

# Research Universities as Drivers of Science-Based Innovations

ATP Advisory Committee  
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Lewis M. Branscomb  
UCSD and Harvard University

## ATP and the Research Universities

- Sec. Evans recommendations on ATP in 2001 included:
  - allow universities to lead ATP joint ventures.
  - allowing universities to negotiate with joint venture partners over the IP rights
- What is the role of research universities in creation of high tech innovation clusters?

## Outline:

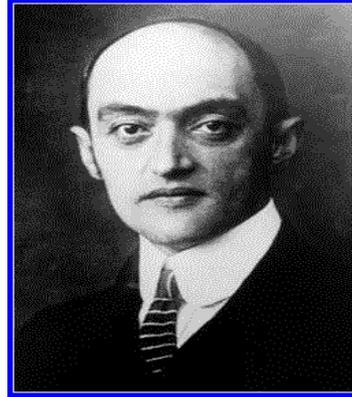
- Part I: Regional Innovation Clusters: understanding from case studies
- Part II: Role of universities in creation of viable regional innovation clusters
- Part III: Case study: Innovation cluster in San Diego
- Part IV: New methods for identifying emergent innovation clusters ['hot spots']
- Part V: Findings and Questions

## Why are regional innovation clusters important to economic growth?

- Almost all GDP growth is due to small but steady improvements in productivity and customer value of established goods and services.
- Science based innovations employ a tiny fraction of work force and create little near-term revenue.
- Venture capital represents a future economic promise, not a present GNP asset.  
In aggregate, all the biotech firms in San Diego are unprofitable even today [but losses are exceeded by inflow of capital].
- Schumpeter gave the answer 64 years ago.

## Role of New and Small Firms in “Creative Destruction”

- Allows innovative competitors to compete successfully with, or help to transform established, large enterprises (OEMs).
- Sustains profitable growth of large firms when established products become commodities.
  - OEMs outsource innovations to SMEs
  - OEM strengths: finance, world markets, efficient manufacturing.



Joseph A. Schumpeter (1883-1950) *Capitalism, Socialism and Democracy*. 1942

## Requirements for High-Tech Regional Cluster

- “Honest Broker” community leadership
  - A research university may play this role
- A creative, risk-tolerant, culture
- Sources of seed equity investment
- Research institutions – creative, ambitious
- Skilled human resource base
- Established industries, professions willing to help with the solution, not be the problem

AND

A  
place  
where  
there  
are

Fun  
Things  
To Do



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## Academic Inventions and patents

[AUTM data for FY 2002]

- **15,573 Invention Disclosures** were reported in FY 2002 by 221 institutions, up 14.8% from 2001.
- **7,741 New U.S. Patent Applications** were filed in FY 2002 by 216 institutions, up 13.6% 2001.
- **3,673 U.S. Patents Issued** in FY 2002 reported by 219 institutions, down 1.3% from 2001, bringing the total US Patents Issued 28,093 since 1993.

<http://www.autm.net/surveys/dsp.Detail.cfm?pid=100>

## Academic Licenses and Options

- **26,086 licenses and options were active** in FY 2002 reported by 217 institutions,
  - 22.4% of them generated Running Royalties on product sales.
- **46.5%** of new licenses and options executed were **exclusive** and **53.5% were non-exclusive**,
  - compared with 50.3% exclusive: 49.7% non-exclusive in 2000.
- **\$1.267 billion in gross license income** was reported by 218 institutions in FY 2002,
  - up 18.3% from 2001.

<http://www.autm.net/surveys/dsp.Detail.cfm?pid=100>

## Academic New Firm Startups

- 450 new companies based on academic discovery were formed in FY 2002.
- 83.1% were located in the state of the university where technology was created.
- 4,320 new companies formed since 1980 based on a license from an academic institution.
- 2,741 of them still operating as of the end of FY 2002.
- Universities received equity interest in 69.6% of their startups in 2002.

