Effective Invention & Knowledge Diffusion: A View from the Ground

PP 190/290-009
Ed Lazowska & Steve Maurer
October 21st, 2004

Dean A. Richard Newton
Berkeley
University of California

Outline

- *My Background—A Context for my Comments*
- "Berkeley's" Credentials
  - People Impact Reputation Brand Value People
- Why is this Topic Increasingly Important Today?
  - The Evolving (Critical?) Role of the Modern Research University
- Diffusing Knowledge & Understanding
  - An Example: Electronic Design Automation (EDA)
  - Transfer what?
- Facilitating Invention & Diffusion
  - The Moon Shot Principle—Use-inspired basic research
  - The Priests versus the Shamans
- Impeding Collaboration & Diffusion
  - Example: Faculty consulting in the UC system today

Who am I?

- Grew up in Melbourne, Australia, 1951-1975
  - Left because I met UCB Prof. Don Pederson in Melb. and helped him with SPICE—Open Source
- Ph.D. Student, UC Berkeley, 1975-78
  - Continued work on SPICE at UCB
  - Observed problems arising from student consulting
- Professor, UC Berkeley, 1979-present
  - Worked with Sematech, MCC, Bell Labs, Xerox PARC, Interval Research, many high-tech co's.
  - Chair, Department of Electrical Engineering and Computer Sciences, 1999-2000
  - Dean of Engineering, 2001-present

Who am I?

- ◆Founder, Cadence Design Systems, 1982
- ◆Founder & Director, Synopsys, 1987

cadence SYNOPSYS®

- ◆Together, these companies represent:
  - ▲9,000 jobs, $2.5B revenues, $8B market cap.
  - ▲Represent over half of the industry revenues and this is an industry that the US dominates

Who am I?

- Venture Partner, The Mayfield Fund, 1988-2002
  - Helped found 20+ high technology companies
  - Attended partner's meetings

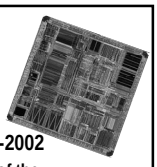
Founded in 1969
$1.5B of capital under management
> 300 companies funded
Market value > $100B

MAYFIELD

- Venture Partner, Tallwood Venture Capital, 2002-present

TALLWOOD Venture Capital

Who am I?



- Founding Director, The Gigascale Systems Research Center (www.gigascale.org), 1998-2002
  - Established in 1998 to address the challenges of the growing chip design productivity gap
  - Cosponsored by government (DARPA) and industry (SIA)
  - One of six MARCO national research centers
  - Annual research budget of around $8M
  - In 2000 had grown to 24 faculty at 11 universities, 11 postdocs, 56 PhD students, many industrial fellows

GSRC

Who am I?

- Acting CEO, Silicon Light Machines, Jan-Aug 1994

- Director, Simplex Solutions, Tensilica, Crossbow

- Member, Technical Advisory Board, Microsoft Research Laboratories (with Ed Lazowska)

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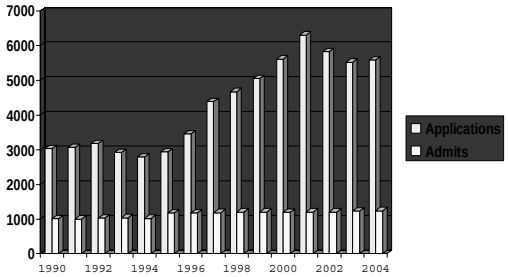
Berkeley Engineering: A Tradition of Impact in Research

- Pre-stressed Concrete
- Ground Fault Interrupter
- Berkeley Unix
- Relational Database Technology (following IBM)
- Electronic Design Automation: SPICE to Synopsys
- RISC (with Stanford), RAID
- CyberCut online manufacturing systems
- NOW (Networks of Workstations)
- Salmon with antifreeze (grapes next?)
- IEEE Floating Point
- Infopad (now called WebPad, TabletPC,...)
- Semiconductor Devices & Modeling
- MEMS, Smart Dust, ...

