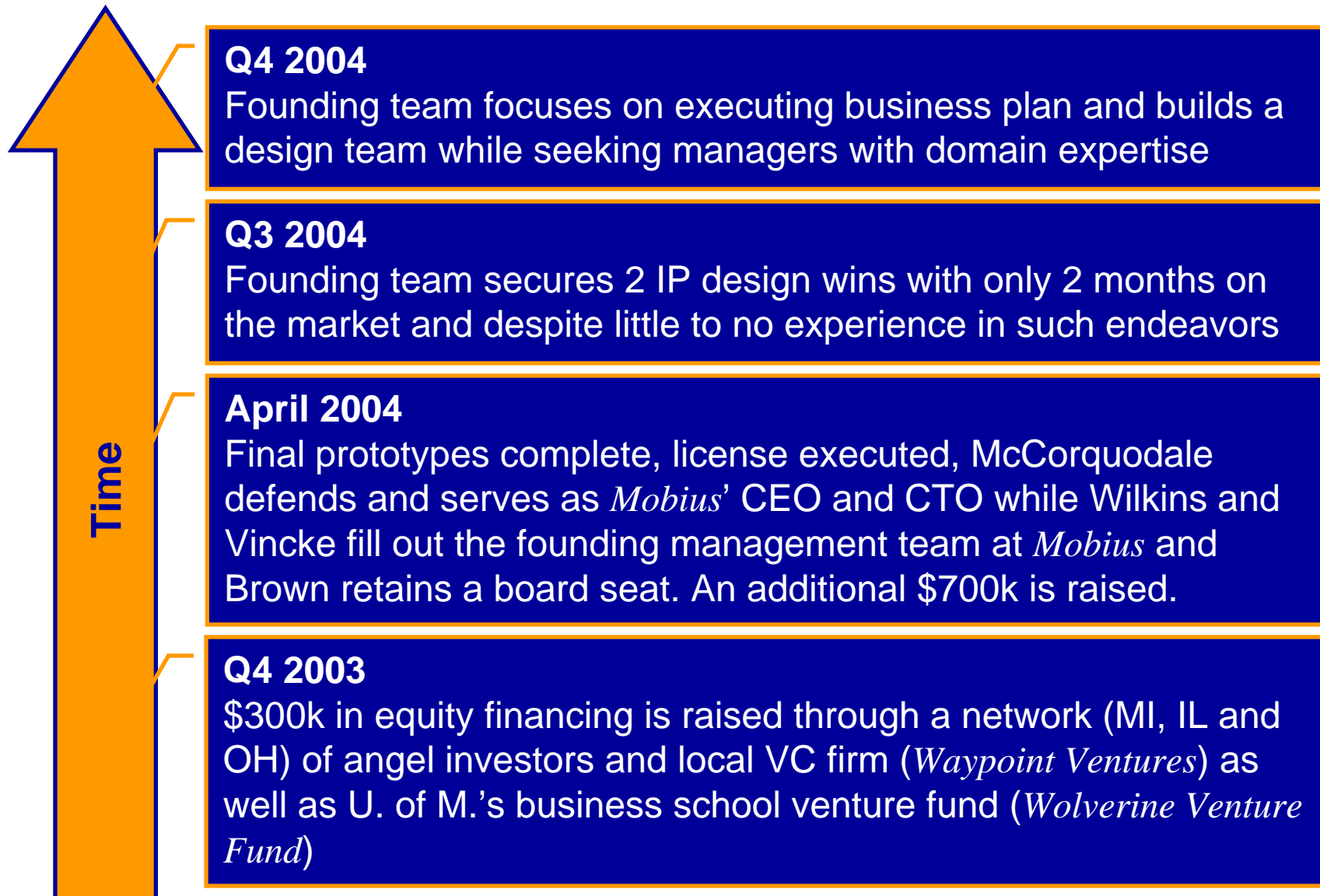


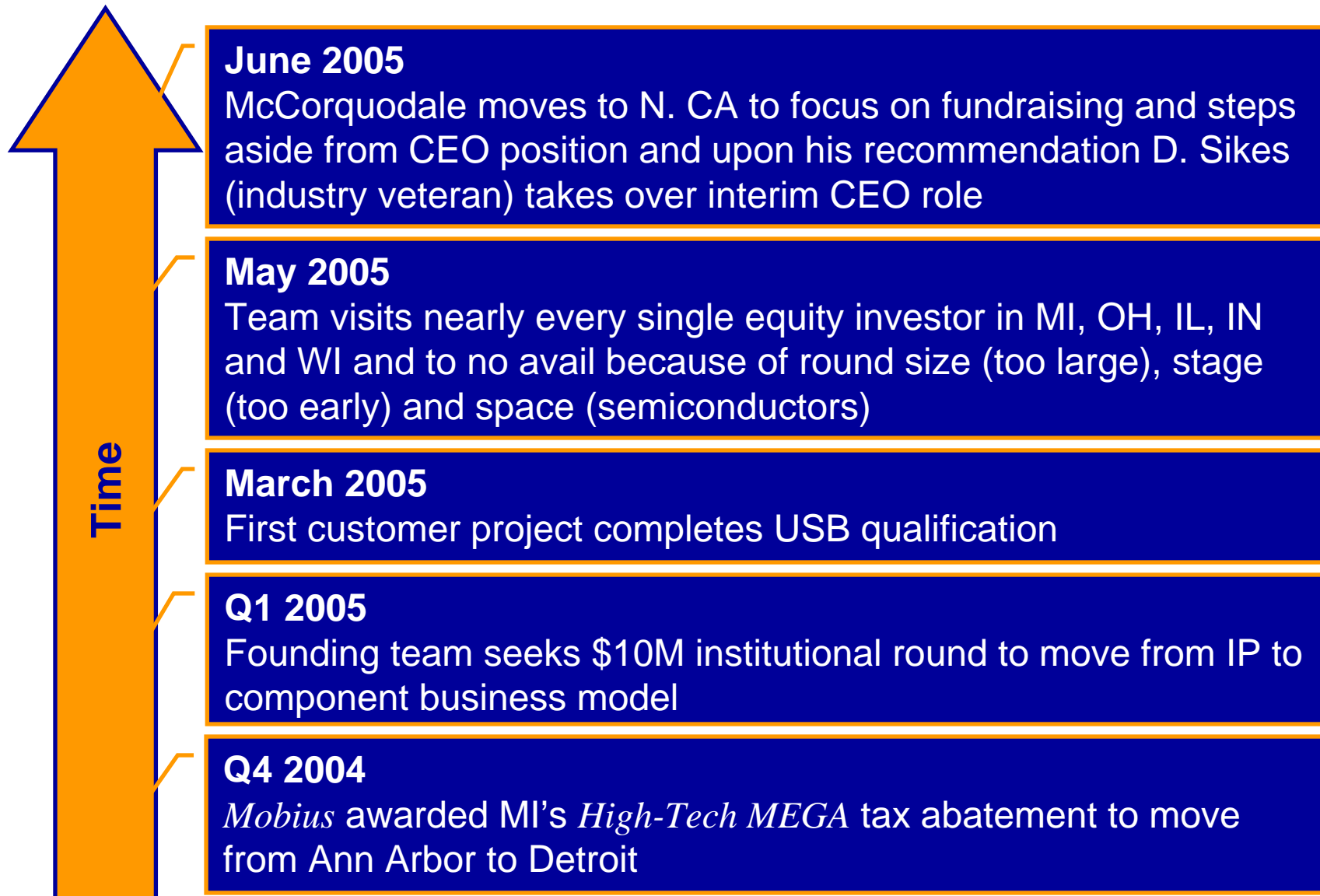
- Proactively pursued business education opportunities and learned that engineers can be businessmen/women
- Proactively engaged in extracurricular business plan competitions
- Networked with local professionals to support logistics of business creation
- In hindsight, fully understood the process of commercializing research