<http://www.autm.net/surveys/dsp.Detail.cfm?pid=100>

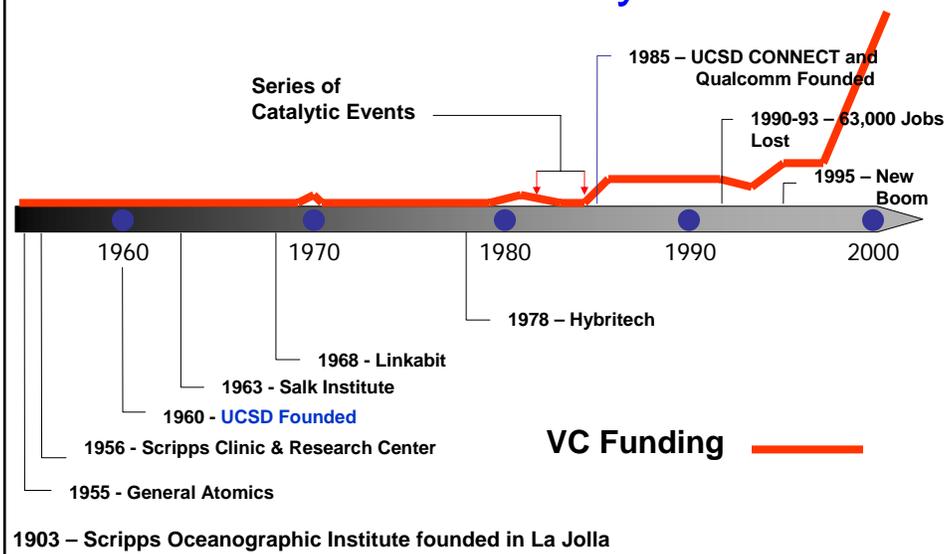
## What Do Universities Bring Besides S&E Research and Education?

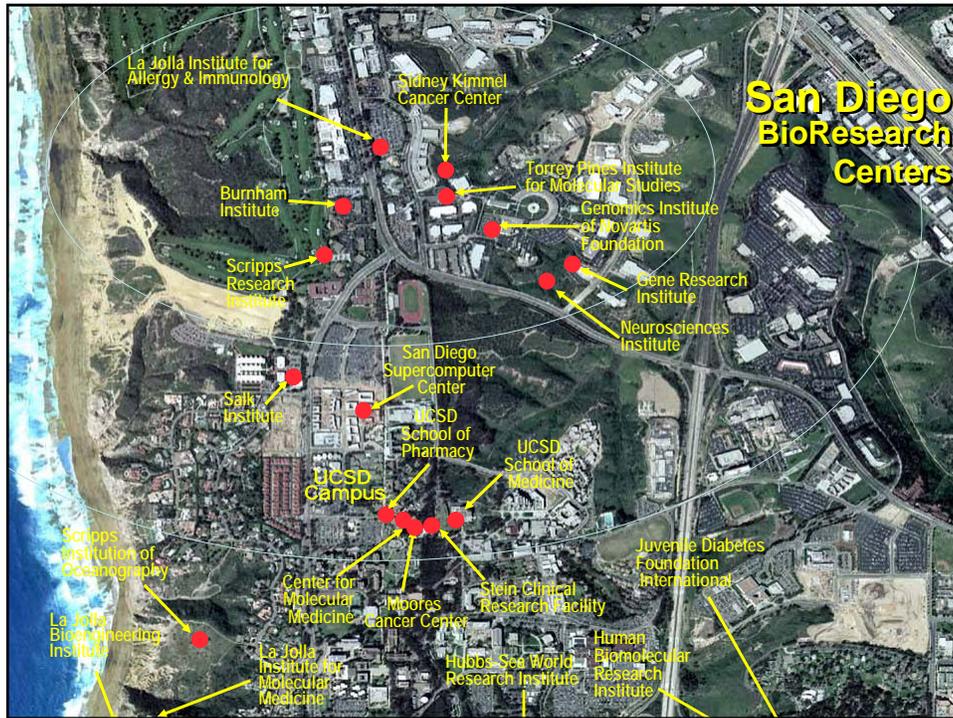
- A growing local population of educated people who welcome and foster change.
- Professional skills outside S&E: economics, law, international reach, business management, education, public policy.
- Codified technical knowledge and information tools to access and transfer it.
- Ethical values, creative culture,
- Potential “honest broker” role.

