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Center for Nanotechnology in Society

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Who is the Nanotechnology Economy? Obstacles and Methods of Identifying and Estimates of U.S. Nano Firms & Workers

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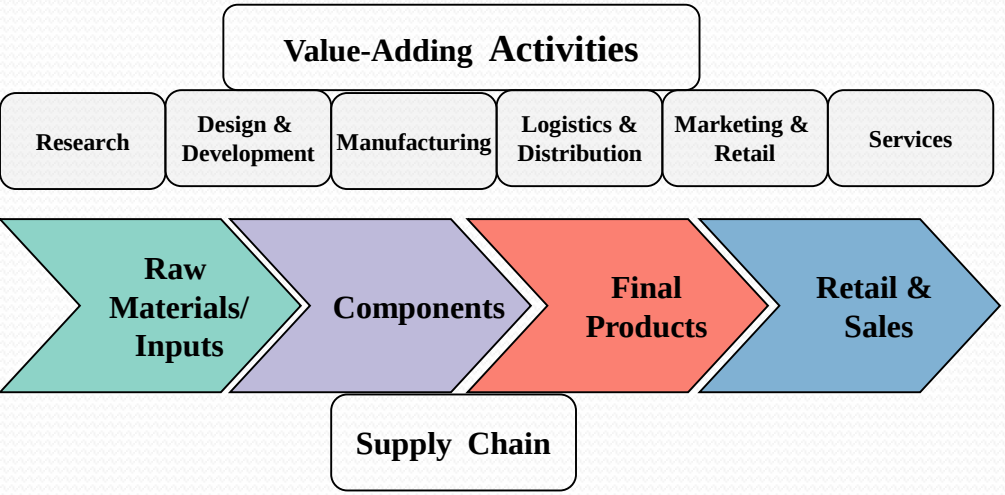
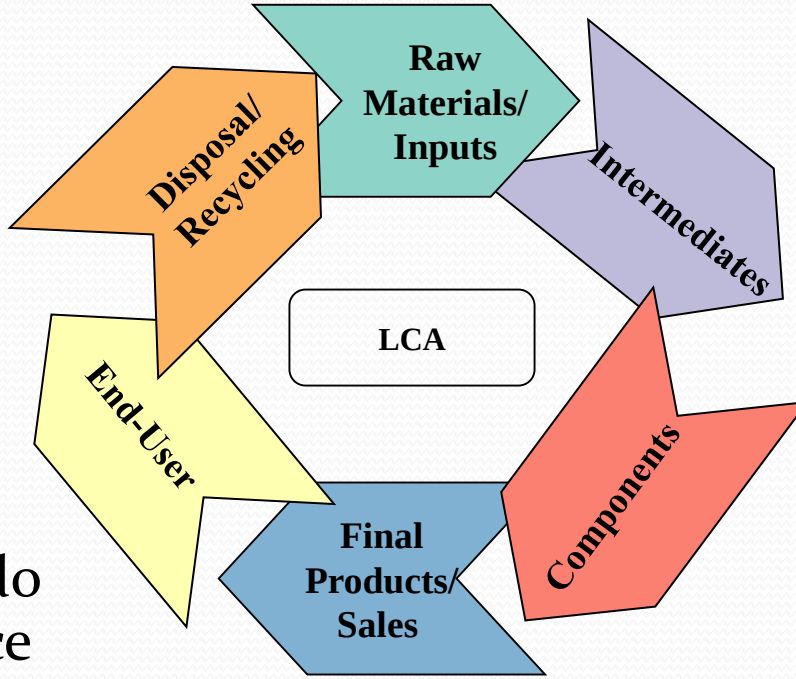
Duke
CENTER on GLOBALIZATION, GOVERNANCE & COMPETITIVENESS
at the Social Science Research Institute

Goals & Obstacles

- **Goal/Objective:** Track and measure economic, social and/or environmental impacts related to nanotechnology.
  - Positive: return on investment, job creation, revenue generation, energy efficiency
  - Negative: exposure & risk
  - Common key variables: firms, workers, products & geography
- **Obstacles:**
  - Nanotechnology is not an industry; it enables developments in all industries in different ways
  - U.S. firms are not required to disclose activities on nanoscale
  - No centralized effort to collect nano firm/product/worker data
  - No firm or product classification
  - Need to track developments along the entire value chain

