Nano-focused business resources and perspectives for future founders of university-based nano-ventures

Think NanoPreneurship™

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Think NanoPreneurship concept born from a project funded by the National Science Foundation

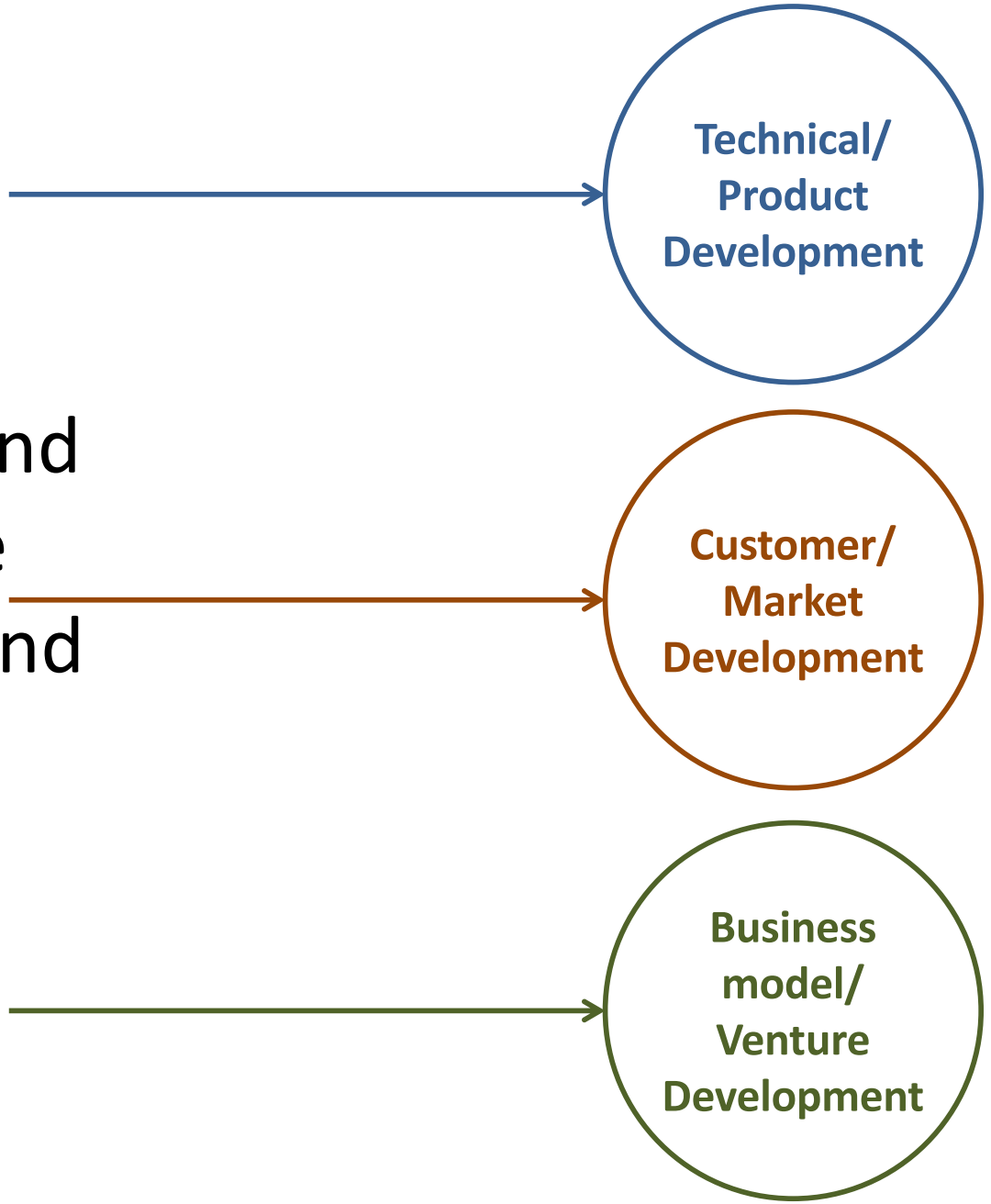
Agenda/outline

- Overview of a general approach to entrepreneurship
- Special considerations for nanotechnology-driven entrepreneurs and their new ventures
- Next steps for future nanopreneurs