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## San Diego's High Tech History





## UCSD and Research Neighbors Nucleated Many High-Tech Firms

### University of California San Diego

120 start-ups with UCSD licensed technology

### Scripps medical

40 companies since late 80's

### Salk

20 companies have been founded using Salk technology

### Burnham

4 FDA-approved products, 6 in clinical trials

From Carolyn W. Lee, <cwlee@ucsd.edu>

Source: *Nature*, UCSD, TSRI, Burnham, Salk



## Venture Capital & Large Corporate Investors in San Diego

- Amgen Ventures
- Ampersand Ventures
- Avalon Partners
- Biogen Idec
- Enterprise Partners
- Forward Ventures
- Forrest Binkley Brown
- Hamilton BioVentures
- Hamilton Technology
- Inglewood Ventures
- Johnson & Johnson
- Mission Ventures
- ProQuest
- Shepherd Ventures
- Sorrento Ventures
- Timeline Ventures
- Ventana Capital
- Windamere Partners
- Windward Ventures
- QUALCOMM Ventures

## Summary of lessons learned in CONNECT (San Diego)

- **Each region's innovation capacity ("regional DNA") differs**
  - Every region has its unique path to building its cluster
  - Scientific expertise concentrated in a region is distinct from other regions
  - Regions need to understand what they *truly* have as assets
- **Must couple world-class science with business smarts for successful tech. commercialization**
  - Synergy in a cluster depends on functional social structures between technologists and business community

## Summary of Lessons Learned, cont.

- **Research capacity asset-mapping is a tool**
  - engages regional leadership in an initial dialogue
  - in depth understanding of regional assets
- **Social networks that can accelerate business transactions are a necessary part of the "soft" infrastructure to any successful region**
- **Collaborative institutions are not built overnight**
  - Must engage ALL stakeholders (inclusiveness)
  - Trust building before transactions is key

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## Geographic Diversification of Innovation-Based Growth

- “Systems of Innovation” are not “national”; they are local, (within a commuting range for supportive networks).
- Can we understand why the disparities among cities and regions are so great? Can we learn how to predict emerging areas of innovation clusters – “hot spots”?
- If we can, government should be able to adopt policies that encourage new “hot spots” of innovation.
  - Would support diversification outside big cities
  - Would support more equality in economic opportunity within a nation.
  - Would help measure effectiveness of government-funded R&D for economic growth

## Hot-Spot Cluster Project

- **Hot-Spot Analysis** provides a filter on recent patents by focusing on the 20% of recent patents that reference “hot” patents and that are likely to have impact in the future.
  - Using recent patents with no filtering mechanism is problematic.
  - There are >300,000 patents issued in the last 2 years, and most of them may have little value.
  - Need a filter because identifying early-stage, high-risk technologies is difficult.<sup>3</sup>

## Hot Patents

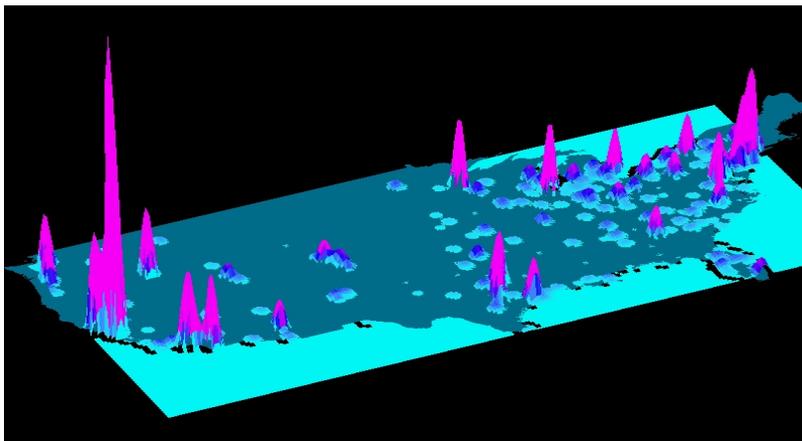
- Can be 1 year or 25 years old; it does not matter as long as they are **highly cited** by recent patents.
  - High citation is correlated with various measures of impact and quality.
  - Very few patents receive many citations. Those that do represent key technologies that have led to many subsequent innovations.
  - A **Hot Patent** has to have 10+ recent citations. Old patents have to have 25% of their citations as recent to be hot spots; new patents have to have a higher proportion

