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Standards Road Map Project Criteria Analysis

A task of the Manufacturing-Enterprise-Integration Project

**James G. Nell
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U.S. DEPARTMENT OF COMMERCE
Technology Administration
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Standards-Road-Map-Project: Report

Criteria Analysis

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Abstract

This document describes a research project to recommend a decision tool that the Manufacturing Systems Integration Division (MSID) could use during its strategic-planning process to evaluate which standards activities to support. This paper describes the criteria selected to give priority, in National Institute of Standards and Technology (NIST) and MSID terms, to the standards activities that NIST and MSID do, or should, support. There are criteria for judging the quality of the standard itself, independent of how applicable to the NIST mission. Other criteria are designed to help MSID decide whether or not to participate in a standard's development. A computer-aided, decision-analysis tool was used to show that computer assistance would be useful to make decisions when many variables impact that decision.

Key Words:

Information-technology standards, criteria evaluation, NIST mission criteria

1 Introduction

The standards road-map project is part of the Manufacturing Enterprise Integration Project of the Manufacturing Systems Integration Division [THOM97]. MSID is a division of the Manufacturing Engineering Laboratory (MEL), one of the seven National Institute of Standards and Technology (NIST) laboratories. The MSID mission is to promote economic growth by working with industry to develop and apply technology, measurements, and standards for information-based manufacturing. This is accomplished by working with the U.S. manufacturing industry, software suppliers, systems integrators, and standards-development organizations.

The purpose of this research project is to recommend a domain, relevant to MSID, of enterprise-integration-related standards, and to indicate what is to be included and what is to be excluded from that domain. Enterprise-integration-related standards are those, at any level in the enterprise, that help processes to interoperate. Assume, however, that all standards considered will be in the information-technology category. There are three document deliverables that are required to satisfy the objective. In addition there are written summaries of findings.

The three project documents described below comprise the deliverables of this project.

1. The *Criteria Analysis* describes criteria to help MSID justify participation in a particular standard. [This document]
2. A *Standards Baseline* [unpublished] describes current MSID standards activities. This is a logical predecessor to a standards-information resource, called the standards landscape, that would include a list of sources and/or the standards by category in the enterprise-integration-related-standards domain. The landscape would also include the purpose of the standard, and the status of standard development. This resource could be a database, a World-Wide-Web site, a paper document, or a combination to be determined. The information resource is to be completed in later work.

3. The *Standards Classification Strategy and Methodology* summarizes findings, recommends a methodology to identify needed standards, and recommends a schema to classify relevant standards. [NELL99]

This document is the Standards Road-Map Project--*Criteria Analysis*. The purpose of this document is to describe an approach to help MSID ascertain what standards apply to a certain manufacturing domain, to offer decision support for determining to what degree should MSID support the development of those standards, and the justification for the support. The Standards-Information Resource, the data tool that would provide information to support decision-making is a work in progress. The information resource, a database such as Access, or a World-Wide-Web site using hyperlinks to the standards information, is a compendium of information about standards relevant to the enterprise-integration domain. The Standards Classification Strategy and Methodology document has been completed [NELL99]. That document defines categories for the standard set and ways to both expose and prune the search space. The total search space is considerably larger than the amount of resources available to support such a search task, even when using computer-assisted tools.

Standards development is a labor-intensive process. In the information-technology domain many of the standards that are perceived to be needed to improve enterprise integration are leading technology before that technology has been developed fully. Therefore, the standards-development process is additionally costly because elements of the technology are being developed concomitantly with the standards. With limited resources, choosing which standards activities to support and how much support is appropriate is more difficult without some criteria that would rank the various standards developments with respect to their value to the MSID and, ultimately, its customers.

2 Standards-evaluation process

A standard is a documented agreement about rules, guidelines, criteria, or definitions regarding a product, process, or service. Standards apply to a product, process, or service only in a context and to the extent that the standard serves its function; that is, it is apropos, of high quality, and is easy to use. For example, a standard specifying interfaces requiring a user to configure operations in such a way that is not productive for that user, will not have utility and probably will not be used.