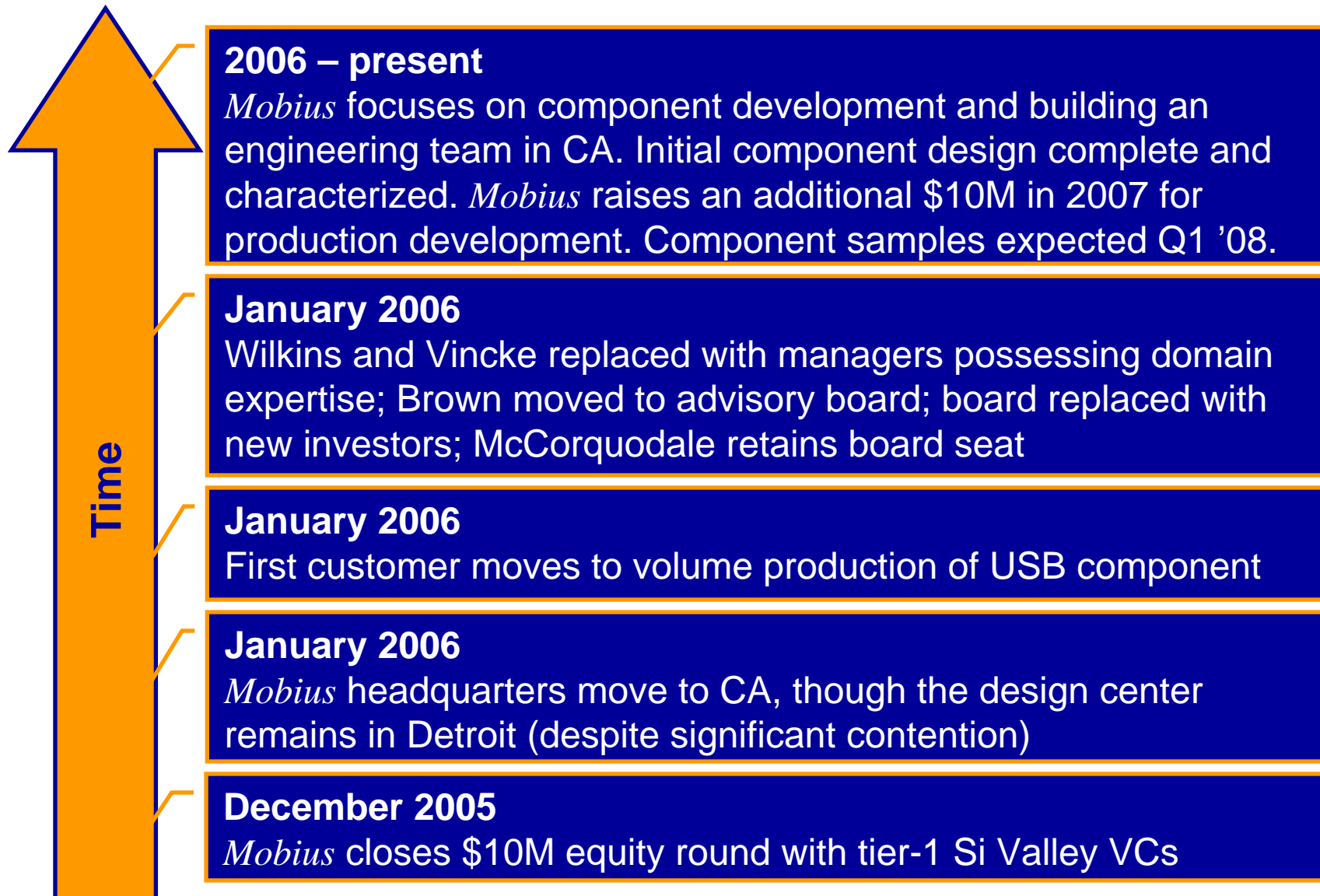
Academic incubation: summary



[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.]