## Next Generation Patents

- The **NEXGEN** patents are the current (“citing”) patents building on hot spot technology (ie Hot Patents).
- Patents in a **Next Generation** group reference one or more patents in the corresponding group of hot (cited) patents.
  - NG represents lots of patent activity around the same hot technology, usually by many companies.
  - NG are often applications developing around a more basic “platform” technology,
  - But – Some NG patents may well represent a new Hot patent from which new clusters of NG patents may arise.

## Visualizing 2002 Hot Patents by Number of their Inventors

Visualization of the 2002 Hot-Spot Patents



	Regions in the Early 1990s MSAs with most inventors of frequently- and recently cited "hot patents" (2002 cohort)	Regions in 2002 MSAs with most inventors of "emerging technology patents" (2002 cohort)	In the Rankings
1	San Jose CA	San Jose CA	-
2	Boston MA-NH	Boston MA-NH	-
3	San Francisco CA	San Francisco CA	-
4	New York NY	New York NY	-
5	Oakland CA	Boise City ID	+4
6	San Diego CA	Oakland CA	-1
7	Minneapolis-St. Paul MN-WI	San Diego CA	-1
8	Chicago IL	Chicago IL	-
9	Boise City ID	Minneapolis-St. Paul MN-WI	-2
10	Los Angeles-Long Beach CA	Austin-San Marcos TX	+1
11	Austin-San Marcos TX	Los Angeles-Long Beach CA	-1
12	Dallas TX	Seattle-Bellevue-Everett WA	+1
13	Seattle-Bellevue-Everett WA	Houston TX	+4
14	Washington DC-MD-VA-WV	Dallas TX	-2
15	Detroit MI	Washington DC-MD-VA-WV	-1
16	Rochester NY	Detroit MI	-1
17	Houston TX	Rochester NY	-1
18	Orange County CA	Portland-Vancouver OR-WA	+2
19	Philadelphia PA-NJ	Orange County CA	-1
20	Portland-Vancouver OR-WA	Philadelphia PA-NJ	-1
21	Newark NJ	Newark NJ	-
22	Bridgeport CT	Bridgeport CT	-
23	Middlesex-Somerset-Hunterdon NJ	Atlanta GA	+2