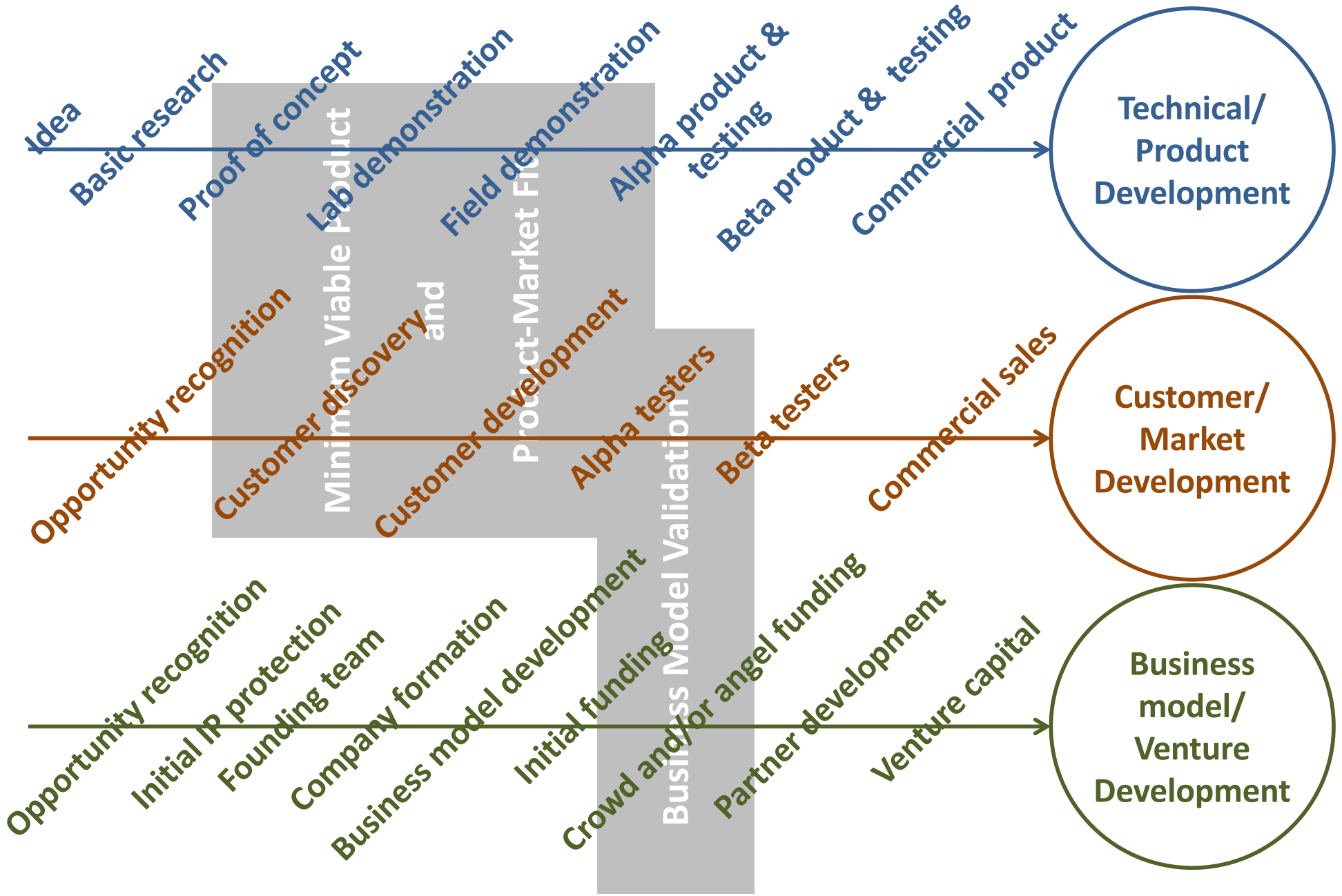
Overview

GENERAL ENTREPRENEURSHIP

Technology commercialization requires entrepreneurs/founding teams to juggle three concurrent and interconnected development processes

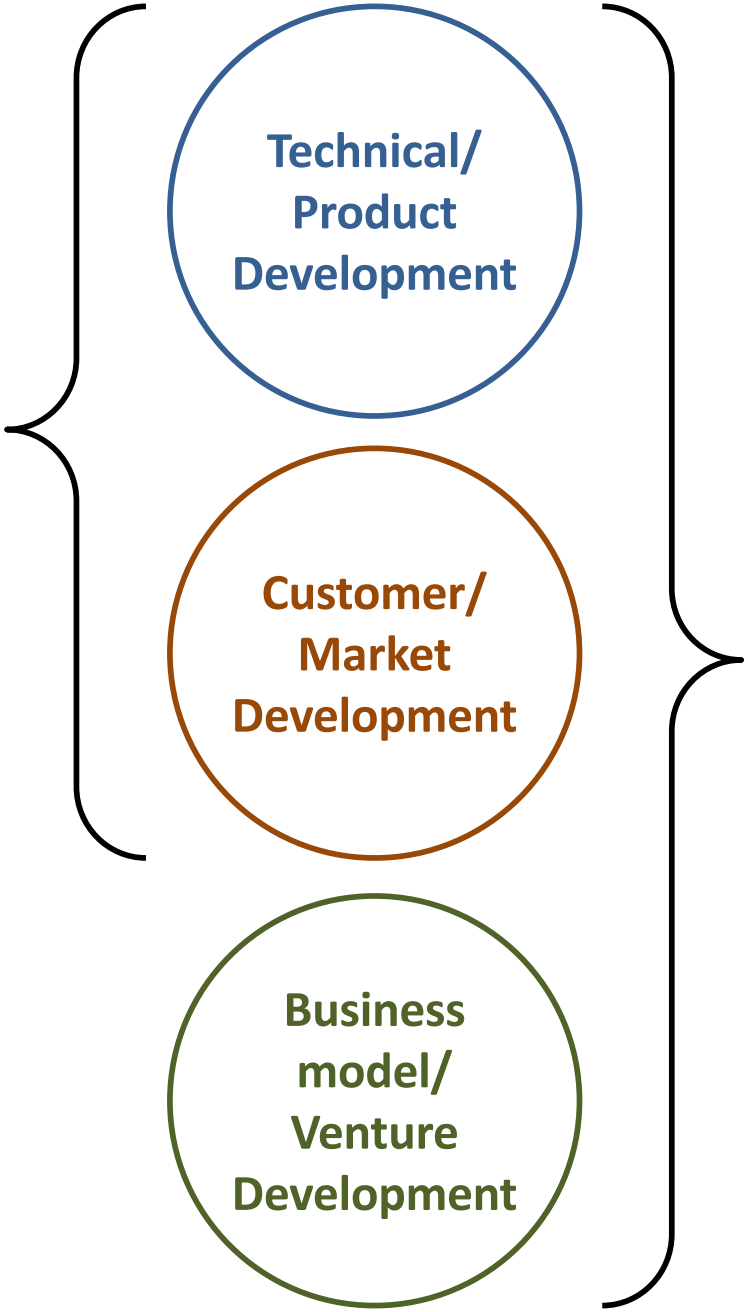


Generic iterative, interdependent steps*



* Order of the steps varies. Iteration back to earlier steps is almost always necessary.