Value Chain Analysis -> Life Cycle Assessment

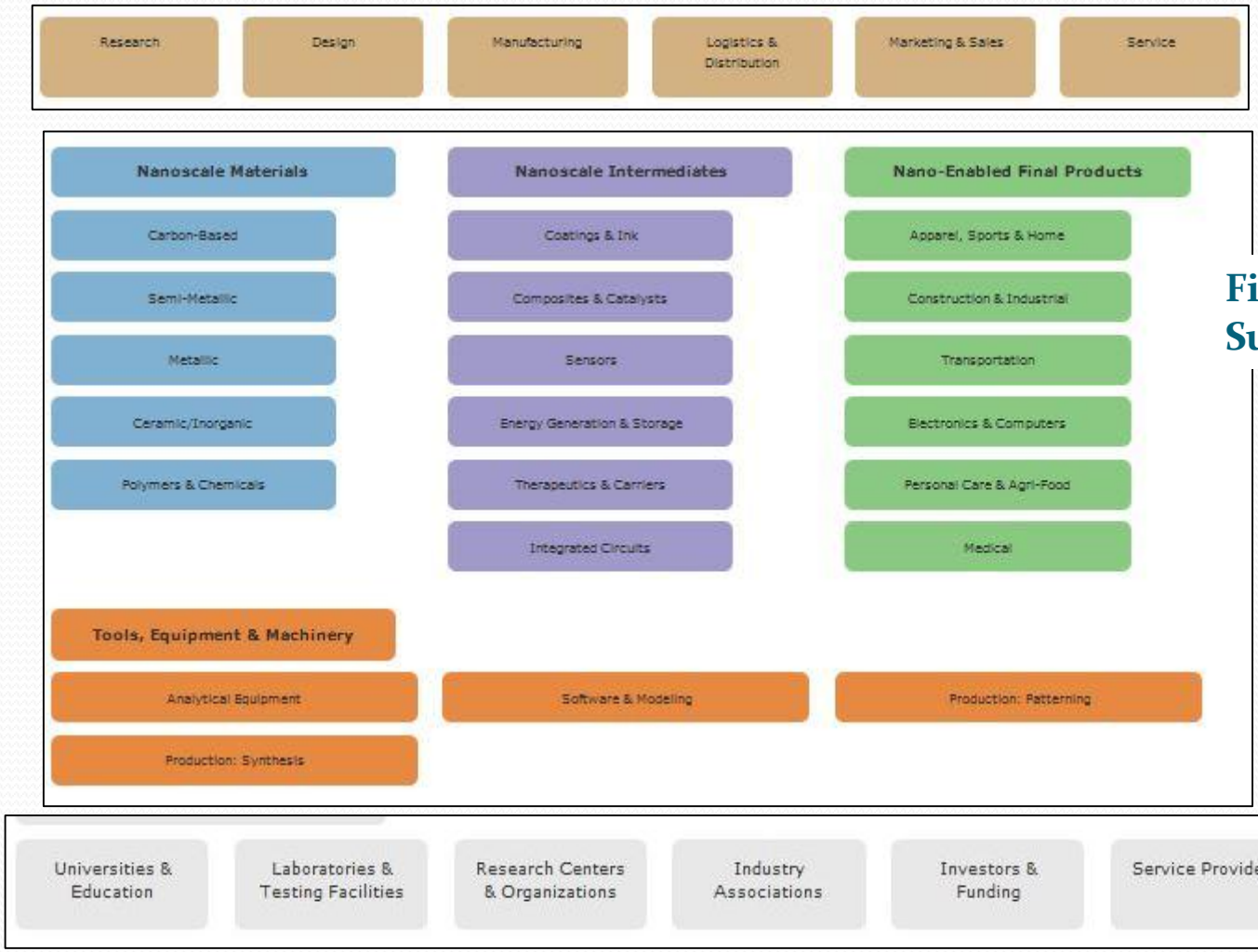




- Value chain: activities firms and workers do in the process of creating a product/service
  - Physical alterations (supply chain) + activities that add value (research, branding, services)
  - Six main activities – need to identify firms in each stage performing each activity

Value chain, supply chain, production network, life cycle analysis – different research questions, rely on same data