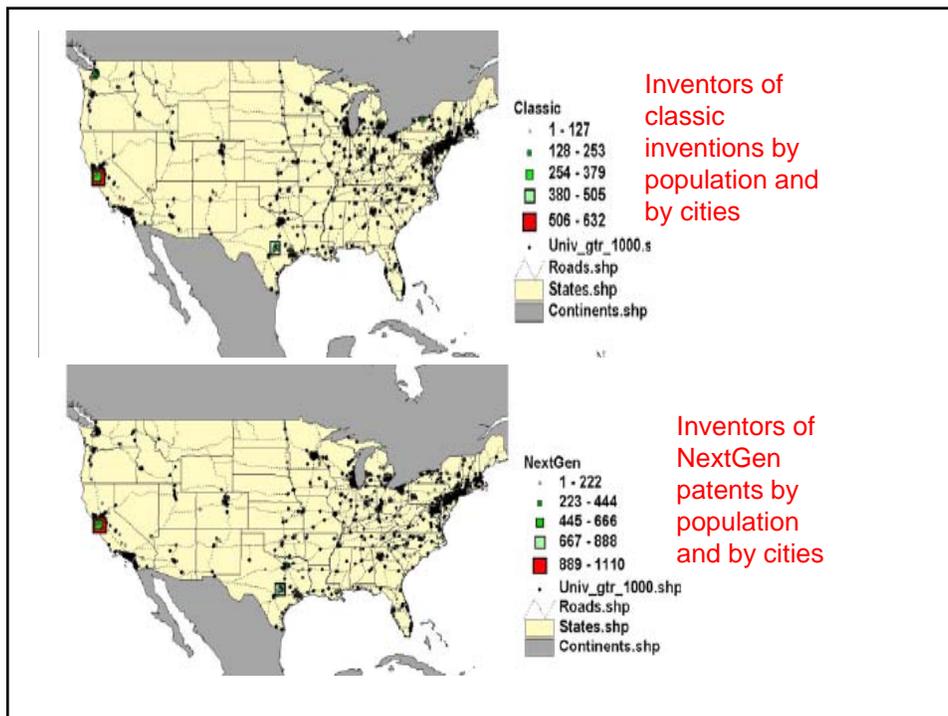
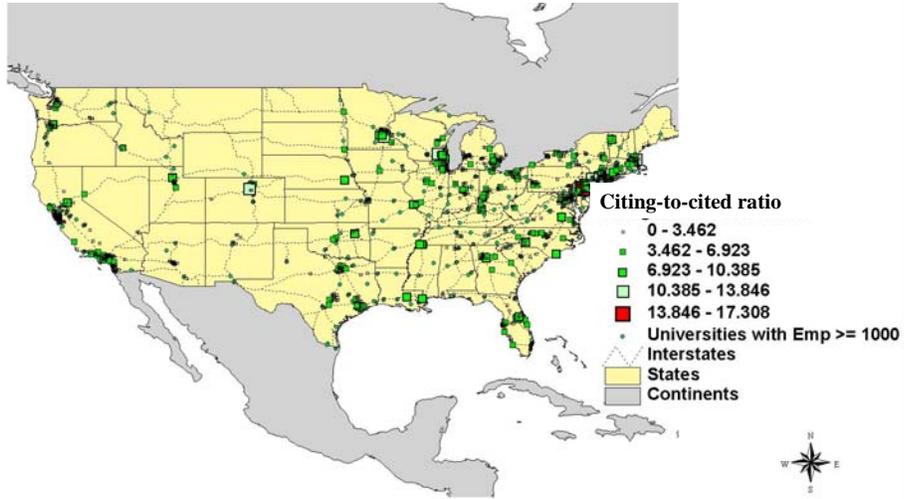
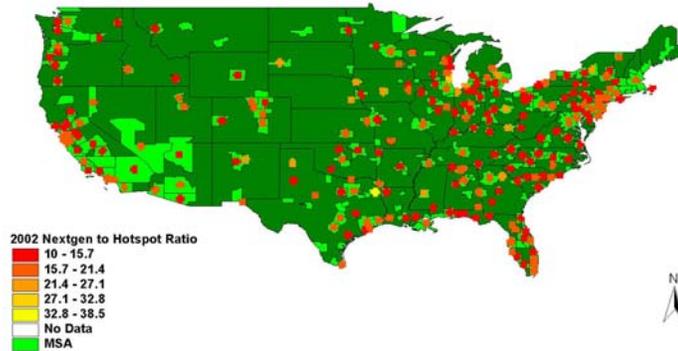


Figure 22. Emerging technology regions, identified by the ratio of citing to-cited patents (both defined by 2002 cohort), by cities



2002: Ratio of citing (NEXGEN) patents to cited (HOT) patents by MSA (not by city as in previous slide)