- Berkeley faculty are fundamentally motivated by high-potential-impact, long-range research

Berkeley College of Engineering Applications and Admissions 1990-2004



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Such approaches must be global and should include partnerships among universities, industries, and governments

We must find new approaches to effective collaborative research management in an era of hyper-development

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Principles

- We must all take a truly global view
  - Berkeley/Bay Area has a unique and differentiated role to play
- Major research universities are becoming the "DMZ" of research
  - It's all about leverage
  - Tackle projects of a scale otherwise not possible by a single company
  - Build informal connections to other companies—established and start-up
  - Opportunity to really be in touch with latest developments, at the University but also in the start-up environment—globally
- Most important aspect is extracting maximum, bilateral value through synergy
  - Requires focused, sustained investment on both sides
  - Tech transfer in IT happens via people
  - True collaboration requires ability to influence research agenda through dialog

Why Universities?

- Major corporate research laboratories of significance have mostly faded away (a few exceptions!), so who is going to do the work?
- Consortia take too long to assemble and often have very high infrastructure investment costs
  - Universities can be seen as the "choice of last resort"
- Universities are attractive to very smart people from around the world—at all ages
- Universities usually have a broad range of human capital representing many different disciplines
- If they do it right, universities can form the neutral, research commons—the "DMZ of Research"
- Ideally, a global network of universities, inspired by a common set of grand-challenge "uses" (e.g. energy, education, communicable diseases), could "hold" the global community needed to address such Great Works of the 21st Century—but that's another talk!

The Essential Ingredients for Business Success: In Priority Order!

(1) People
(2) Markets
(3) Products

The Essential Ingredients for Relevant Research: In Priority Order!

(1) People
(2) Innovation (Science & Engineering)
(3) Relevant Application Context

Observations

- Almost all projects involve multiple sponsors (federal, state, and corporate) and overlapping research agendas
- In all cases, the specific research artifacts developed during the projects could have been circumvented relatively easily
- In all cases, many millions of dollars have flowed to the campus during and since the projects in support of faculty in their research—a tradition of support
- Conversely, in almost all software & embedded systems cases where technology was protected and licensed, the financial return has not been high and the full potential of the research has been (arguably) compromised

"Seed Billion $ Industries not Kilo $ Licensing"

Summary

- Berkeley Engineering faculty are primarily motivated by the IMPACT of their work
  - In ICT, impact is usually maximized by making the work widely available—ACE
  - In other disciplines (e.g. Biological sciences), impact may be maximized by exclusive licensing for royalties—ADC
- Corporate sponsors that collaborate with Berkeley are primarily concerned about ACCESS to research results
  - In certain areas, access is actually maximized by making work open and available
  - Access clearly includes consideration of background rights and shared rights

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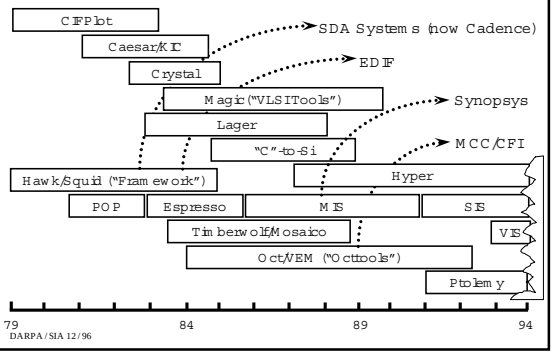
Impact of DARPA-Sponsored Design Technology Research at Berkeley



Transfer What?

- There is an important difference between Artifacts of Collaborative Evolution (ACE) and Artifacts of Discrete Contribution (ADC)
  - Each may be made by an individual or a group
  - Each may be comprised of, or influenced by, one or more of the other
- Both kinds of artifacts are extremely important, but must be managed *entirely differently* to *maximize impact*

(Ed, was that "SUN" or "BUN"?)