Product/market fit (alignment of the product with customer priorities) **enables success in the marketplace**



Product/market/ business model fit (alignment of the business model with the product and customer priorities) **enables new venture success**

If these generic processes apply to every technology-driven venture, why Think NanoPreneurship™?

Because every nanopreneur will benefit from awareness of special challenges related to industries, technologies, and markets when making decisions about

Special issues for nanotechnology-based ventures and entrepreneurs

NANOPRENEURSHIP

Special Challenges

Nano-entrepreneurs may need to:

- Work across an extraordinary range of scientific and engineering disciplines.
- Think through the NewCo's immediate markets and customers as well as end users (customers' customers)
- Develop and utilize an exceptionally broad range of funding and non-funding resources

Factors to consider:

- Applications in multiple industries
- Integration into a customer's product
- Technology related product development options
- Complicated resources landscape

Key question:

How will you characterize your NewCo?

Industries as Markets

Industries that integrate nanotechnologies into their products are the nano-entrepreneur's markets:

- Solar
- Battery
- Electronics/computing
- Coatings and paints
- Materials
- Cosmetics
- Clothing/apparel
- Textiles
- Pharmaceuticals
- Consumer products

Factors to consider:

- Growth
- Profitability
- Structure
- Innovation customs/culture
- Customers/markets served
- Regulations/standards
- Competitive landscape

Key question:

Which industry(ies) will you pursue as your first market?

An invention may have potential applications in multiple industries. Some examples from UMass Amherst labs…

Invention	Applications
Rapid Colorimetric Sensor for Detection of Bacteria in Water (V. M. Rotello, Ph.D. + 2) Retrieved 6/20/16 from http://tto-umass-amherst.technologypublisher.com/tech/Rapid_Colorimetric_Sensor_for_Detection_of_Bacteria_in_Water	• Rapid detection of bacteria in recreational water • Rapid detection of bacteria in drinking water, beverages, and food
Natural-Polymer Nanofiber Mats with Enhanced Antimicrobial Properties (J. Schiffman, Ph.D. + 1) Retrieved 6/20/16 from http://tto-umass-amherst.technologypublisher.com/tech/Natural-Polymer_Nanofiber_Mats_with_Enhanced_Antimicrobial_Properties	• Drug delivery/wound healing scaffolds • Medical fabrics, surfaces, and devices • Military protective clothing and textiles • Agriculture protection from pesticides • Food processing and packaging • Anti-corrosive surface coating • Separation barriers

More examples from UMass Amherst labs…

Invention	Applications
Optically-Responsive Quantum-Dot-Based Sensors for Rapid Detection and Quantitation of Bioanalytes (T. J. Mountizaris, Ph.D. +1) Retrieved 6/20/16 from http://tto-umass-amherst.technologypublisher.com/tech/Optically-Responsive_Quantum-Dot-Based_Sensors_for_Rapid_Detection_and_Quantitation_of_Bioanalytes	• Point-of-care medical diagnostics • High-throughput screening of biomolecules for drug discovery and development • Rapid testing of biological threats for public safety and military applications
Direct Surface Attachment Methods for the Preparation of Light Emitting Quantum Dot Nanoparticle - Poly(phenylene vinylene) Composite Materials (T. Emrick, Ph.D. + 2) Retrieved 6/20/16 from http://tto-umass-amherst.technologypublisher.com/tech/Direct_Surface_Attachment_Methods_for_the_Preparation_of_Light_Emitting_Quantum_Dot_Nanoparticle_-_Poly(phenylene_vinylene)_Composite_Materials	• Fabrication of light-emitting devices such as light-emitting diodes, solar cells, photon counters, sensor materials, materials for flat panel displays.

Companies as Customers

Companies operate within industries and can vary widely.

Companies can cut across different industries or belong to more than one industry.

Within an (industrial) market, some companies will be potential early customers while others will not.

Factors to consider:

- Needs and wants
- “Jobs” to be done
- Segments
- Niches
- Individual prospects
- Specialization
- Technology adoption habits
- Purchasing practices

Key question:

Which companies within an industry will you target as potential early customers?

Technology Readiness and Product Options

Technology development may be necessary to enable product development

- Performance beyond the laboratory
- Scalability
- Manufacturability
- Reliability
- Durability

Technology Readiness Level (TRL) is a commonly applied metric

Factors to consider:

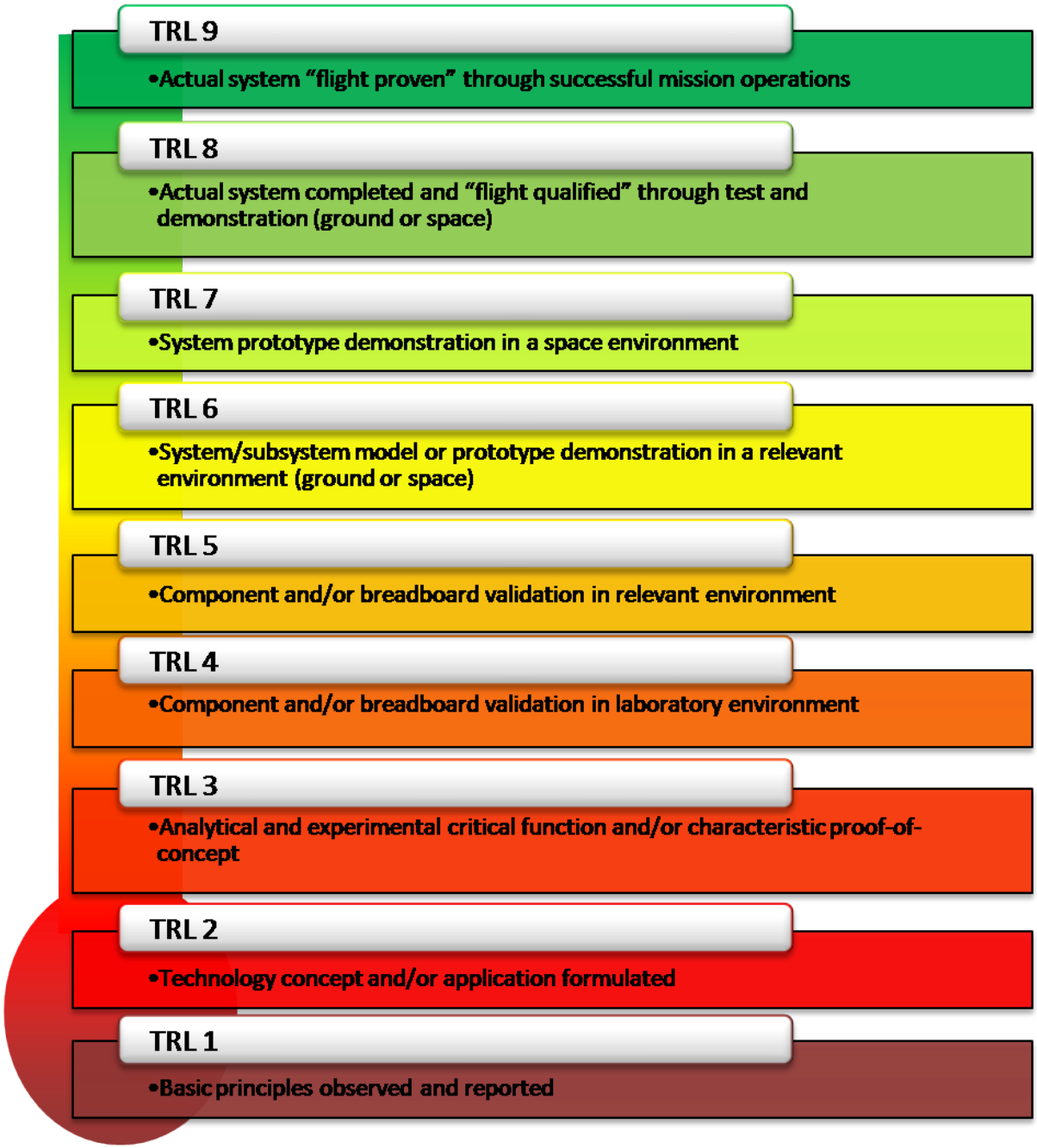
- NewCo's capabilities
- Time to market
- Customer requirements
- Product requirements
- Competitive landscape
- Regulations and standards

Key questions:

What product(s) is the NewCo capable of delivering? What product does it want to deliver?

The Technology Readiness Level (TRL) is a well known “measure” of technology development.

Here is NASA’s version.



Retrieved 3/21/16 from https://www.nasa.gov/directorates/heo/scan/engineering/technology/txt_accordion1.html

Regulations and Standards

Different government organizations, laws, industries, products, or customers may subject the NewCo to a variety of regulations, standards, or guidelines:

- Terminology, methods, measurements
- Product safety
- Product efficacy
- Environmental impact
- Nano-focus
- Industry-focus

Factors to consider:

- Government regulators
- Standards organizations
- Industry practices

Key question:

What are the likely implications (challenges and opportunities) of regulations, standards, guidelines, and practices on technology, customer, and venture development?

ANSI Nanotechnology Standards Panel

The American National Standards Institute's Nanotechnology Standards Panel (ANSI-NSP) serves as the cross-sector coordinating body for the purposes of facilitating the development of standards in the area of nanotechnology including, but not limited to, nomenclature/terminology; health, safety and environmental aspects; materials properties; and testing, measurement and characterization procedures.

Nanotechnology, as defined by the National Nanotechnology Initiative, is the understanding and control of matter at dimensions of roughly 1 to 100 nanometers (one-billionth of a meter), where unique phenomena enable novel applications. Encompassing nanoscale science, engineering and technology, nanotechnology involves imaging, measuring, modeling, and manipulating matter at this length scale.

Retrieved 3/21/16 from https://www.ansi.org/standards_activities/standards_boards_panels/nsp/overview.aspx?menuid=3

Nanotechnology standards cover definitions, testing methods, etc.

Nano.gov
National Nanotechnology Initiative

Retrieved 3/21/16 from
http://www.nano.gov/you/standards

Who Sets Standards?