Basic Nano Value Chain Model Overview



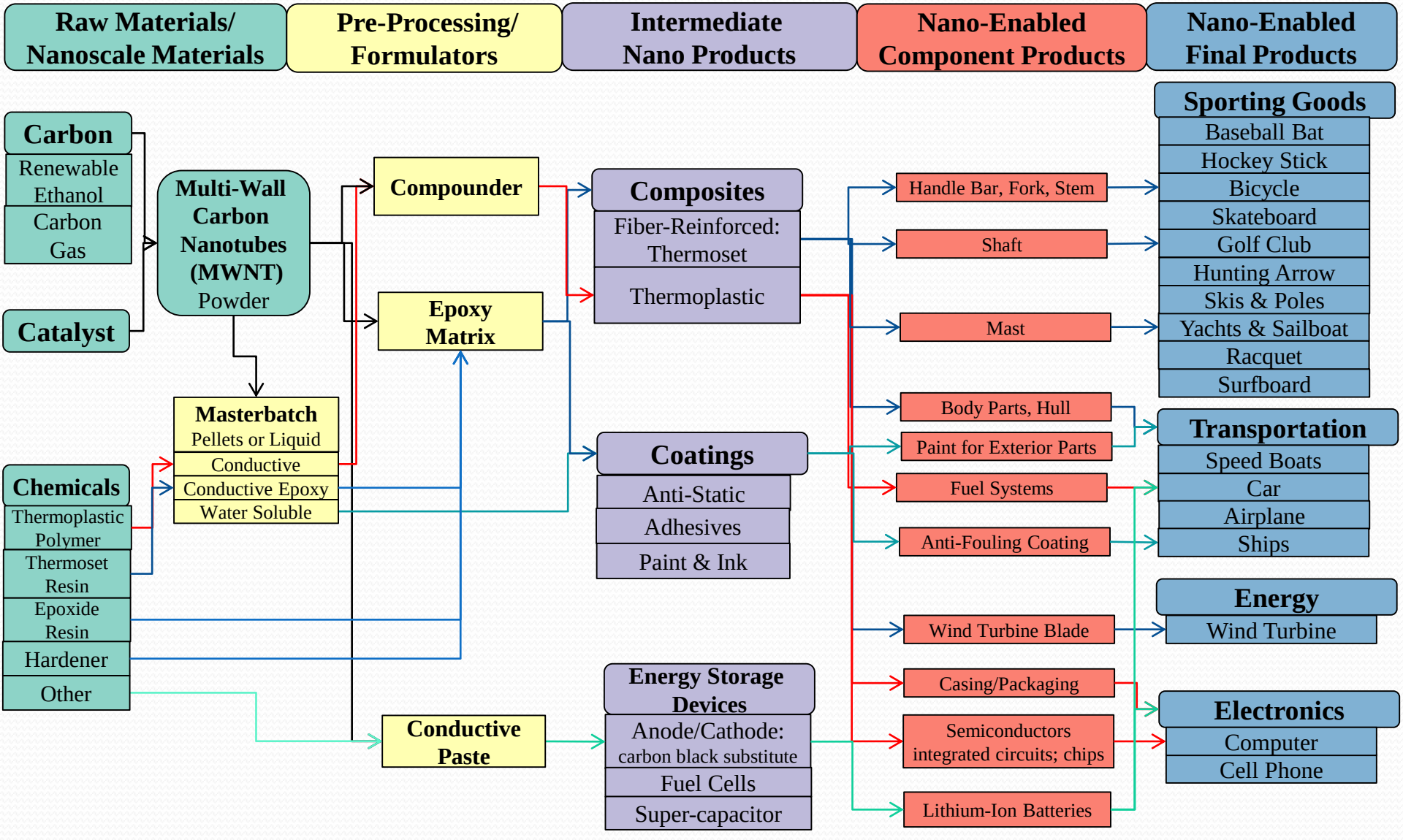
Value-Adding Activities

Firms / Supply Chain

Layers: 120+
Stages: 5
Sectors: 27
Subsectors: 91

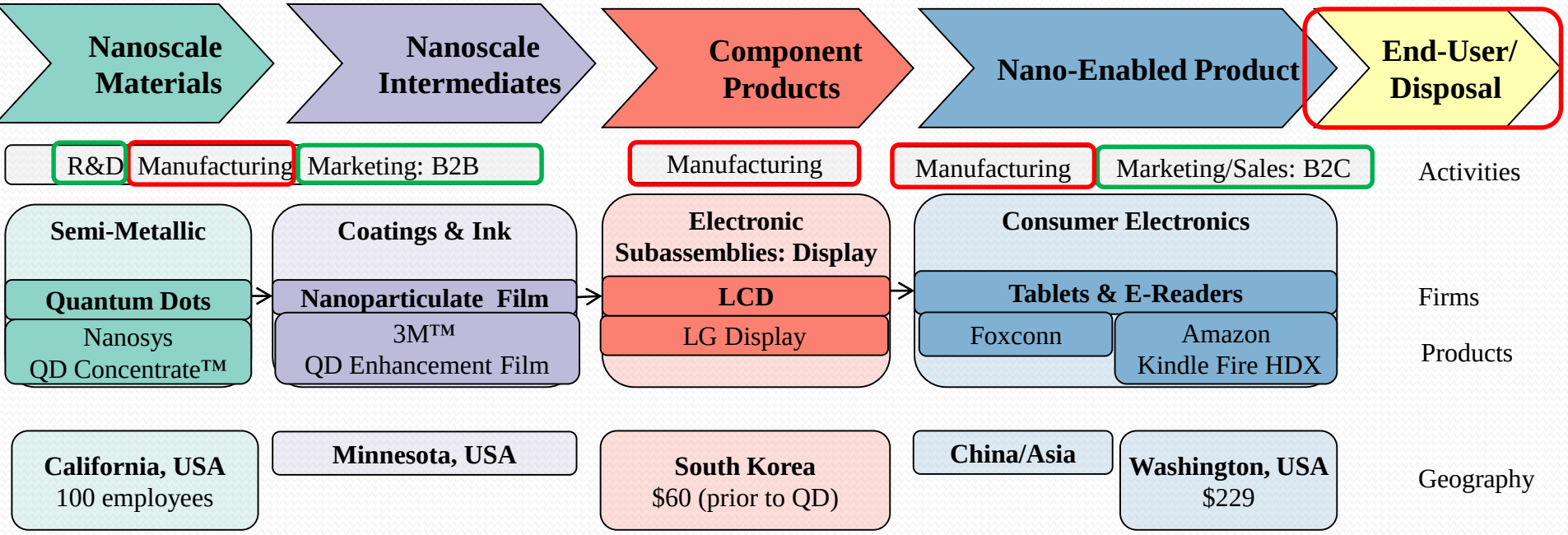
Supporting Organizations

Value Chain Mapping Example: MWNT Applications



Value Chain Mapping Example

Quantum Dots in Displays



Publicly discuss collaboration; mention quantum dots; no change to mfg. process; improves color; more energy efficient

No claims

"Perfect color"

Claims

Red: negative exposure & risk
Green: positive benefits

Strategy 1: Firms/Organizations ->Workers

Broad

- Identify firms
- Find total number of workers employed by firms and organizations purportedly engaged in some degree of nano-related development by location

Focused

- Estimate 'nano' portion of total employment
  - Based on degree a stakeholder appears to be focused on nano-related activities
  - Apply percentages to total employment
    - Nano-specific: 100%
    - Partial or Micro/Nano: 10- 50%
  - Subjective, yet important step towards more accurate estimates

Strategy 1: Identify Firms

Data & Methods to Identify Firms and Metrics

Research | **Design & Development** | **Manufacturing** | **Logistics & Distribution** | **Marketing & Retail** | **Services**

Industry , Worker & Product Classification Codes (NAICS, SOC, HS, etc.) — Do not exist for nanotechnology