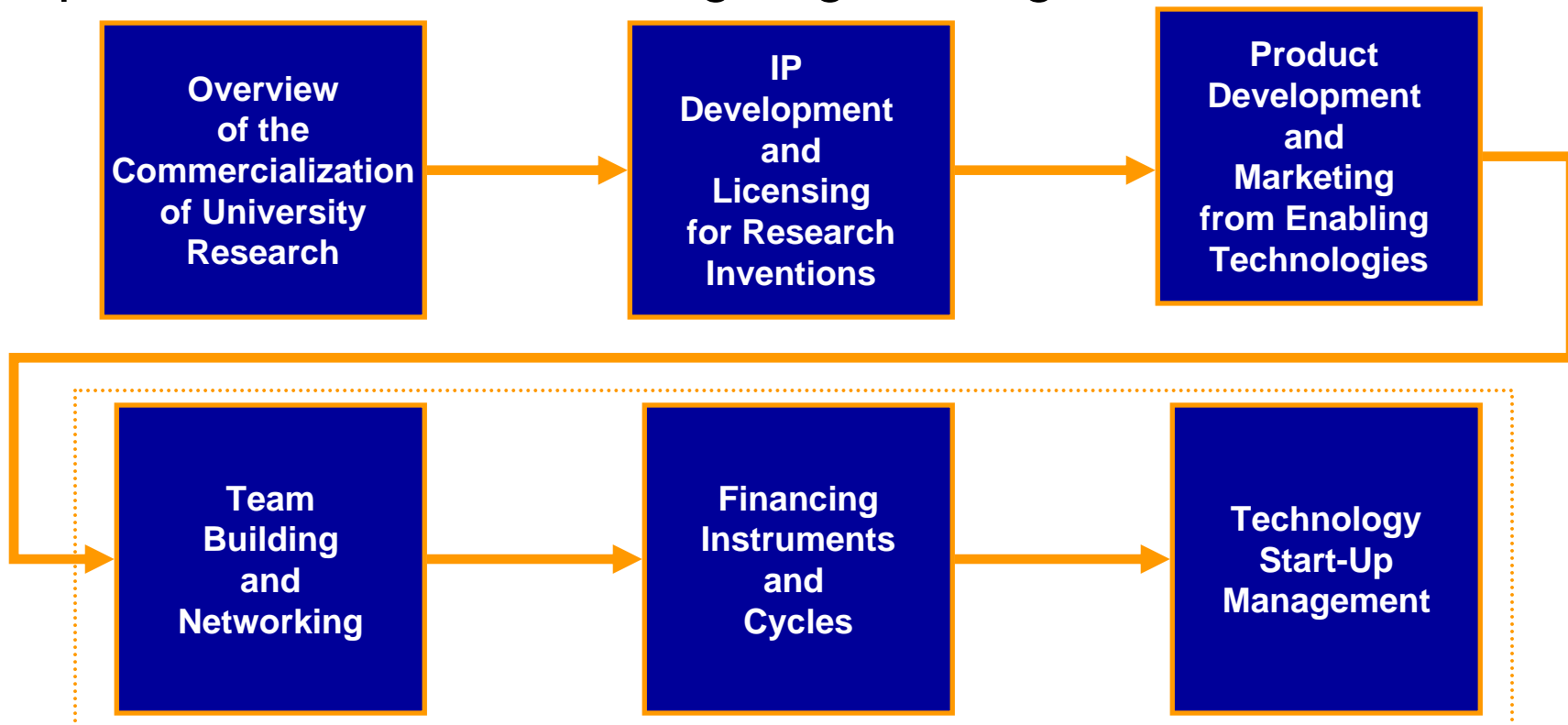
- Initially thrust into challenging management role without formal training
- Still continued to network and was awarded tax break through government
- Had little knowledge of financing requirements
- Didn't understand the reality of VC
 - Former MBA teammates replaced (irrelevant experience)
 - Experienced CEO and management team hired
 - Despite achievements, not much management opportunity going forward