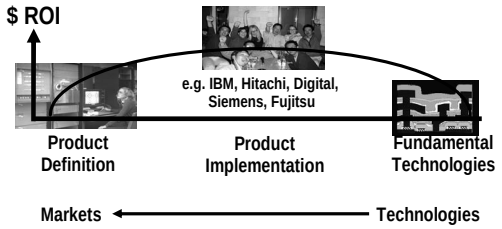
Value Creation in Product Development

... The Way It Used to Be

Source: Stan Shih, Acer, 1992

Value Creation in Product Development

... The Way It Used to Be



Source: Stan Shih, Acer, 1992

Value Creation in Product Development

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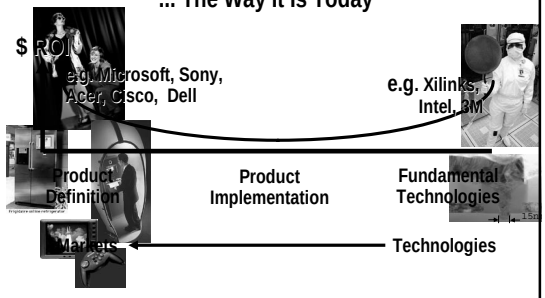

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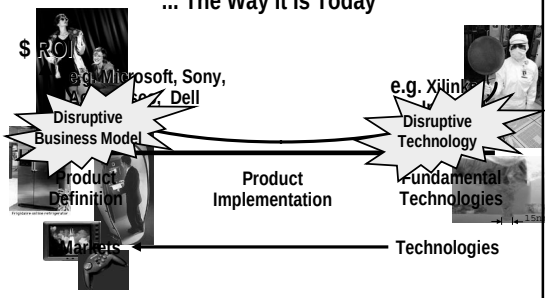

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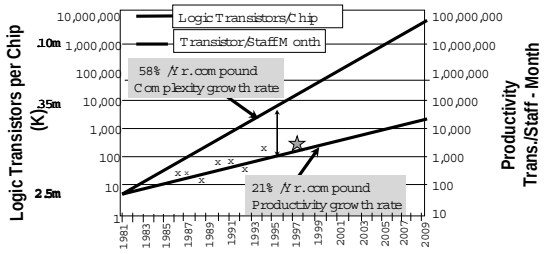
The Productivity Gap



Source: SEMATECH

The Need for Long-Term Research

- We cannot "solve" today's design productivity crisis
- We must change the problem to one we can solve, and where we can demonstrate efficient solutions!
- We have done this before, but it requires a comprehensive approach to the problem and a long-term investment
- It is a methodology change, not just a technology change

The Gigascale Silicon Research Center

http://www-cad.eecs.berkeley.edu/GSRC

"Empowering designers to realize the potential of gigascale silicon by rebuilding the RTL Foundation and by enabling scaleable, heterogeneous, component-based design."

Artifacts of Discrete Contribution

- All you need to know is in a paper or a patent or a piece of code
  - The key ideas can usually be exploited quickly via investment
- The key ideas can be protected and defended efficiently and effectively
- Usually what people have in mind when they speak of "technology" in the sense of "technology transfer"
- Nowhere near as common as ACE in terms of contribution and large-scale impact
- What University Technology Licensing offices usually imagine life to be like

Artifacts of Collaborative Evolution

- Impact is maximized through a community of smart people adding increments of value (technology, understanding, explanation)
  - The "right answer" usually evolves over a long period of time
  - Usually a lot of disagreement (people "not getting it") in the early phases, and a "seems really obvious" attitude after success
- Usually a low protection barrier before the community is built
  - To "get it" early you need to be immersed in the community
- Often preserved and taken to scale as a "standard"—formal or informal
- Often involves a number of protectable/defensible Artifacts of Discrete Contribution
- Examples: The Internet & Web, Berkeley UNIX, Window-based UI, TiVO, TinyOS,

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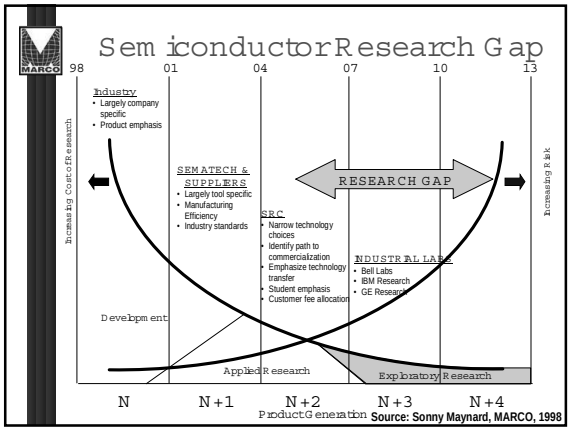