Publications

Patents

Government Funding

→ Only capture a subset of value-adding activities

Lack supporting methodology & dataset

Expert Opinion Statistics

Firm-Level Reports & Directories

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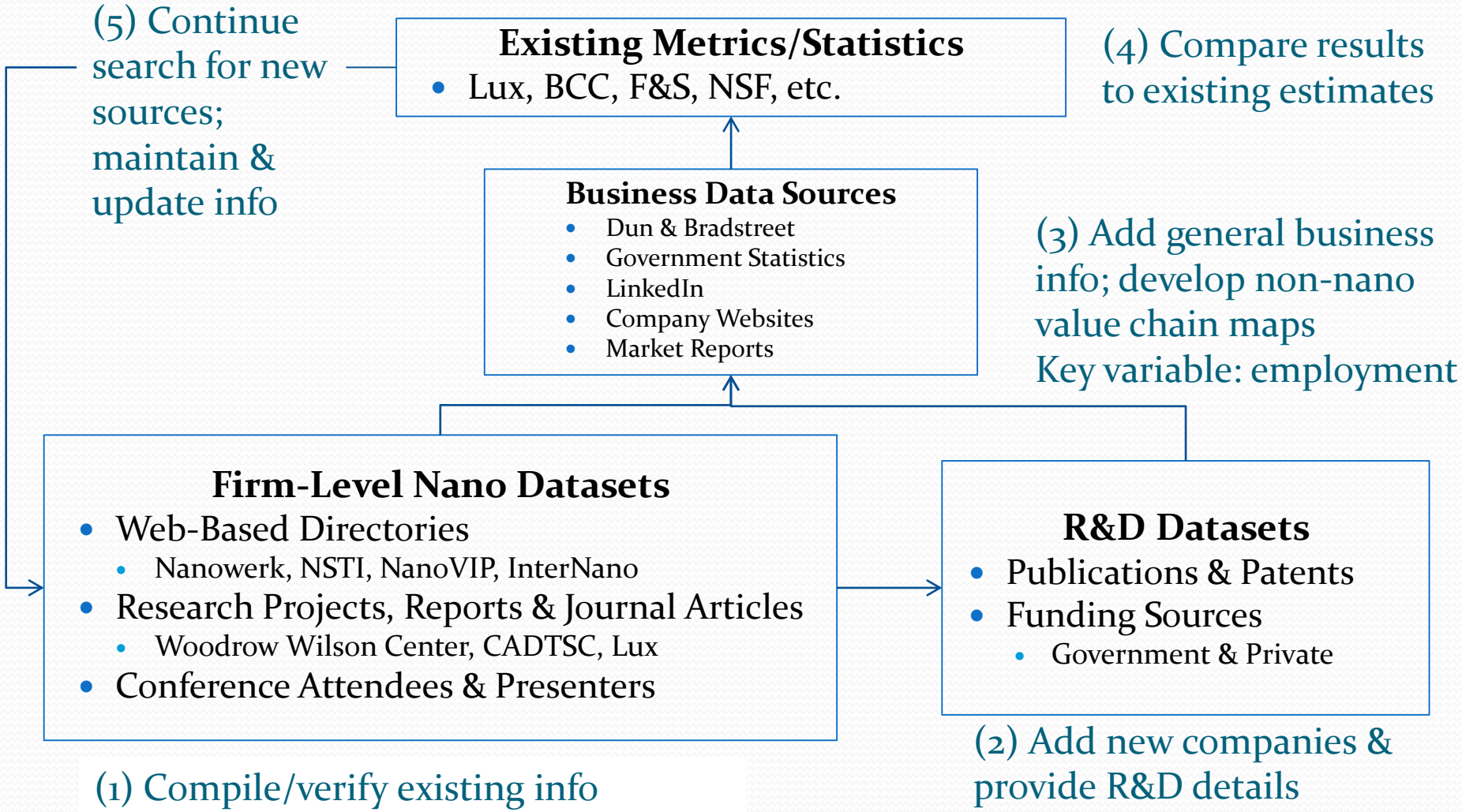
Often one-time efforts * Limited scope (geography, activities or supply chain) * Several lack a methodology

Strategy 1: Data Collection & Estimate Model



Strategy 1: Initial Results

- Firms & Organizations
  - Locations: 2,125
  - Employment:
    - Total: 446,900
    - Share (10-50%): 52,200-224,200
- Firms->Classification Codes: top three NAICS codes at three-digit level: 60% of all firms
  - Computer & Electronic Product Mfg. (NAICS 334): 23%
  - Professional, Scientific & Technical Services (NAICS 541): 23%
  - Chemical Mfg. (NAICS 325): 15%
- Shortcomings/Findings:
  - Employment at nano-specific companies low (~2% overall)
  - Top five states (CA, MA, NY, TX & PA): ~50% of U.S. firm locations and total employment
- Next Steps
  - Refine focus areas using subsequent strategies & primary research
  - Primary data; focus on states with largest shares of firms/workers
  - Long term: produce data useful for classification development; potential micro-data project

Strategy 2: Workers->Firms

- Companies and people can select "nanotechnology" as industry on LinkedIn
- People:
  - Global: 105,390
  - USA: 24,800
  - California: 5,060
- Companies
  - Global: 1,353
  - USA: 389
  - California: 77
- Shortcomings/Findings:
  - Likely underrepresents manufacturing
  - "Noise" – fake profiles
  - Benefit of being self-reported
- Next Steps
  - Collect data on occupations
  - Identify shares of nano employees at firms to help refine focused employment estimates
  - Add new companies to track

People & companies selecting "nanotechnology" as their industry on LinkedIn : October 16, 2013

Strategy 3: Education->Workers->Firms

Identifying potential "supply" (in-progress)

- Identified U.S. education nano-related programs
  - Community college & universities: 88 programs
    - 50 degree programs & 38 minors/concentrations
- Identify students engaging in nano-related research
  - Search U.S. dissertations for nano-related terms
    - 1997-2009: 4,800 people[+]

- Next Steps
  - Survey of programs to get number of graduates
  - Update dissertation data through 2012
  - Track students into the workforce

[+] Walsh & Ridge (2012). Knowledge production and nanotechnology: Characterizing American dissertation research, 1999-2009. Technology in Society (34), 127-137.