2.1 Quality of the standard

Before determining whether a particular standard should be supported and to what degree, an analysis to evaluate if that standard itself is, or will be, a good document would be prudent. The Institute for Defense Analysis [ROBY96] has developed a model to provide a user with specific information about a standard. This information is intended to facilitate decisions about whether a standard can meet specific needs.

The IDA standards evaluation model consists of 15 criteria grouped into four categories: quality, standards support, stability, and marketplace.

- *Quality*: completeness, technical quality, unambiguous expression, clarity, strictly defined interface, and flexibility.
- *Standards support*: credentials of the standard's approving body, standard's scope of acceptance, and standard's conformance specification.
- *Stability*: stability of domain, life cycle of the standard, stability of the standard.
- *Marketplace*: number of acceptable products, marketplace presence, cost of standard.

Usage issues:

One should be cautious about using a particular rating in the IDA analysis. A high or a low rating in this analysis does not indicate whether MSID should or should not change its emphasis toward supporting a

particular standard. A high score could indicate that the standard is important and relevant to industry, government, and NIST, and deserves considerable MSID support. Alternatively a high score could mean that the standard is mature and stable and that NIST development support is unnecessary.

A low score could indicate that the standard is not needed and that the standard should not be replaced. Or, a low score could indicate that the standard is not needed and there is need for a replacement. Therefore, results of this analysis should be accompanied with some explanatory notes to explain the reason for the score assigned to the standard.

Information generated by this analysis should be used in an objective-analysis environment only. A low rating in these criteria makes a statement about the standard itself, and only within the context of the assumptions and conditions at the time of the analysis. The information must be applied knowing how the standard should be used and by whom. Perhaps some of the criteria are not as important as are others in a particular context. Also, the information should not be a major determinant about whether NIST should support the standard. Rather, NIST should use the criteria discussed above to form notes that point to areas where NIST could concentrate to help create a better standard--should the analysis described below indicate that NIST support is warranted.

2.2 Objectives and viewpoints of the standards

The International Organization for Standardization (ISO) has stated the objectives of standardization, in the ISO directives, part 2, section 5 and also in ISO TR 10314 [ISO90][ISO91]:

- Mutual understanding
- Health, safety, protection of environment
- Interface, interchangeability
- Fitness for purpose
- Variety control

ISO TR 10314 [ISO90][ISO91] also has selected several viewpoints that a standard may take in a manufacturing enterprise:

- Safety
- Environment
- Compatibility
- Performance
- Operability
- Maintainability
- Reliability
- Qualifications
- Description

In evaluating need, NIST must in turn evaluate the nature of the standard being considered to be sure that the objective and viewpoint of the standard are in the NIST purview.

3 Standards road-map project--selecting the criteria

One objective of this project is to use certain criteria selected by the project to allow MSID to help determine whether or not MSID should assign resources to support a particular standards-development activity. The criteria are intended to add priority-setting capability to the information resource and to facilitate recommendations to MSID about which standards to support and why.

3.1 Rationale for choosing the criteria

In general, the relevance and priorities of MSID participation in the manufacturing domain would parallel the relevance and priorities of NIST work for US industry in general [BELLO94]. Indeed, the flavor of the

NIST laboratories' priorities was the basis for defining criteria for the standards road-map project, and the nature of these criteria can be seen in the Technical-Approach section of the standards road-map project plan [THOM97]. Thus, the criteria for MSID participation in standards-development activities were developed by adapting the for the NIST laboratories' priorities into a context that is more directly applicable to criteria that help manufacturing enterprises. The project named the adapted criteria *applicability criteria*.

The purpose of the applicability criteria is to encourage users to know and anticipate NIST customer needs over the next five years. The criteria will be used by MSID to evaluate a standard and its relevance to our industrial customer's manufacturing work.

Then, having determined the applicability of a standard to MSID participation, the information provided by the applicability criteria should be used to help decide whether, and how much, support is appropriate; or whether NIST support should be curtailed or not started. The additional criteria that guide this process have been defined and have been called *decision criteria*. These decision criteria were given to the project by MSID management at the beginning of the project and are presented in the Needs-Addressed section of the project plan [THOM97].