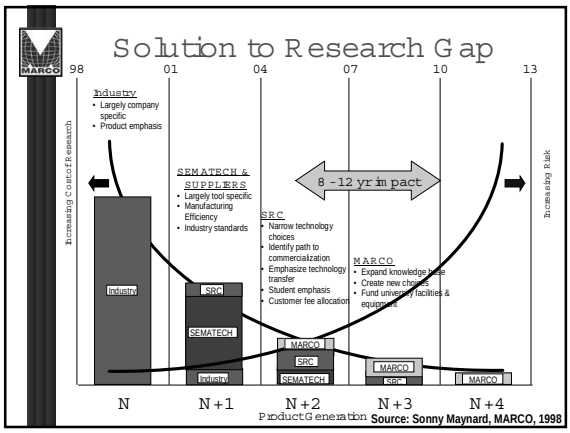

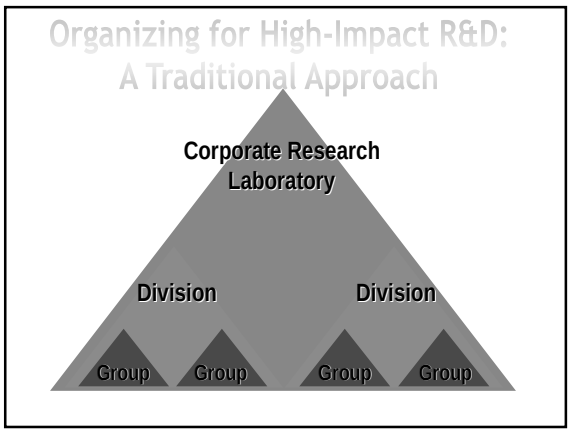

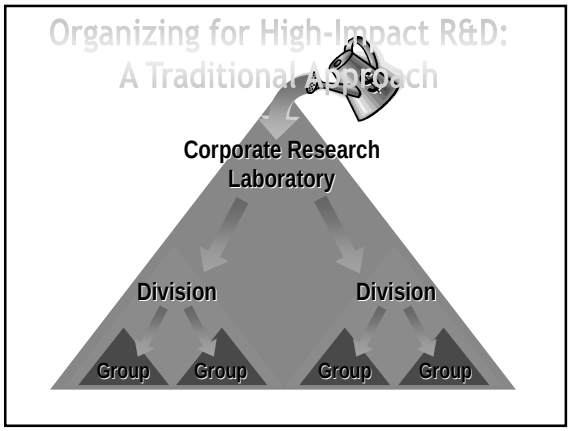

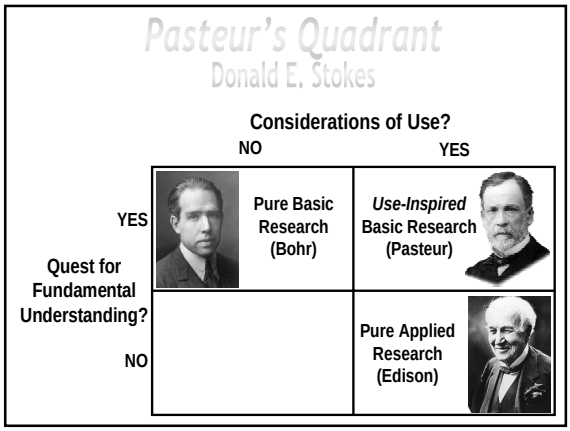

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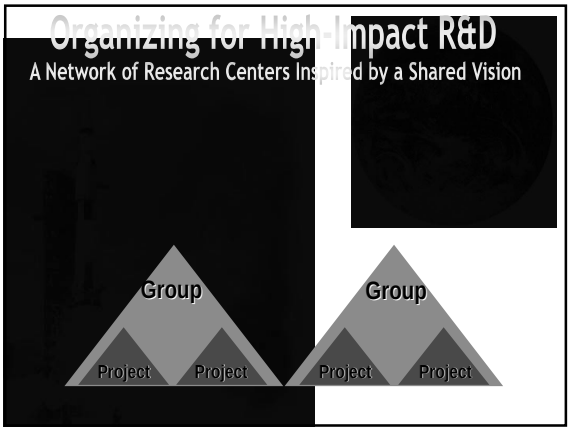