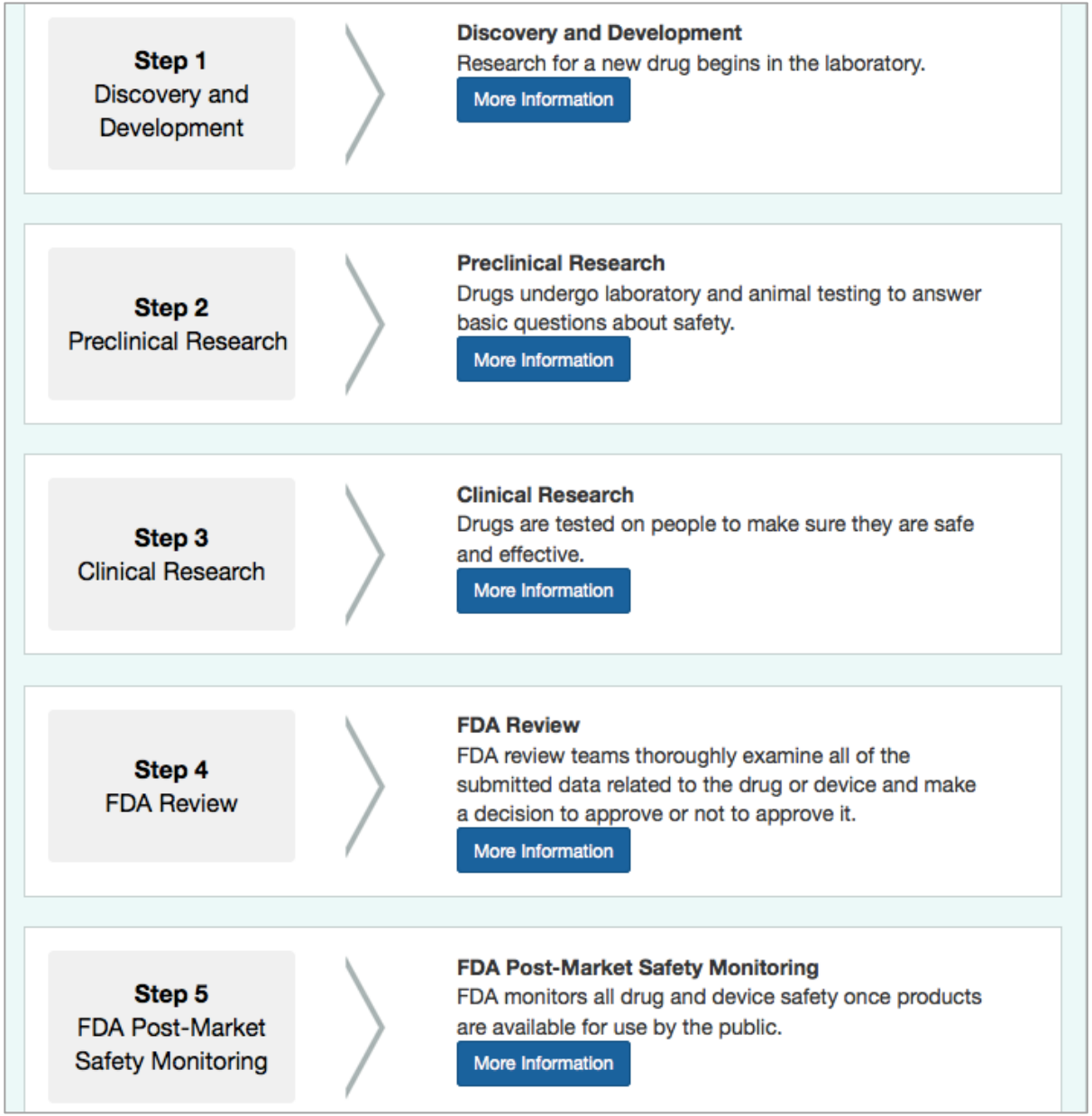
Around the world, there are numerous standards-setting groups that are involved in developing nanotechnology standards. Some of the leading standards setting organizations and their relevant nanotechnology committees are (in no particular order):

- International Standardization Organization (ISO) Technical Committee (TC) 229 on Nanotechnologies
- ASTM International's Committee E56 (Nanotechnology) (formerly known as the American Society for Testing and Materials)
- International Electrotechnical Commission Technical Committee 113 (Nanotechnology Standardization for Electrical and Electronics Products and Systems)
- Institute of Electrical and Electronics Engineers' Nanotechnology Council

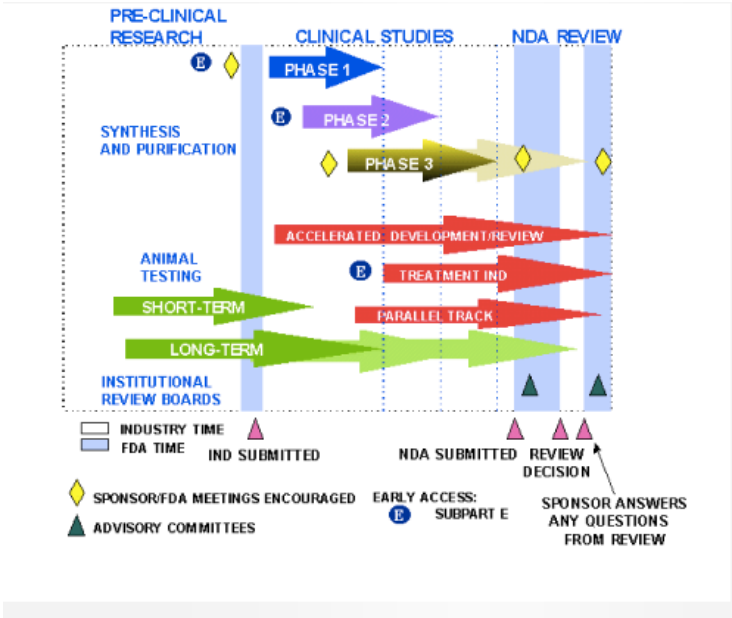
These groups develop **voluntary** standards. Standards that are the best formulated, with the strongest basis in science, are most likely to be adopted by the global community. U.S. leadership and participation in the international standards-setting process allows the United States to help shape the strategic and technical direction of nanotechnology development everywhere. Additionally, other groups are involved in coordinating the development of standards, such as the American National Standards Institute (ANSI), which hosts a Nanotechnology Standards Database and accredits organizations involved in standards.

U.S. Federal Government research related to measurement within science and technology is led by the National Institute of Standards and Technology (NIST). NIST representatives lead ASTM International's Committee E56 on Nanotechnology. A U.S. Technical Advisory Group (TAG) (accredited by ANSI) represents the United States at ISO TC 229, Nanotechnologies. The TAG is responsible for formulating positions and proposals on behalf of the United States with regard to ISO standardization activities related to nanotechnology. The U.S. also holds leadership of ISO TC 229's Working Group 3: Health, Safety and Environmental Aspects of Nanotechnologies, with a representative from The National Institute for Occupational Safety and Health (NIOSH).