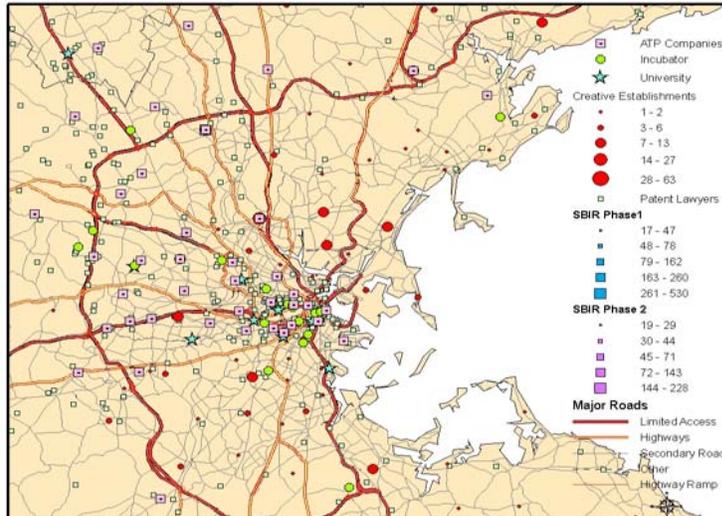
Emerging Technology MSA (high ratio of next generation patents to hot patents)	Population	Hot patent ranking	Incubators	Universities and Colleges
Longview-Marshall TX	213,608	185	1	17
Racine WI	192,284	150	1	9
Huntington-Ashland WV-KY- OH	313,661	119	2	10
Kenosha WI	156,209	186	0	5
Flint MI	442,250	214	1	11
Amarillo TX	224,668	187	1	8
Columbus OH	1,597,271	46	6	46
Gary IN	640,009	151	0	9
Utica-Rome NY	298,077	174	1	9
Santa Fe NM	155,225	80	3	9
Sioux City IA-NE	123,712	163	1	3
Lincoln NE	260,995	175	1	11
Rapid City SD	453,540	188	2	19
Jackson MS	476,751	189	0	29
Des Moines IA	91,881	215	0	11
Benton Harbor MI	162,766	143	2	11
Athens GA	158,853	152	3	6
Champaign-Urbana IL	186,800	153	2	5
Dothan AL	140,707	216	1	8
West Palm Beach-Boca Raton FL	1,216,282	50	4	25
Houston TX	4,496,835	17	10	114
Sherman-Denison TX	115,153	190	0	4
Milwaukee-Waukesha WI	1,514,313	53	9	93
Pittsburgh PA	2,338,671	28	10	57

## ANNEX: Correlation Coefficients

HOT SPOT		NEXTGEN		NEXTGEN/HOT SPOT	
Patent Lawyers	0.532961555	Patent Lawyers	0.531242676	0.149143759	NonCommercial Phys. Research
IT & Software	0.527085683	IT & Software	0.521427035	0.126102704	Manag. Consulting
ATP awards	0.435562689	ATP awards	0.41778179	0.120207246	Patent Lawyers
Nonphysical Res	0.412913104	Nonphysical Res	0.409792585	0.117602617	University/ Colleges
Physical Research	0.36883396	Manag. Consulting	0.36676441	0.093492971	Manag. Services
Manag. Consulting	0.366151798	Physical Research	0.354707465	0.080696082	Nonphysical Res
Eng. Services	0.346291146	Eng. Services	0.336075736	0.079484848	ATP awards
Architectural Services	0.314502664	Architectural Services	0.327139523	0.075782177	IT & Software
Manag. Services	0.284678037	Manag. Services	0.284399373	0.070054754	Live Band/Orchestras
Incubators	0.19850791	Incubators	0.18890777	0.064183555	Architectural Services
Live Band/Orchestras	0.184166188	Live Theatre	0.180585534	0.063449659	Civic & Social Asso
Live Theatre	0.181129472	Live Band/Orchestras	0.17119402	0.056667691	Business Asso
Book Stores	0.166601545	Testing Labs	0.16563953	0.056212397	Testing Labs
Testing Labs	0.166509735	NonCommercial Phys. Research	0.156525111	0.035462568	Physical Research
NonCommercial Phys. Research	0.144697441	Book Stores	0.154197309	0.023201531	BowlingCenters
Hobby Shops	0.086858166	Museum & Art Galleries	0.081108527	0.016750784	Hobby Shops
Museum & Art Galleries	0.079867567	Hobby Shops	0.07284976	0.009616558	Souvenir/Gift Shops
Souvenir/Gift Shops	0.079188423	Souvenir/Gift Shops	0.067329736	-4.36407E-05	Live Theatre
Business Asso	0.04774181	Business Asso	0.048303867	-0.003360511	Incubators
Civic & Social Asso	0.044880013	Civic & Social Asso	0.024303223	-0.005611685	Eng. Services
BowlingCenters	0.030983165	BowlingCenters	0.015256805	-0.022928976	Religious Org
University/ Colleges	-0.024951002	University/ Colleges	-0.017486347	-0.033976616	Museum & Art Galleries
Religious Bookstores	-0.088466167	Religious Bookstores	-0.086639855	-0.048564307	Race Tracks
Correctional Facility	-0.092054576	Correctional Facility	-0.095456399	-0.065884071	Book Stores
Race Tracks	-0.123531366	Race Tracks	-0.130536896	-0.094654324	Religious Bookstores
Religious Org	-0.221488686	Religious Org	-0.223001524	-0.102401632	Correctional Facility