3.2 Organizing the criteria

As stated in 3.1, the criteria selection began by considering the six guiding criteria that the NIST laboratories use to set priorities in their strategic planning [BELLO94]. These six criteria are intended to guide decisions regarding whether NIST should engage in some activity. For this project, these *applicability criteria* are intended to reflect the relevance of MSID participation in the development of a standard. The specific criteria are described in section 4 of this report. These criteria are:

- Magnitude and immediacy of industrial need.
- Degree of correspondence between a particular industrial need and the NIST mission to develop infrastructure technologies.
- Opportunity for NIST participation to make a major difference.
- Nature (the quality of) and size of the anticipated impact resulting from NIST participation.
- NIST capability to respond in timely fashion with high-quality solutions.
- Nature (support of process and infrastructure technology) of opportunities afforded by recent advances in science and technology.

MSID management asked that these six criteria be grouped into levels that were specified at the outset of the road-map project and, they were presented in the Technical-Approach section of the project plan [THOM97]. Rather than interpret these items as levels, the project saw them as categories into which the six criteria could be arranged. The categories are listed below:

- Category 1: Setting priorities and measuring results at NIST
- Category 2: Relevance for MSID involvement
- Category 3: Does or could NIST use the standard--This category became a criterion as well.

The decision criteria specified at the outset of the project by division management to try to quantify the needed support for a standard are:

- What kind of standard is it?
- Should NIST support the standard development with people?
- How many people will it take to be effective?

The applicability-criteria and decision-criteria wording has been slightly modified in 4 to be more directly applicable to MSID work with manufacturing enterprises and with standards affecting enterprise operation.

4 Analyzing and quantifying the criteria

Users of the methodology were to identify a subject standard activity and assign a numerical value to that standard activity depending on how well the standard activity satisfied a criterion. Because the differences among various activities would be largely subjective and qualitative, a coarse numerical scale was selected rather than a fine one. The first trial assigned values of small, medium and large to the ratings. A value of five for large, three for medium, one for small or nil was selected. While values of one through ten and one through one hundred were considered, being able to distinguish between, say, a score of sixty and a score of fifty three, would be meaningless and have no statistical relevance.

Having a rigid scoring system would imply that there is a hurdle score. Ratings above the hurdle would receive MSID support and ratings below that would not. This would be, as with investment opportunities in organizations with rigid hurdle rates, very unfortunate. Any valuation based on qualitative judgements that receives a quantitative score must be judged more on a case-by-case analysis and organizational mission than the score. Managers seeking to relinquish their judgement process with rigid tools such as this would do better in an occupation with a more numerically oriented structure.

Appendix A lists the criteria categorized in 3.2, above, with abbreviated titles. Preliminary values are given as an example. The values have been assigned to each criterion relating to the degree of compliance judged for each standard. These values have been assigned numbers:

- The first corresponds to the weakest applicability, and assigned a number 1
- The second corresponds to a medium applicability, and assigned a number 3
- The third corresponds to the strongest applicability, and assigned a number 5

The values listed this way for these criteria can lead to curious results, as the criteria analysis and interpretation discussed below indicates. In many cases the criteria need an associated possible MSID position to state whether the low or the high value is better for MSID, either politically, organizationally, technically, or to satisfy an industrial need. Sometime the lowest and highest are not desirable, thus the middle might be preferred. The problem is that resulting criteria values depend on the MSID position attached, and that position must be reviewed every time the process is used. The position depends on the current environment that could change on very short notice. Please refer to Appendix B for possible interpretations of the criteria.

Another issue is that the criteria are not orthogonal, in the sense that a change made to the value of some of them has an effect on the value of some of the others. Appendix C has been constructed to illustrate the interrelationships among the criteria.

4.1 Criteria listing

The standards-road-map criteria listed above in 3.2 are organized into the three categories, also mentioned in 3.2. Appendix D is a complete listing of the criteria. The criteria listed below have been modified slightly to make them directly applicable to the standards-development activities of MSID.