Industry-specific regulations include the FDA's drug development process



From http://www.fda.gov/ForPatients/Approvals/Drugs/default.htm viewed February 4, 2016



http://www.fda.gov/Drugs/DevelopmentApprovalProcess/SmallBusinessAssistance/ucm053131.htm retrieved February 4, 2016

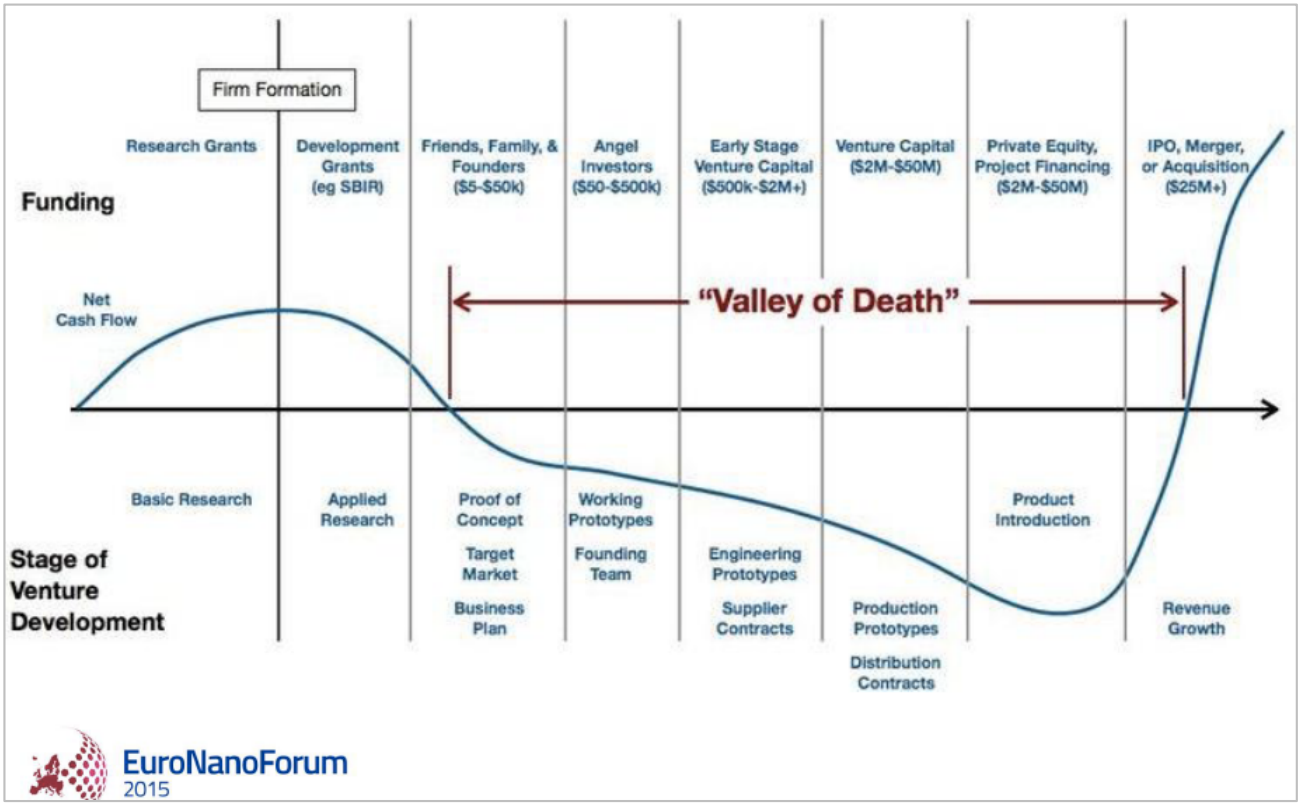
Finding Funds

The “valley of death” is wide and costly.

A wide variety of funding sources will likely be needed.

Investors are usually focused on individual industries rather than nanotechnology.

Factors to consider:

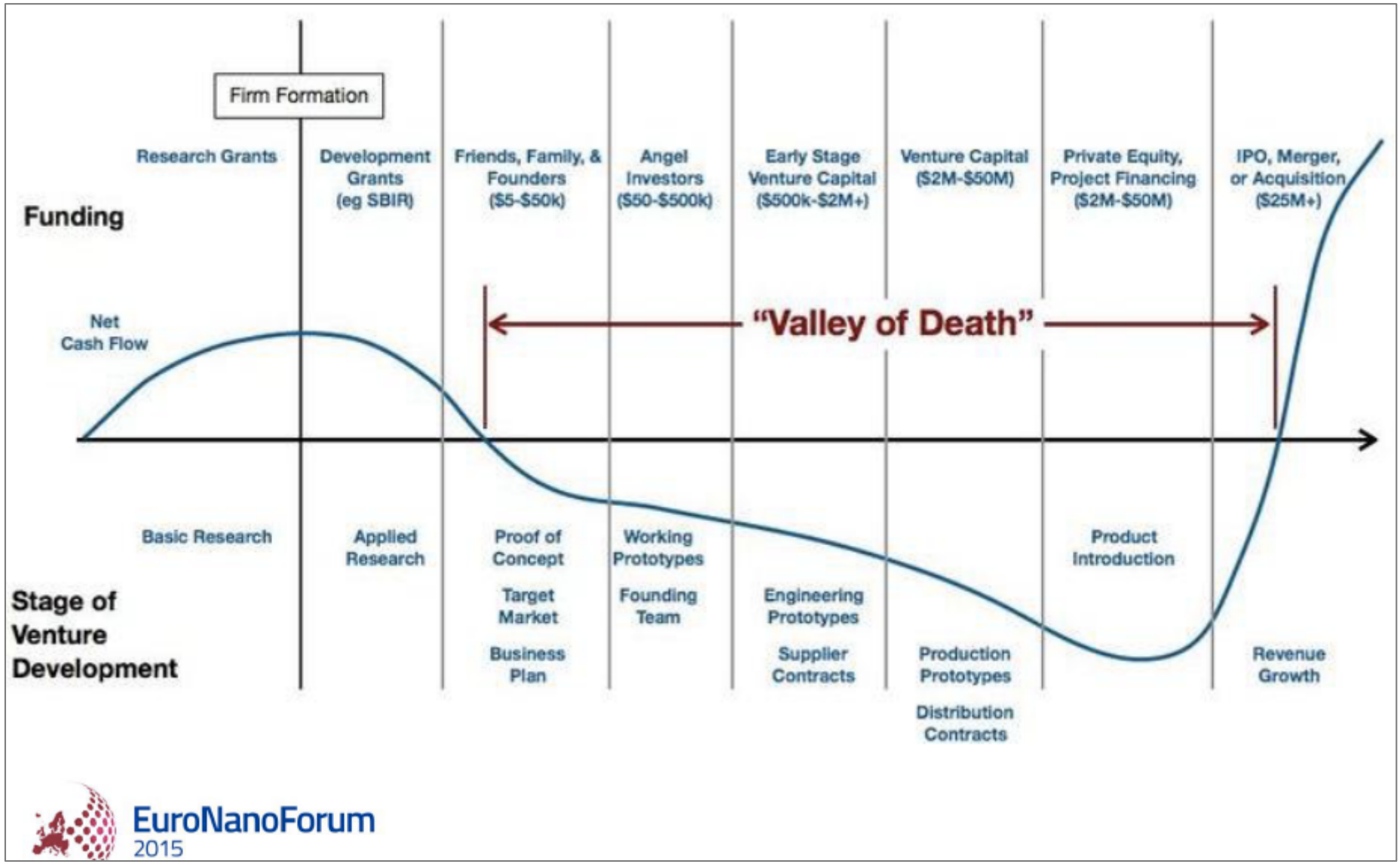


Key question:

How do funding sources and stages match with technology, customer, and venture development?

Slide 7 from “Venture Investments in Nanotechnology,” Kirill Mudryy, Enso Ventures. Retrieved June 20, 2016 from http://euronanoforum2015.eu/wp-content/uploads/2015/06/EuroNanoForum-2015-Kirill-Mudryy-Final.pdf

Development beyond basic research is complicated and expensive



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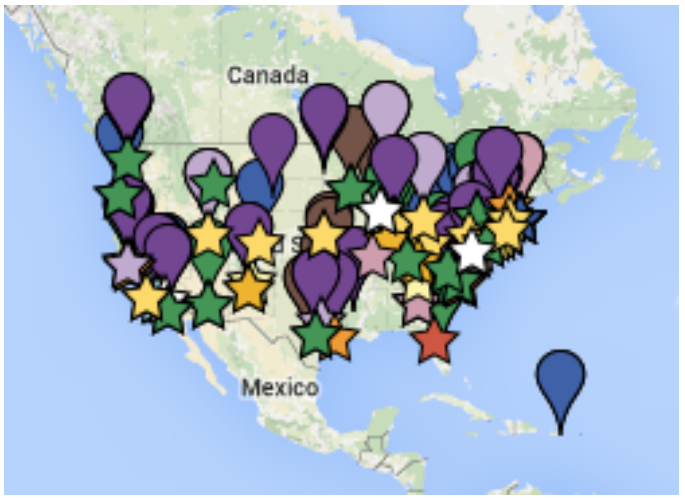
Finding Other Resources

It takes more than funding to fulfill customer contracts/orders.

Use non-financial resources to reduce risk, expense, and time to market

Factors to consider:

- Economic development resources and organizations
- Technical resources, e.g.,



Map retrieved February 1, 2016 from http://www.nano.gov/USnanoresourcemap

Key questions:

How can other resources match with technology, customer, and venture development?

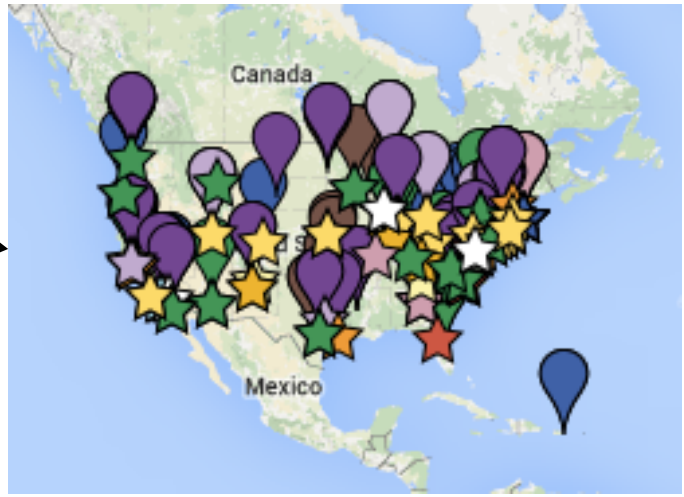
The funding and resources landscape for new ventures is complex

Nano.gov
National Nanotechnology Initiative

Collaborations and Funding

- **Federal Funding & Infrastructure**
  - NNI R&D Centers and Networks
  - NNI R&D User Facilities
  - Funding Opportunities
  - Current Solicitations
  - Interactive U.S. Nanotechnology Resource Map
- Nanotech Challenges
- Business Development
- FAQs for Business

SBIRs in ~ 10 federal agencies
Geographically dispersed technical resources



Map retrieved February 1, 2016 from
http://www.nano.gov/USnanoresourcemap

Investors and technical resources include:

US and other national governments

State and regional governments, including universities

"Venture capital investments remain a "drop in the bucket" at about 5% of the funds poured into nanotechnology by corporate R&D and government sources."