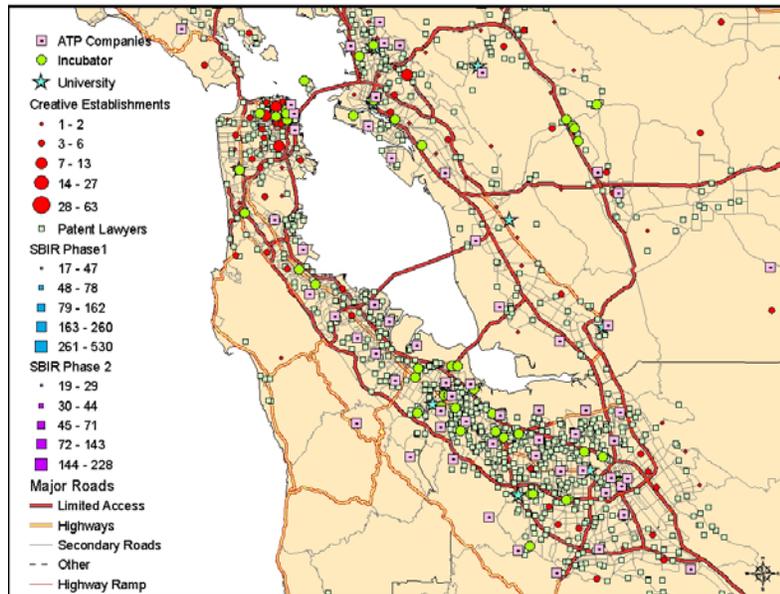
## Boston (MA) metro area, by zip code:

ATP award-recipient firms, SBIR award-recipient firms, universities, intensity of patent lawyers, and number of bands & orchestras (SIC code 7929, Bands, Orchestras, Actors and Other Entertainment Groups, labeled "creative establishments" on map).



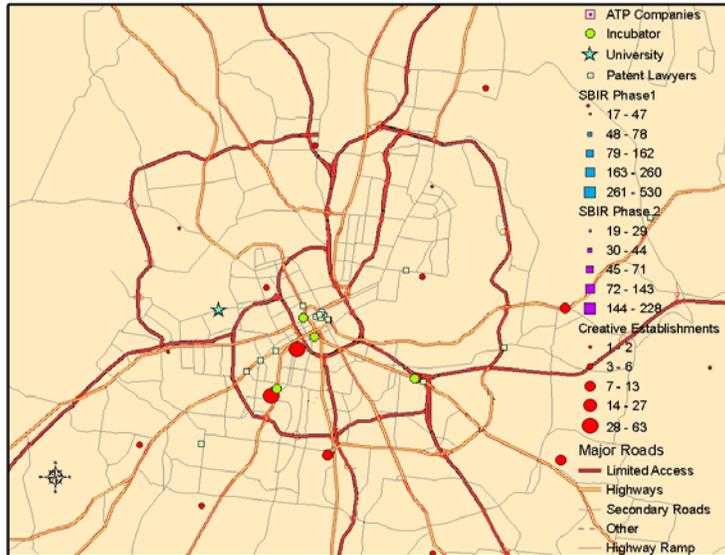
## San Francisco Bay area, by zip code:

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## Nashville (TN) area, by zip code:

ATP award-recipient firms, SBIR award-recipient firms, universities, intensity of patent lawyers, and number of bands & orchestras (SIC code 7929, Bands, Orchestras, Actors and Other Entertainment Groups, labeled "creative establishments" on map).



## HOT SPOT ANALYSIS

### Most Highly Correlated Attributes

- 0.149144 • Non-profit physical research
- 0.126103 • Management Consulting
- 0.120207 • Patent Lawyers
- 0.117603 • University/ Colleges
- 0.093493 • Management Services
- 0.080696 • Non-physical Research
- 0.079485 • ATP awards
- 0.075782 • IT & Software
- 0.070055 • Live Band/Orchestras
- 0.064184 • Architectural Services
- 0.063450 • Civic & Social Associations
- 0.056668 • Business Associations

## HOT SPOT ANALYSIS\*

### Negatively Correlated Attributes

- -0.00336
- -0.00561
- -0.02293
- -0.03398
- -0.04856
- -0.09465
- -0.10240
- *Incubators*
- *Eng. Services*
- *Religious Org*
- *Museum & Art Galleries*
- *Race Tracks*
- *Religious Bookstores*
- *Correctional Facility*

\*Unpublished work of P. Auerswald, Sean Gorman, Rajendra Kulkarni, Laurie Schintler,, (George Mason University) and Lewis Branscomb (UCSD and Harvard)

### Do Hot Spot Clusters Validate ATP project selection process?

- Only 20% of ATP-related patents are found in 2002 NEXGEN clusters, but
- 47% of ATP-related patents are found in 2002 NEXGEN clusters, and
  - 44% are found in 1998 clusters.
- Remember criterion for ATP has been to focus on national leverage, not hot spots.



## Findings

- **Few places excel, but many accelerate.** While levels of innovation are highly concentrated, emergent innovation activity is broadly distributed.
- **Within MSAs, different types of creative professionals locate in different places.** While Florida and others found that the concentration of creative professionals explains differences in innovative output among MSAs at national scale, not so at zip code scale.
- **Differences within states are as great as differences between states.**

- **Technologies migrate.** In most cases, technologies appear to diffuse outwards from a few source points rather than concentrate (figures 29-32).
- **Mid-sized cities are big; peripheries are central.** In a number of large MSAs, emergent innovative activity is taking place in mid-sized cities and in urban peripheries rather than in established locales.

## Work to Do

- Ground Truth: Field interviews and data gathering in MSAs identified as emergent.
- Develop way of adding data from industries that rely on other forms of IP.
- Investigate large MSAs that seem very far from developing high tech innovation cluster.
- Understand what government policies would optimize their contribution to new clusters.
- And understand appropriate policies for universities and governments.

## Resolving the University Mission and the Federal Role in Innovation

- How far should research universities go in
  - Performing applied research for high tech companies?
  - Encouraging the formation of spin-out firms?
    - Taking equity interest in such firms
    - Creating university-funded seed venture funds
  - Shifting professional school emphasis to lucrative executive programs for business?
- Should government encourage universities to lead creation of high-tech? If so, how?

Figure 19 illustrates the same phenomenon seen in figure 18 at a micro scale instead of a macro scale. The map shows the Manhattan area of New York along with the density of information infrastructure, ATP award winners, and R&D labs. The map clearly shows the ATP award winners locating along major fiber optic trunk lines, while the large number of R&D facilities is evenly distributed across the landscape.

**Figure 19.** Fiber optic cable, ATP award winners, and R&D laboratories, New York metropolitan area.  
*Data sources:* GMU project on critical infrastructure mapping, ESRI Business Analyst.