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Applicability criteria

Category 1

1. Magnitude and immediacy of industrial need
2. Nature and size of anticipated impact
3. Nature of opportunity afforded

Category 2

4. Degree of correspondence between industrial need and MSID mission
5. Opportunity for MSID to make a difference (covered in criterion 4.2 and becomes criterion 2, see Appendix E)

6. Ability to anticipate and respond in timely fashion

Category 3

7. Does or could NIST use the standard (No breakdown recommended)

Decision criteria

8. The nature of the standards activity (No breakdown recommended)
9. The need for NIST resources (No breakdown recommended)
10. The *bang-for-the-buck* (No breakdown recommended)

4.2 Criteria analysis

After the discussion of each criterion, the criterion is stated in a more precise way by dividing it into segments of meaning. For example, the criterion 1, *magnitude and immediacy of industrial need*, has two main segments: the magnitude and the immediacy. Each of these segments can, in turn, be divided into sub elements. The segments are numbered to make it easier to refer to them. Appendix E shows a graphic organization of the criteria and how they decompose into sub elements.

Usage issues must be considered when applying many of these criteria to better interpret what some of the results could mean. Some results are ambiguous. The usage issues are intended to lead a strategic planner toward a statement of a possible MSID position relative to the criterion. Appendix B offers a summary of possible interpretations when evaluating the criteria with respect to standards activities.

Finally, some assumptions are suggested to help guide the thinking process associated with interpreting what a particular value for a criterion is assumed to mean.

4.2.1 Applicability criteria

Category 1: Setting priorities and measuring results

Criterion 1: Magnitude and immediacy of industrial need:

Description: This criterion arises from the basic way that NIST and MSID determine and justify much of their work [BELLO94]. Industrial needs come from continuous interaction with industrial associates that are directly involved in the technology and with those who control the investment funds for such projects. There are two dimensions to this criterion; the size of the stated need and the amount of time available before solutions must be implemented.

Criterion 1 breakdown:

- 1 Magnitude and immediacy of industrial need
 - 1.1 Magnitude of industrial need
 - 1.1.1 Nature of entity expressing need
 - 1.1.1.1 Congress--new law
 - 1.1.1.2 Industrial--segment
 - 1.1.1.3 Industry--general
 - 1.2 Immediacy of industrial need
 - 1.2.1 NIST anticipated the need (therefore no stated need)
 - 1.2.2 Ability to respond to stated need
 - 1.2.2.1 Industry needs benefit in less than three years
 - 1.2.2.2 Industry needs benefit in less than five years

Values assigned: Magnitude and immediacy of industrial need for standards that improve process interoperability and information-technology infrastructure. This criterion has two dimensions: time and stated need. The time dimension will be assigned a 1 = no time stated, 3 = need within 5 years, or a 5 = need within 3 years. The need dimension will be assigned a 1 = no need stated, 3 = need qualified by industry type or size, 5 = general industry need.

Usage issues: The term need must be defined on a case-by-case basis. For example is *need immediacy* best expressed by critical industries, most competitive companies, least competitive, most endangered industries, largest, small-to-medium sized, or most politically acceptable? Do other relevant need categories apply?

Does the need magnitude mean that the highest quality or most effective NIST support impacts companies, industries, individual workers, balance of trade, or the national economy?

Receiving an explicitly stated need for a particular standard from industry is difficult because, in our opinion, industry has no direct need for standards and there will be no consistent answer about standards from specific data points in industry. In addition, industry really does not have an opinion, people within the industry do, and that opinion is most relevant in the context of their particular function. Most people in industry are fairly consistent about stating industrial needs such as lower cycle time, improved productivity, better agile performance, and lower product cost. Standards are one way to help achieve some or all of these.

For that reason, MSID must be able to translate standards development as one of many solutions to the kinds of needs normally expressed by industry. MSID must then balance resources so that the need for standards is resolved simultaneously with other needs that can improve industrial climate. There are many others, such as better metrology, improved processes, improved infrastructure, and employee training. Continued interactions with persons in industry responsible for these improvements and carefully inferring the need for each of the various standards that apply are imperative activities for MSID people interested in standards.

Another issue is whether no stated need is better than an immediate need stated by many companies. No stated need could reflect MSID anticipatory focus is sharp or that *crunch time* has not yet arrived. Or, no stated need could mean that the crisis is past and NIST is too late to be effective.

A high and immediate need also could mean that MSID anticipatory focus is ineffective, MSID is too late, and that many industries have perceived the need and are desperate. Whether or not MSID should enter the process at this time will certainly depend on MSID resource capability to work under pressure in situations such as this.