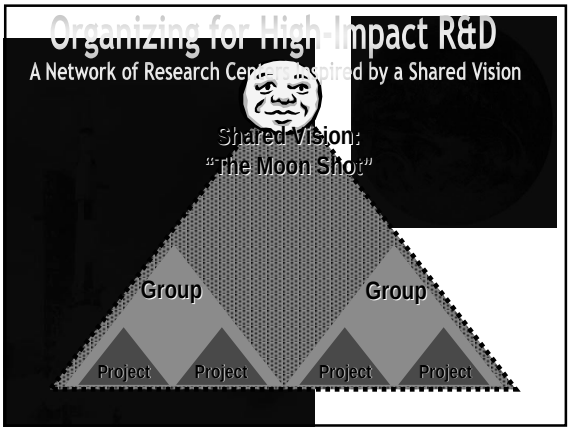

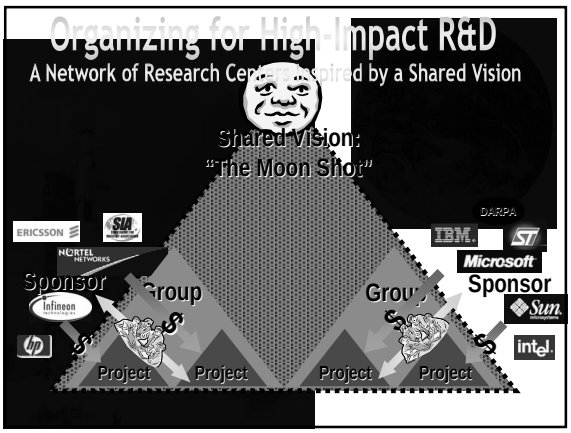

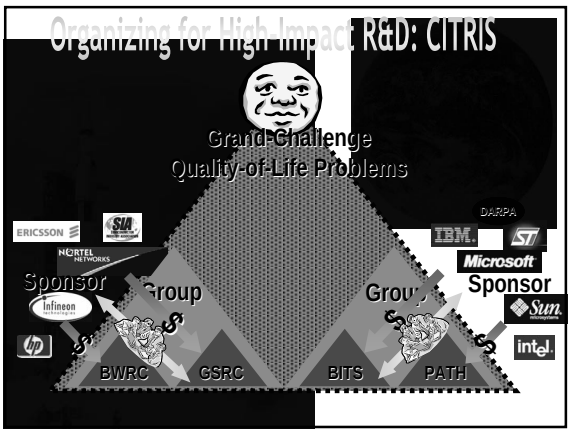

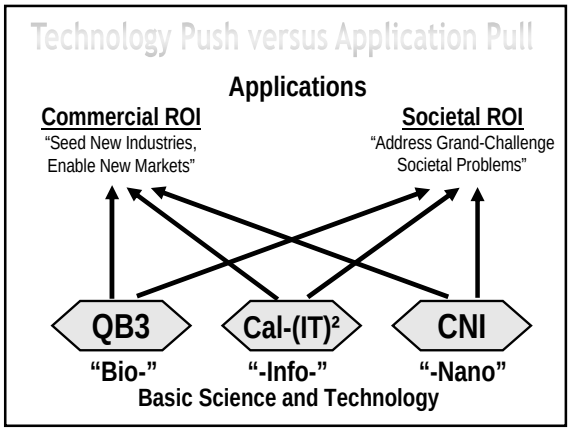

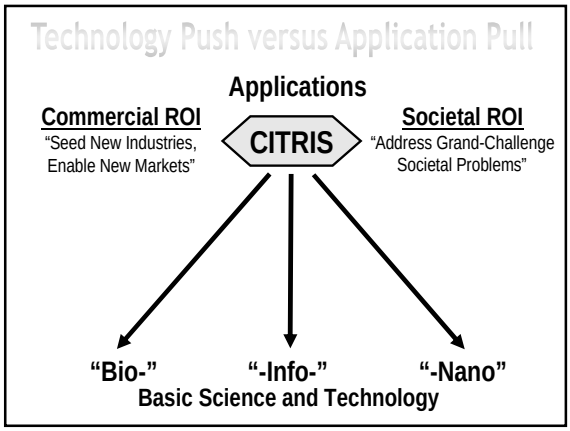

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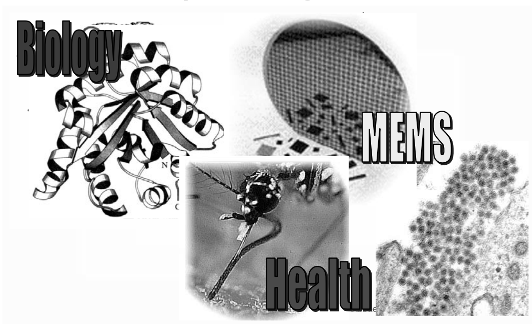
Example: Dengue Fever



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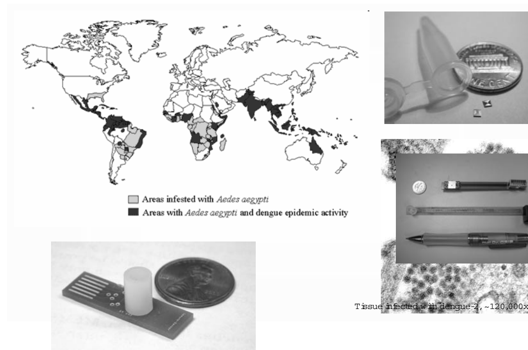

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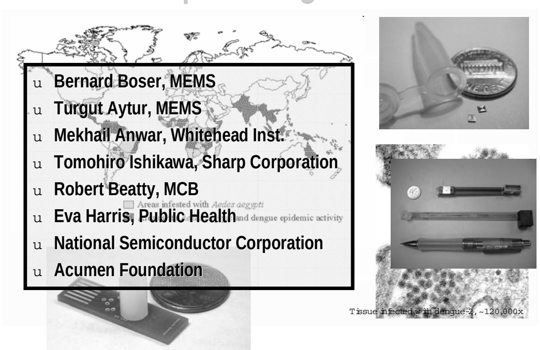


- Bernard Boser, MEMS
- Turgut Aytur, MEMS
- Mekhail Anwar, Whitehead Inst.
- Tomohiro Ishikawa, Sharp Corporation
- Robert Beatty, MCB
- Eva Harris, Public Health
- National Semiconductor Corporation
- Acumen Foundation

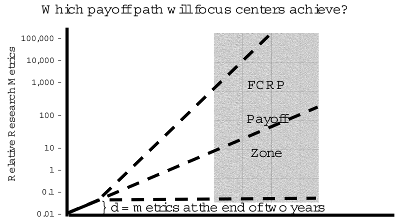
Focus Center Metrics

- First Two Focus Centers:
  - Quality of their Long Range Vision
  - Number of 'Out-of-the-box' Thinkers on the Team
  - Authority & Independence of Center Director
  - Nurturing Environment for New Concepts and Radical Alternatives
- Focus Center Member Companies
  - Buy-in to the Long Range Vision
  - Patient Expectations for Research Results

Source: Sonny Maynard, MARCO, 1998

Elements of Evaluation

Which payoff path will focus centers achieve?



