

NIST Advanced Manufacturing Strategic Planning Study Interview Guide for Robotics/Automation Systems Users

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 adoption of advanced manufacturing in the United States.

The objectives of this critical strategic planning study are to

- identify current and emerging needs related to standards and measurement,
- estimate the economic impact of meeting these needs, and
- review public policy and investment options.

The study has a particular focus on 4 aspects of advanced manufacturing: (1) robotics and automation, (2) smart manufacturing processes, (3) 3D Printing (additive manufacturing), and (4) roll-to-roll manufacturing. The focus of our conversation is robotics and automation.

Your perspective will help guide NIST's planning and investment 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 how investments in standards and measurement technologies 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 late 2015 and these will be shared with you as soon as they are released.

If you have questions, please contact:

- Alan O'Connor, Principal Investigator, RTI, 919-541-8841 or aconnor@rti.org
- Gary Anderson, NIST Project Officer, NIST, 301-975-5238 or gary.anderson@nist.gov

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Respondent Contact Information

1. Name
2. Title
3. Division
4. Company
5. Telephone
6. Email
7. Location, if not USA

Respondent Background

8. Please give a brief description of your experience with robotics and automation systems. How did you come to be in your current position?

9. How familiar are you with the National Institute of Standards and Technology?

About Your Company

10. How would you describe your primary line of business (i.e., industry classification)? What do you produce and sell most?

- a) Approximately what percentage of your company's sales revenue is associated with your division, or the division for which you are responsible? A range is fine.

11. How does your company use robotics and automation systems?

- b) For what manufacturing processes, or for the manufacture of what products?
- c) What types of robotics and automation systems do you use?

12. As far as you are aware, is your division or company engaged with any industry consortia, standards organizations, or governing bodies specifically for advanced robotics and automation? If so, in which bodies do you participate and what are the underlying drivers for participation?

13. Generally, does your company conduct R&D related to the adoption, adaptation, and/or use of robotics and automation systems? If so, what are the broad objectives of that R&D (e.g., cost reduction, quality improvement, other)?

Industry Needs

Several industry-level needs have been identified, and discussions with experts have suggested measurement and test methods, material and process standards, reference databases, and general purpose technologies that could meet these needs.

Industry Needs	Infrastructure Technology to Help Meet Needs
<p>Safe human-robot interactions Universal standards for developers of robotic technologies and the application of these technologies in manufacturing settings with robots working in close proximity to people (see more below on sensing/perception for unstructured environments, relevant for intuitive HRI)</p>	<p>Test protocols, objective scientific and engineering data, reference databases, and other technical inputs into standards for safe HRI (power/force-limiting; speed/separation monitoring; hand-guided operation; safety-rated monitored stop)</p>
<p>Sensing and perception for unstructured (or less-structured) environments Improved perception (and the ability to plan and re-plan its actions based on what it “sees” and “knows”) giving a robot greater autonomy, lessening its demand that its work environment meets stringent tolerances</p>	<p>Sensor registration & calibration Performance characterization (benchmarks, testbeds, and technical inputs to standards to characterize the performance of systems, subsystems, and components) Sensing/perception engines/architectures Proof-of-concept robotics applications of KR&R (knowledge representation & reasoning)</p>
<p>Objective, low-cost performance characterization Making it easier for robotics users to know what they are buying, easier for developers/suppliers to show what their systems do</p>	<p>Common performance metrics, objective data, testbeds, test methods, and benchmarks to characterize the performance attributes of advanced systems, subsystems, and components</p>
<p>Interoperability and modularity Plug-and-play for system components, enabled by standards for physical and electronic interfaces, software interfaces/translators</p>	<p>Objective technical inputs into the standards-setting process: scientific and engineering data, benchmarks, testbeds, objective third-party testing of candidate technologies/configurations</p>
<p>Intuitive interfaces Enabling rapid programming/training without specialized skills</p>	<p>Protocols to simplify the programming, training, and rapid re-tasking of robots Standard programming language for industrial robotics analogous to SQL or HTML</p>
<p>Modeling and Simulation Virtual factory floor allowing modeling and simulation, calibrated based on real-time data feed from robots, machine tools, sensors, control systems on the floor.</p>	<p>Robust, open, real-time operating system on the factory floor Reference models, modeling frameworks to fully integrate robots into models of the manufacturing environment and enable robust simulation/prediction</p>

14. Do any of these needs apply to your company's use of robotics/automation? In other words, if one or more of these needs were to be met, would it benefit your company? If so, how?

15. If several needs were discussed in question 14 as being relevant to your company, could you prioritize them? Which are the most important?

16. Are there needs not included in the table that you would include? If so, what are they?

17. If these needs were all met today, how would that impact your company's R&D and production?

- a) Changes in the types of robotics and automation systems used?
- b) Changes in the range of products for which at least some manufacturing processes/tasks are automated?
- c) Changes in the range of manufacturing processes/tasks that are automated?
- d) Others?

18. Can you describe any types of impacts on your company if these needs were met, in terms of costs of production? A range is fine.

- a) Changes in time needed to configure/test/validate product line or work cell?
(+ / - by roughly what %? _____%)
- b) Changes in cost to configure/test/validate product line or work cell?
(+ / - by roughly what %? _____%)
- c) Changes in unplanned downtime, when workers and equipment are idle?
(+ / - by roughly what %? _____%)
- d) Changes in duration of product-development-to-production cycle?
(+ / - by roughly what %? _____%)
- e) Others?
(+ / - by roughly what %? _____%)

19. To enable us to combine your responses with the responses of others and provide NIST with a sense of potential impacts at the industry level, could you quantify the impacts we have discussed in terms of the following metrics? A range is fine.

- | | |
|-------------------------------|--------------|
| a) Cost of materials | + / - _____% |
| b) Cost of energy/electricity | + / - _____% |
| c) Cost of labor | + / - _____% |
| d) Cost of capital equipment | + / - _____% |
| e) Overall cost of production | + / - _____% |

20. Would you say that your answer to question 19 is representative of your industry (of companies in similar lines of business), or of only a subset? Please explain briefly how, if at all, the anticipated impacts for your company may be different from the industry as a whole, or how different industry segments may be affected differently.

21. Switching from thinking about costs to thinking about your company's product offering, could you briefly describe what changes could be expected if these needs were all met today?

- a) Changes in the quality of existing products?
- b) Changes in the amount of customization within existing product lines?
- c) Introduction of new products or product lines?
- d) Others?

22. To enable us to combine your responses with the responses of others and provide NIST with a sense of potential impacts at the industry level, could you quantify these impacts in terms of a relative change in your company's sales? A range is fine. + / - _____%

23. Would you say that your answer to question 22 is representative of your industry (of companies in similar lines of business), or of only a subset? Please explain briefly how, if at all, the anticipated impacts for your company may be different from the industry as a whole, or how different industry segments may be differently impacted.

24. Would you expect any changes in your company's investment patterns or risk tolerance, if the types of technologies discussed above were made available? If so, what types of changes?

25. Are there any additional comments you would like to share?

We Greatly Appreciate Your Time and Input.