Possible MSID position: MSID will meet or anticipate urgent industrial needs, which if resolved would enable integration improvements.

Assume:

- Industry will recognize and state needs that exist
- Needs will be stated in a consistent way
- Industry will be as effective recognizing incipient needs as NIST is; therefore, no statement of need means there is not and will not be any need
- Addressing a long-term industrial need satisfies the anticipation objective

Criterion 2: Nature and size of anticipated impact

Description: As part of the continuous review process mentioned above, MSID should sort the things industry could best do for themselves, such as process improvements; from the things a government can do to help, such as infrastructure improvements. Other considerations in this category have to do with the status of the standard being considered; for example, the standard may be mature and needs replacing, mature and seemingly serving its purpose, developing and needs consensus improvement, or still in a conceptual stage of a needed standard. A related consideration is whether an existing or alternate technology could be used.

Criterion 2 Breakdown:

2 Nature and size of anticipated impact

2.1 Nature of impact

- 2.1.1 Nature of support needed
 - 2.1.1.1 Develop tools
 - 2.1.1.2 Develop standard
 - 2.1.1.3 Develop test, conformance
 - 2.1.1.4 Develop capability that uses standard
 - 2.1.1.5 Standards administration
- 2.2 Size of impact
 - 2.2.1 Impact in small part (<20%) of problem (stated need)
 - 2.2.2 Impact in large part (>20%) of stated need

Values assigned: Nature and size of the anticipated impact of MSID activities on integration standards and consensus for industrial-information infrastructure. This criterion will be assigned a 1 = slight impact, 3 = indirect impact, or a 5 = direct impact. This criterion is similar to criterion 5.

Usage issues: The term *nature* must be defined or assumed on a case-by-case basis. Does nature of impact refer to the quality of involvement or type of involvement such as funding, administrative, technical, or leadership?

An assigned value indicating slight impact could be due to only one small, but key, area needing MSID support, whereas a high, or direct, impact rating could create a risk of the output becoming a *government* or *NIST* standard.

Possible MSID position: MSID will identify and make significant impact in infrastructural standard domains where needed.

Assume:

- Nature of impact: MSID will be able to improve the situation by applying NIST resources
- Size of impact: NIST will succeed if its efforts will improve significantly [?] the implementation date of the standard
- NIST will impact infrastructure improvements rather than process improvements

Criterion 3: Nature of opportunities afforded:

Description: This is related to the criterion 2, but is more about the nature of the MSID support needed. This item is more pointed toward helping to transfer things such as the technology or knowledge among industry users to accelerate or enable standard acceptance.

Criterion 3 Breakdown:

- 3 Nature of opportunity afforded
 - 3.1 Technology transfer
 - 3.1.1 Documents
 - 3.1.2 Seminars
 - 3.1.3 Co-participation
 - 3.2 Knowledge transfer
 - 3.2.1 Books
 - 3.2.2 Knowledge base
 - 3.3 Publicity
 - 3.3.1 Mass
 - 3.3.2 Focused

Values assigned: Nature of opportunities afforded by recent advances in science and technology; such as, consensus-building workshops and conferences, technology-transfer projects, and needed standards. This criterion will be assigned a 1 = not relevant, 3 = average, or a 5 = highly applicable.

Usage issues: No issues

Possible MSID position: MSID will transfer technology and knowledge to industry about standards research, development, implementation, and testing.

Assume: MSID will find methods to accomplish effective technology and knowledge transfer.

Category 2: Relevance for MSID involvement

Criterion 4: Degree of correspondence between industrial need and MSID mission

Description: The criterion implies that an MSID mission is to develop standards that support manufacturing-enterprise, information-technology infrastructure. Therefore, the criterion focuses on the correspondence between the perceived need and process interoperability. The necessary exchanges among processes can be inter company or intra company (where company = legal entity). This is intended to improve the degree of interface definition, interchange format, or other process interaction, rather than to improve the aspects of a particular process. Working with particular process improvements is deemed to be something industry should support rather than government.