U.S. Nano Workforce Estimates (2010-13)

United States: Existing Estimate (2010)[+]: 220,000

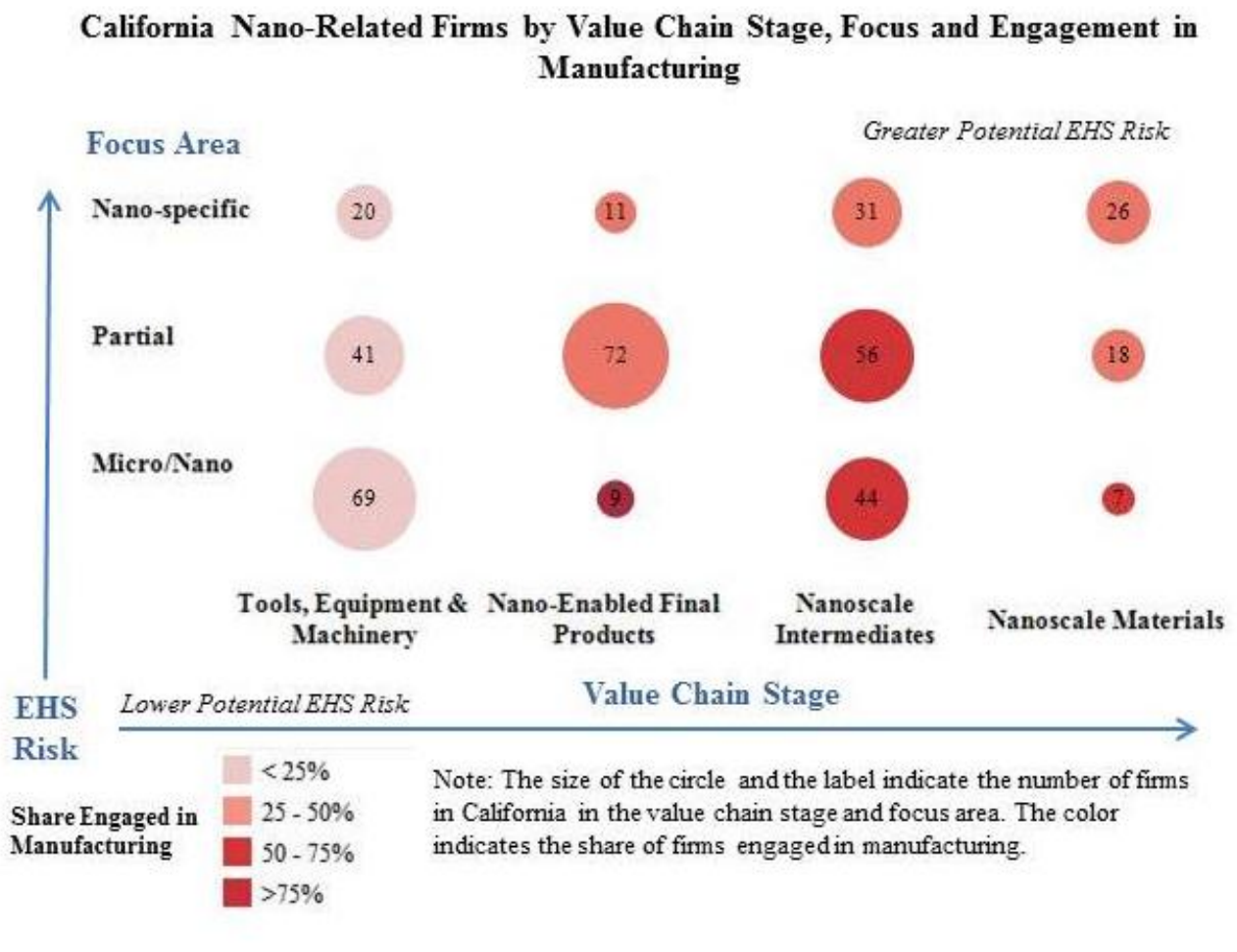
Preliminary estimates based on presented methods:

1) Upper: (all locations, all employees): 446,900
   - Focused (~50%): 224,200
   - Focused (~25%): 116,700
   - Focused (~10%): 52,200
2) Lower (LinkedIn): 24,800
3) Potential "supply": 4,800 + graduates (TBD)

- Focus so far has primarily been on methodology and database development
- Numbers represent people potentially employed due to nanotechnology; not the number of people that will come into contact with nanomaterials

[+] Roco. (2012, March 28). Nanotechnology Research Directions for Societal Needs in 2020. OECD/NNI Int'l Symposium on Assessing the Economic Impact of Nano, Washington, DC.

Application of Data for EHS

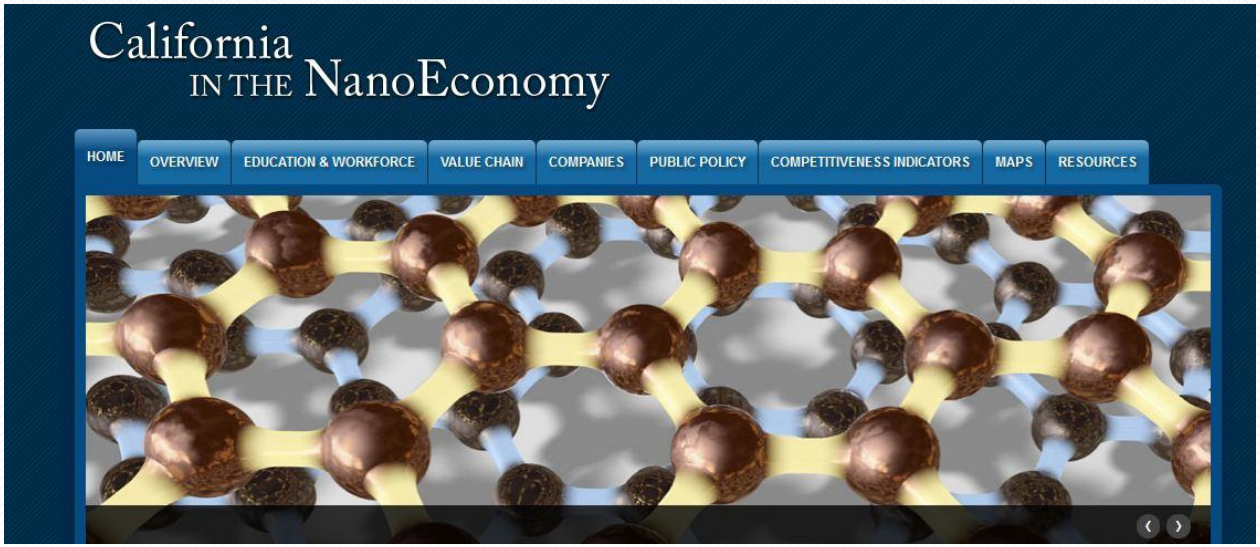


Frederick (2013); based on data from California in the Nano Economy.

California in the Nano Economy

www.CaliforniaNanoEconomy.org

- Industry and education-focused website for the nano community
- Presents California's footprint in nanotechnology
- Interactive, web-based application of a value chain research approach



Main Areas

- Firms & Products
- Value Chain Mapping
- Education and Workforce Development Programs
- Public Policy and Economic Development Initiatives

