

# **NIST Materials Genome Initiative Strategic Planning Study: Economic Analysis of National Needs for Technology Infrastructure to Support the Materials Genome Initiative**

## Interview Guide

The National Institute of Standards and Technology (NIST) in the U.S. Department of Commerce has contracted with RTI International to conduct an economic analysis of standards, measurement, and general purpose technology needs that inhibit efficient development and deployment of advanced materials by U.S. manufacturers.

The objectives of this critical strategic planning study include:

- Identify industry needs related to materials innovation infrastructure.
- Identify barriers/challenges to meeting these needs.
- Estimate the economic impact of meeting these needs.
- Review and prioritize public policy and investment options.

Your perspectives will help guide NIST's strategic planning and program development process. Participation in this analysis is confidential; only aggregated information will be included in any deliverables or communications. Your name and your company's name will not be disclosed. We do not wish to discuss specific products, strategies, or technologies, but rather your thoughts about industry needs and how investments in technology infrastructure to meet those needs would affect your company and companies like yours.

Our research products will be an economic analysis, final report, and presentation materials. All deliverables will be publicly available in 2018 and these will be shared with you as soon as they are released.

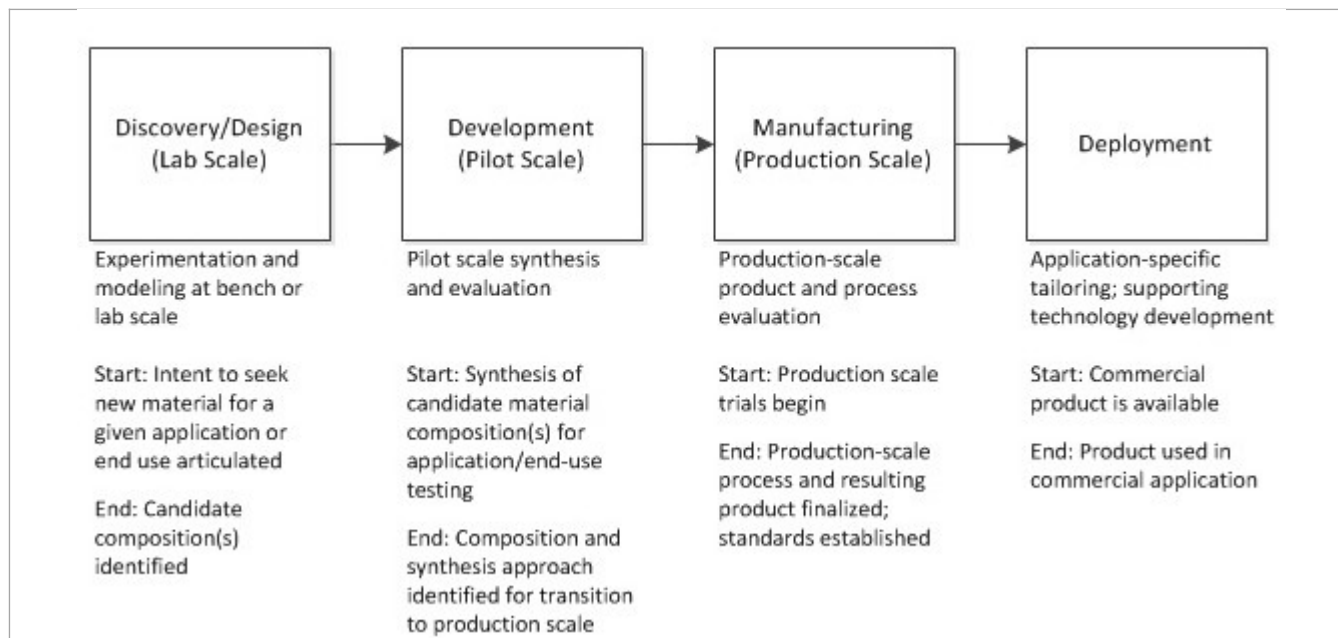
If you have questions, please contact:

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## I. Respondent Background

We will be referring to a stylized depiction of the materials innovation process:<sup>1</sup>



1. Does your perspective cover all four stages, or is it focused within a subset of these stages?

All stages

Only the following stages (check all that apply)

Discovery/Design

Development

Manufacturing

Deployment

Briefly describe the lifecycle of a typical project with which you are involved:

2. What types of materials does your work involve? (check all that apply)

Biomaterials

Polymers

Correlated Materials

Catalysts

Polymer Composites

Electronic and Photonic Materials

Energy storage

Organic Electronic

Lightweight and Structural

Photovoltaic

Ceramics

Caloric Materials

Other \_\_\_\_\_

Briefly describe the types of materials and broad applications (we do not need specific information about any proprietary material or product):

3. Is your background primarily experimental or computational?

Experimental

Computational

Spans both experimental and computational

Briefly describe the roles of experimental and computational approaches in your work:

<sup>1</sup> Based on *Quantitative Benchmark for Time to Market (QBTM) for New Materials Innovation: An Analytical Framework*. [mgj.nist.gov/sites/default/files/uploads/user124/QBTM%20Final%20Analytical%20Framework\\_011216.pdf](https://mgj.nist.gov/sites/default/files/uploads/user124/QBTM%20Final%20Analytical%20Framework_011216.pdf).

## II. Industry Needs Assessment

Table 1 summarizes industry needs identified through scoping interviews.

1. Please rate the importance to your company of addressing each area of unmet need.

(Please briefly explain the relative importance of meeting these needs.)

2. Please rate the difficulty for your company of meeting each need on its own, in terms of both the technical difficulty and the business difficulty (i.e., difficulty justifying investment within the business model).

(Please briefly explain the relative difficulty of meeting these needs.)

3. Are there other needs, of equal or greater importance, not included in Table 1?

(If so, please describe the need, rate its importance and difficulty, and briefly explain.)

**Table 1. Industry Needs: Rating Importance and Difficulty**

Areas of Industry Need	Examples of Infrastructure Technology to Address Need	Importance : 5 = critically 4 = very 3 = moderately 2 = somewhat 1 = not important	Difficulty: 5 = prohibitively 4 = very 3 = moderately 2 = somewhat 1 = not difficult
<b>i. Access to High-Quality Data:</b> – Precompetitive experimental data, computational data, and software code	– Data standardization and curation – Models underpinning accurate and repeatable materials measurement		
<b>ii. Collaborative Networks:</b> – Efficient means of sharing materials information (e.g., along a supply chain, among research collaborators)	– Methods for capturing, characterizing, and sharing materials data in structured formats – Communication standards & translators (“MT Connect for materials measurement equipment”)		
<b>iii. Material Design Methods:</b> – Inverse modeling capability – Shorter paths to better starting points	– Models, simulations, metrologies for advanced materials design – Machine learning tools		
<b>iv. Production &amp; Scale Up:</b> – Model-based alternatives to expensive physical testing/trial & error for scale up – Faster, cost-effective means of producing advanced materials at pilot and full scale	– Multiscale modeling frameworks (integrating macroscopic process models with microscopic materials simulation) – Process technology platforms (e.g., cold sintering, additive, roll-to-roll, directed self-assembly)		
<b>v. Quality Assurance/Control &amp; Component Certification:</b> – Ability to model, predict, and control formation of defects – Ability to forecast manufacturing variation	– Performance metrics (benchmarks, reference data, testbeds to characterize performance of systems and components) – Process control tools (test protocols, objective scientific and engineering data, reference databases)		
<b>vi. Model Validation/Verification &amp; Uncertainty Quantification:</b> – Basis for trust & acceptance of computational models – Basis for objective decision making regarding reliance on computational analysis/simulation at a business level	– Generally accepted and easily applied methods for uncertainty quantification for both experimental and computational data – Validation of analytical methods and procedures, emphasizing industrially relevant systems, comparing predicted and measured properties from multiple sources		

**III. Impacts on Materials Development Process**

1. Given the current environment, please provide generic estimates (i.e., for a typical project) of the relative costs, transition probabilities, and durations of the four stages of materials innovation (Table 2).
  - a. How costly is a year of each stage relative to the cost of a year of Discovery/Design? Assume the cost of a year in Discovery/Design is 1.  
  