- Experienced management is paramount once professional investors engaged
- Professional networking is a critically missing component of engineering education
- High-tech companies are started by technologists, not MBAs
- Engineers simply enter entrepreneurial endeavors nearly completely untrained

Academic incubation: analysis

- Many research institutions have a poor culture toward entrepreneurship (U. of M. has changed dramatically)
- Many research institutions have poor business development resources/training for engineers
- MBA's play a supportive, but unsustainable, role
- Many research institutions have poor educational resources in IP development for engineers
- Technology founders struggle due to lack of management training
- Technology founders have little management credibility post series-A

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



[Michael S. McCorquodale and Richard B. Brown, “Mobius Microsystems: A Case Study in the Commercialization of Graduate Research in Electrical Engineering,” *ASEE Annual Conference & Exposition*, Honolulu, Hawaii 2007.]

- Education
 - Develop entrepreneurial institutes/curricula in CoE (e.g. UC-Davis)
 - Offer IP development courses for engineers (e.g. U of Michigan)
 - Develop positive culture toward entrepreneurship (e.g. Stanford)
 - Create academic and/or financial incentives for faculty and students to become involved in emerging business (e.g. U of Utah)
- Extracurricular
 - Emphasize professional networking as part of career development
 - Work with resources (e.g. seed investors) to facilitate tech. transfer

Thoughts on the future of engineering in the U.S.

- Many of the “best and brightest” are moving to the financial sector
 - Engineering does not quantitatively offer an acceptable compensation/effort ratio
 - Financial sector may offer higher compensation, but no equity
- Best career opportunities in engineering
 - Start-ups (equity)
 - Faculty (a technology channel to start-ups)
- Blue-chip industry serves a single purpose: training

- Venture capital: The “New York” analogy
 - Despite the rise of Dubai and Shanghai, New York remains the financial center of the world
 - Si Valley is likely to remain the center of the VC world
- Venture capital: Do I need it?
 - Venture financing is nearly required to productize high-tech innovation due to high development costs
 - Venture financing is not “true” entrepreneurship
 - Entrepreneurs should continue to seek to boot-strap and forego VC as exits are nearly exclusively M&A (very few venture-backed fortune 500 companies)
 - Innovation occurs everywhere; capital doesn't

- Globalization: The rise of China and India
 - These countries do NOT have research institutions that rival the U.S.
 - The U.S. continues to be the center of innovation
 - Future engineers should seek careers in innovation
 - Nearly all of the off-shoring is due to labor costs, not labor shortages, thus costs will equalize long term and labor cost advantage will diminish¹
 - Biggest risk to U.S. is losing immigrant-entrepreneur scientists and engineers (from 1995-2005 52.4% of Si Valley start-ups founded by immigrants²)

1. Wadhwa, Vivek, Rissing, Ben and Gereffi, Gary, "Industry Trends in Engineering Offshoring," October 24, 2006.

2. Wadhwa, Vivek, Rissing, Ben, Saxenian, AnnaLee and Gereffi, Gary, "Education, Entrepreneurship and Immigration: America's New Immigrant Entrepreneurs, Part II," June 11, 2007.

Conclusions

- Mobius was presented as a case study for developing future engineers
 - Entrepreneurship is much more than just engineering
 - Engineers can succeed with the proper tools
 - Students should demand access to educational resources in business and IP development
 - Educators should seek to develop new programs/courses as proposed
- Thoughts on the future of engineering in the U.S.
 - Careers: many engineers lost to the financial sector though best opportunities in start-ups
 - Entrepreneurship: 1 of the best career paths for engineers

Questions welcome