- Patents, Papers, Citations Not Fast Enough
- Two-Year Research Products May Be Limited
- Metrics Must Assess the Research Process & Goals
- Find Indications That the Payoff Curve is Steep

Source: Sonny Maynard, MARCO, 1998

3 Jobs for 3 Different Groups

- Technology Management—Create the Shared Vision and Manage the Project

  University Center Director; FCRP Managing Director; DARPA Program Manager

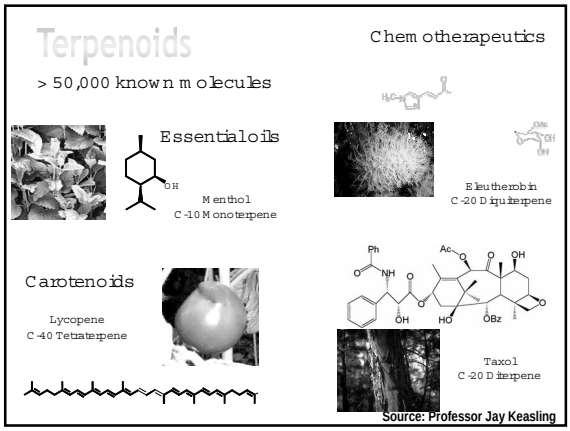
- Technology Diffusion—Member Companies Buy Into the Shared Vision and Exploit the New Concepts

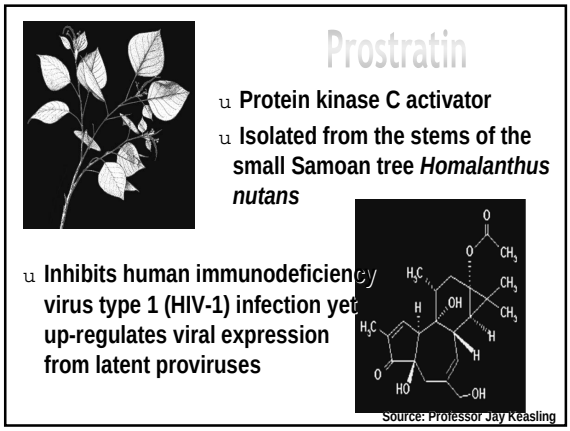
  Member Company Management & Personnel

- Process Assessment—Evaluate the Focus Center Concept & Execution

  Blue-Ribbon Evaluation Panel

Source: Sonny Maynard, MARCO, 1998





CITRIS Intellectual Policy Principles

"Patents are expected to be rare, but…"

If and where IP protection is indicated and desired:

- **Ownership follows inventorship**
  - **Except when obligations are imposed by State tax-free bond funding of facilities or by 3rd party agreements, existing and new.**
- **Licensing: CITRIS corporate participants will all gain non-exclusive, world-wide, royalty-free, access to all IP generated within CITRIS, as will any other company**
  - **Exclusive, royalty/fee-bearing license an option**
- **In effect, we are defining an "Openness Agreement" rather than an "Ownership Agreement"**

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Introduction and Principles

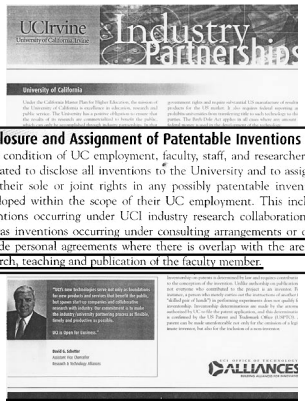
- **Advantages:**
  - **Engineering is a discipline of practice**
  - **Technology diffusion in ICT is via people**
  - **Essential for Visibility/Resources/Impact for College and for the University**
- **Challenges:**
  - **Lost time of key faculty for instruction, research and administration**
  - **Possible conflicts of interest:**
    - **Bias in student research**
    - **Bias in student placement**

UC Consulting/Intellectual Property Guidance

January 15, 2003

- ***Employees must disclose all inventions***

"The University must be able to meet its obligations assumed under legally binding contractual obligations with regard to intellectual property rights generated by faculty and other researchers as a result of sponsored research agreements, material transfer agreements, and other research support agreements entered into on behalf of those faculty and research staff. Therefore, *all* inventions made by a University employee must be disclosed to the University, including inventions made on weekends, on leave, at home "in the garage," or during paid or unpaid consulting work. Disclosure is a legal obligation of employment at the University."



Other Topics…

- Issue of Trust
- Butterfly in China
- Incubators in the IT world
- Corporate schizophrenia & IP
- Sematech vs MCC vs SRC vs MARCO