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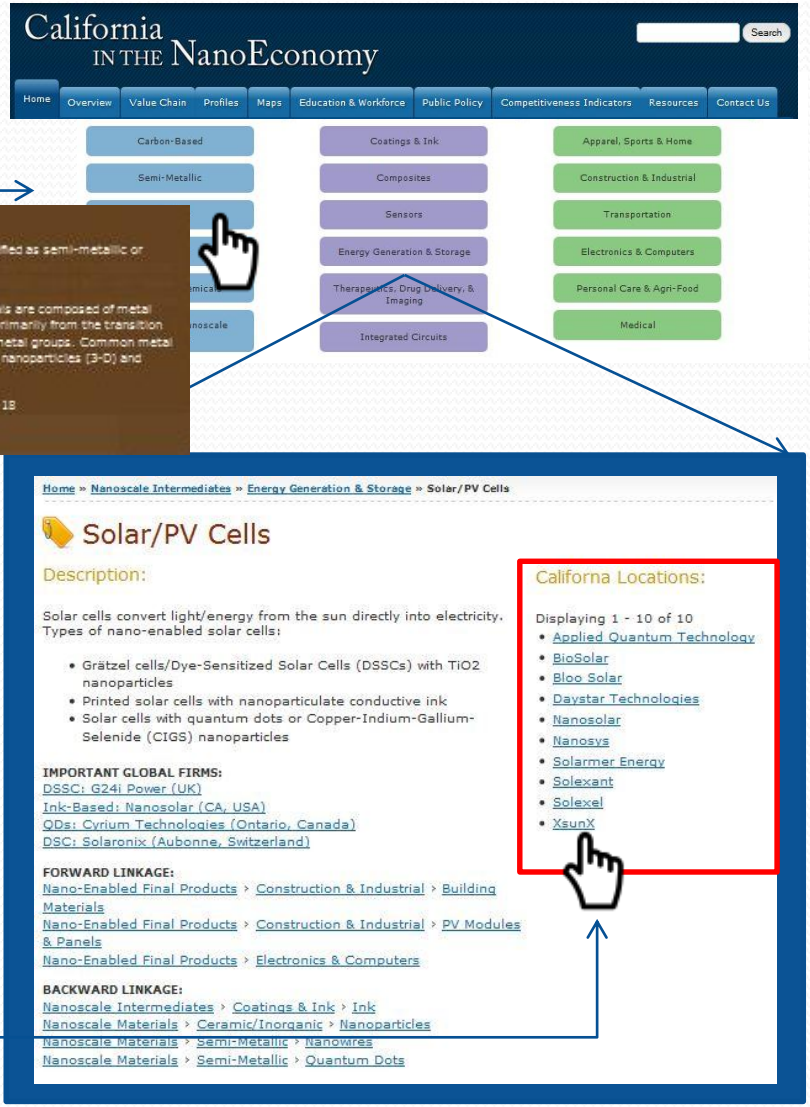
Value Chain Section

Educational

- Interactive value chain diagram
- Hover cursor over boxes for description & stats
- Click boxes for detailed info
  - Forward & backward linkages
  - Important global firms & organizations
  - Manufacturing methods
  - California locations



Firm & Organization Data

- **Location Pages (Fig. 1)**
  - Physical Location & Basic Info
  - Value Chain Mapping
  - Products
- **Profile Pages:** 100+ more-detailed profiles of firms & organizations
  - Company Overview
  - Buyers , Suppliers & Strategic Partners
  - Innovation & Technology

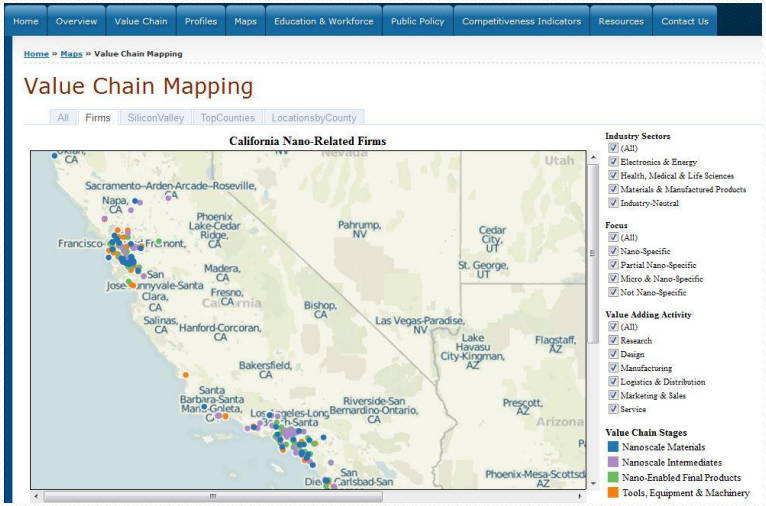


Fig. 2: Interactive Geographic Maps of Nano-Related Firms & Organizations

Fig. 1: Example Location Page on California in the Nano Economy Website

- **Maps:** interactive, geographic maps of locations by key variables (Fig. 2)

Summary

- Ability to measure and track impacts of nano (environment, social, economic) depends on ability to identify key actors: firms, workers & geography
  - Same data central to research questions from various groups; different terms, same fundamental ideas
- Complex process for nano but enough data exists to begin the process
- Focus of this research is to begin to put the necessary pieces together and make information available for multiple uses

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Thank you!

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