Criterion 4 Breakdown:

- 4 Degree of correspondence between industrial need and MSID mission
- 4.1 Industry mission
- 4.2 MSID mission
- 4.2.1 Stated industry need (criterion 1)
- 4.2.2 Availability of resources (criterion 6)
- 4.2.3 Nature of opportunity afforded (criterion 3)
- 4.2.4 Nature and size of anticipated impact (criterion 2)
- 4.3 Other mission

Values assigned: Degree of correspondence between a manufacturing-process-interoperability need and the MSID mission to develop standards that support manufacturing-enterprise, information-technology infrastructure. This criterion will be assigned a 1 = slight correspondence, 3 = indirect correspondence, or a 5 = direct correspondence.

Usage issues: It is important to determine whether meeting a US industry need is more important than MSID mission, should the two conflict. Almost by definition, however, US industrial needs will correspond to MSID mission regardless of what the need is and the MSID ability to satisfy that need. Otherwise, the sense of this criterion is meaningless.

Possible MSID position: MSID will assign resources to meet US industrial need to the degree it can; for example, with respect to priorities provided by a standards road map, and the appropriateness of the need as inferred from analyzing these criteria.

Assume: That the MSID mission will, in some way, correspond to US industry needs.

Criterion 5: Opportunity for MSID to make a difference:

Description: Another interpretation of the MSID mission is to improve the state-of-the-art of information technology and information-technology standards. These are considered to be infrastructural in nature and thus highly applicable for MSID participation.

Criterion 5 Breakdown: None recommended.

Values Assigned: Opportunity for MSID participation to make a difference in SOTA for information-technology infrastructure and standards. This is affected by the timeliness of NIST reaction. This criterion will be assigned a 1 = slight opportunity, 3 = indirect opportunity, or a 5 = direct opportunity. This criterion is too similar to criterion 2 to be separate.

Usage issues: No issues.

Possible MSID position: MSID will identify and make significant impact on infrastructural standards where needed. (Same as criterion 2)

Assume: Criterion 2 will subsume this criterion.

Recommendation: Combine this criterion within number 2 either totally, or add any sub-meaning element from this criterion to the second.

Criterion 6: Ability to anticipate and respond in timely fashion:

Description: A key part of the NIST mission is to anticipate US industrial needs before they become critical. In the MSID domain this would apply to infrastructural-information technology. The degree that the need perceived is anticipatory or reactive is the essence of this criterion. The criterion applies to aspects of an ability to perform, the time until a usable standard can be realized, and the appropriateness of the MSID resources available to work on the problem

Criterion 6 Breakdown:

- 6 Ability to anticipate and respond in timely fashion
- 6.1 Human resources available
 - 6.1.1 Degree of management support or commitment
 - 6.1.2 Current NIST goals
 - 6.1.3 Current fiscal climate
 - 6.1.4 Expertise level of resource
- 6.2 Standard status--Availability of standard
 - 6.2.1 Short time until use
 - 6.2.1.1 Committee draft exists
 - 6.2.1.2 Draft standard prepared and balloted
 - 6.2.2 Long time until use
 - 6.2.2.1 Work not yet started--NIST to help generate consensus re need for standard

Values assigned: The MSID capability to anticipate and respond in timely fashion with high-quality solutions. The degree of high quality can be defined only by the users who have, or will have, the need. This capability will be affected by the priorities involved with availability of NIST staff. This criterion will be assigned a 1 = reactive response, 3 = with technology, or a 5 = anticipating technology.

The other part of the criterion is the time it will take to produce the standards effect desired. This could result in a 1 = no way to have a standard in time, 3 = just make the time requirement, and 5 = Beat the time-and anticipate the need, so to speak.

Usage issues: Issues are related to those in the first applicability criterion, as regards being able to decode the messages of need or no need from industry. A good response rating could be interpreted as bad anticipation, because good anticipation will obviate the need for a stated need, and hence, a response to that need. Therefore, if NIST is perfect in meeting the anticipation objective, there will rarely be statements of need from industry.

Possible MSID position: MSID will respond in timely fashion as in the position of criterion 1.

Assume:

- That this criterion focuses only upon the nature of human resources required and the status of the standard being considered, while criterion 1 focuses on the origin of the need and the time to solution
- That the assumptions of criterion 1 are good:
 - (a) Industry will recognize and state needs that exist
 - (b) needs will be stated in a consistent way
 - (c) Industry will be as effective recognizing incipient needs as is NIST

Therefore assume that no statement of need means there is, and will be, no need.