Page 201/PDF page 235, Nanotechnology: A Realistic Market Assessment, NANO31F from BCC Research, November 2014 (available via UMass Library)

Positioning in the value chain

The nanotechnology value chain will look different when applied to different industries and products:

- Solar
- Battery
- Electronics/computing
- Coatings and paints
- Materials
- Cosmetics
- Clothing/apparel
- Textiles
- Pharmaceuticals
- Consumer products

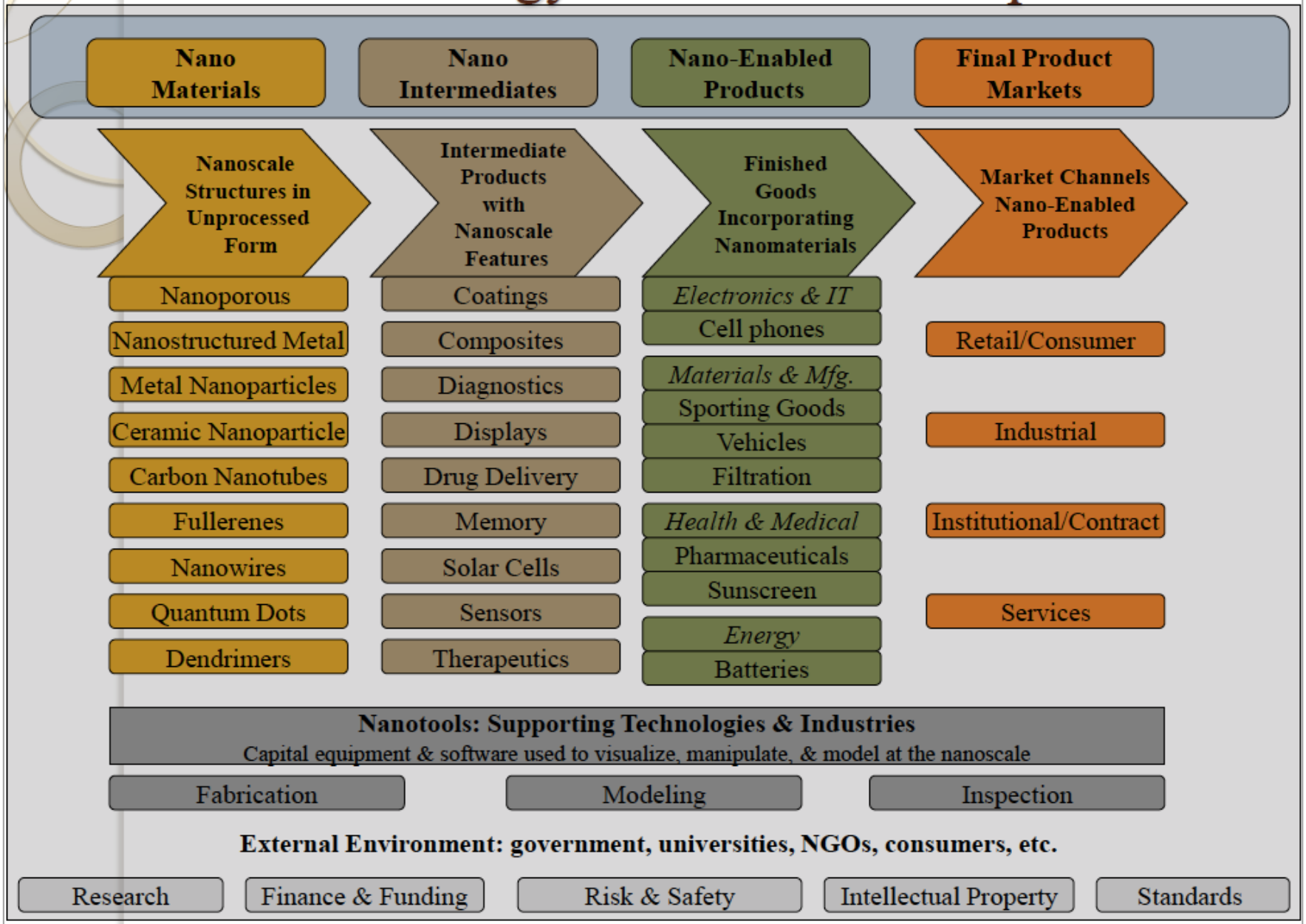
Factors to consider:

- What (if anything) will the NewCo manufacture?
- What can we license for others to use in their manufacturing processes and/or products?
- What do we have that our customers don't?

Key question:

Where in a value chain do we want to/need to operate?

Nanotechnology Value Chain Template



Slide 7 of http://www.cggc.duke.edu/pdfs/Nanotech_Presentations/Frederick_CNS_Seminar_2_March_2011_Presentation.pdf

Next steps for future nanopreneurs

- Be open to application ideas
- Be alert to possible inventions
  - http://www.umass.edu/tto/sites/default/files/Did%20I%20Invent%20Something.pdf
- Learn to talk about your ideas without giving away the “secret sauce”
- Talk to faculty in your field
- Leverage UMass innovation and entrepreneurship resources
  - Berthiaume Center for Entrepreneurship
    - https://www.isenberg.umass.edu/centers/berthiaume-center-for-entrepreneurship
  - Technology Transfer Office
    - http://www.umass.edu/tto/
  - Entrepreneurs-in-Residence
  - Grants, fellowships/scholarships, awards, competitions