(For example: A relative cost of 2 at the Development stage would indicate that a year of Development is twice as expensive as a year of Discovery/Design.)
  - b. What is the probability that a project that starts a given stage advances to the next stage?  
  
(For example, 0.75 at Development stage implies that a project that starts the Development stage has a 75% chance of advancing to enter the Manufacturing stage.)
  - c. About how many years does it take to complete each stage?
2. How would your answers change in an improved environment where the needs discussed in Section II are addressed? (Table 3).  
  
Note that Relative Cost is not necessarily 1 at the Discovery/Design stage in Table 3. Entering a value of 1 would indicate that the cost per year in the Discovery/Design stage would be unaffected by improvements in infrastructure.
3. Finally, please describe how changes would come about. How are potential impacts tied to improved infrastructure?

**Table 2. Materials Innovation Process in the Current Environment (Existing Technology Infrastructure)**

	Discovery/Design	Development	Manufacturing	Deployment
a. Relative Cost (per year)	<b>1</b>			
b. Probability of Advancing				<b>N/A</b>
c. Duration (years)				

**Table 3. Materials Innovation Process in the Improved Environment (Improved Technology Infrastructure)**

	Discovery/Design	Development	Manufacturing	Deployment
a. Relative Cost (per year)				
b. Probability of Advancing				<b>N/A</b>
c. Duration (years)				



#### IV. Impacts on New and Improved Products

1. In addition to the impacts on the development process discussed in Section III, would the improved infrastructure lead to new opportunities to provide value to your customers or reach new markets?

If so, how?

2. Broadly speaking, would these impacts be more or less important to your company than the R&D impacts discussed in Section III?

Could you quantify the relative importance?

More important. Enter a number greater than 1: \_\_\_\_\_

Equally important.

Less important. Enter a number between 0 and 1: \_\_\_\_\_

#### V. Company Characteristics

To help us aggregate responses and control for differences in company characteristics, please provide the following information for your company:

1. Industry (NAICS)

Food (311)

Petroleum and Coal Products (324)

Chemical (325)

Plastics and Rubber Products (326)

Primary Metals (331)

Fabricated Metal Product (332)

Machinery (333)

Computer and Electronic Product (334)

Electrical Equipment, Appliance, and Component (335)

Transportation Equipment (336)

Miscellaneous, incl. medical equipment and supplies (339)

2. Company Size (Total Number of Employees)

less than 50

50–99

100–249

250–499

500–999

1,000–4,999

5,000–9,999

10,000–24,999

25,000 or more

## V. Company Characteristics Continued

### 3. R&D Size (Total Number of R&D Employees)

- less than 5
- 5–9
- 10–24
- 25–49
- 50–99
- 100–499
- 500–999
- 1,000–2,499
- 2,500 or more

### 4. What percentage of your company's R&D effort is related to developing and applying advanced materials?

- |                          |                          |                          |                          |                          |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 0% to 20%                | 20% to 40%               | 40% to 60%               | 60% to 80%               | 80% to 100%              |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

### 5. On average, for companies in your industry, roughly what percentage of R&D effort do you think is related to developing and applying advanced materials?

- |                          |                          |                          |                          |                          |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 0% to 20%                | 20% to 40%               | 40% to 60%               | 60% to 80%               | 80% to 100%              |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

## VI. Concluding Thoughts

1. Is there anything else that we have not covered that you think is important for us to know?
2. Is there anyone else that you would recommend we reach out to for our analysis?

Many thanks for your input!