Category 3: Does/could NIST use the standard

Criterion 7: Does or could NIST use the standard:

Description: In addition to the degree of meeting industrial needs an added bonus implied by this criterion is whether the standard helps NIST do its job of supporting US industry better or more effectively.

Criterion 7 Breakdown:

Since this is a yes or no answer, there is no breakdown

Values Assigned: Does/Could NIST use the standard? Yes or no. Who uses it?

Usage issues: Since NIST does not have the same mission or competitive pressures as industry the parallel relevance of this criterion between NIST and industry is unclear. Since none of the NIST priorities is to make NIST more efficient, a high or low rating in this criterion should not affect the decision process. This criterion should be treated as a bonus. However, NIST could recommend certain standards or standard suites in its work with enterprise architectures, frameworks, and manufacturing research. NIST could also apply certain standards and products that employ standards to make information-technology aspects of its work easier.

Possible MSID position: NIST will apply the relevant standards developed for US commerce.

Assume:

- NIST would only use a standard if it is relevant
- NIST use would not impact industrial need or the decision to help US industry, and
- NIST use of the standard would help justify industrial use but NIST non-use would not impair justification

4.2.2 Decision criteria

The decision criteria mentioned in 3.2, above, have been restated to be directly applicable to the objectives of the Standards Road-Map project. The values assigned to the decision criteria are intended to recommend whether or not to support the subject standard. These decision criteria and the values are:

Criterion 8: Determine the nature of the standards activity:

Description: There are several ways that MSID could participate and it is important to define what is needed to be done so that the correct NIST resources can be identified and applied.

Criterion 8 Breakdown: No breakdown recommended.

Values assigned: No value assigned, see assumption below. Determine the model that the standard-development process is using; such as:

- National standard; such as ANSI (American National Standards Institute)

- International standard; such as ISO or IEC (International Organization for Standardization, International Electrotechnical Commission)
- Consortium; such as Consortium for Advanced Manufacturing--International (CAM-I)
- Other recognized standards body; such as Institute of Electrical and Electronics Engineers (IEEE)
- Program; such as National Industrial Information Infrastructure Protocols (NIIP)
- Proprietary (eventually to be open)

This criterion will be assigned a text notation of the type of development process.

Usage issues: This is the model of standard development rather than the nature of the work covered in criterion 2.

Possible MSID position: NIST will consider any standards-making model to be relevant that mitigates US industrial need.

Assume: Each category of activity to develop a standard carries equal weight; that is, no rating. This is an informative criterion only.

Criterion 9: Determine the need for NIST resources:

Description: This criterion is simply the number of NIST people forecasted to be required to accomplish the standards task envisioned.

Criterion 9 breakdown: No breakdown needed.

Values assigned: Evaluate the need for resources against stated needs of manufacturing industry over the next five years. This criterion will be assigned a 1=no resources, 3=one to five people, or a 5=more than five people.

Usage issues: The overall goal for applying NIST resources should be known; that is, whether it is more favorable to use more or fewer NIST resources on a particular standard. This goal could change depending on factors such as the type of standard, the industrial climate in the US, and the availability of funding in a particular fiscal year for the NIST people. Therefore, this issue must be resolved before completing the process to rank a standard using this criterion.

Possible MSID position: MSID will apply NIST people to resolve industrial needs for standards--the more people, the better.

Assume: NIST support of US industry somehow has been quantified. For example: applying more resources is better than applying few. This probably will be true except as changed by environment, such as scarce funding.

Criterion 10: Determine the bang-for-the-buck:

Description: This is related to the criterion above and it adds a kind of productivity factor to it by relating the number of NIST persons to the desired effect. The criterion will then be the number of persons per unit of desired effect.

Criterion 10 breakdown: No breakdown needed.

Values assigned: Analyze the *bang-for-the-buck* aspect; that is, how many NIST people will it take to produce the desired effect on the standard activity and on the industrial need. This criterion probably will be quantified by a ratio of *NIST investment A* divided by *NIST investment B* and then normalize the result somehow. Sometime during the process, however, an analyst must decide if a ratio greater than one or less than one is better.

Usage issues: While this type of criterion is desirable, it is difficult to partition the desired effect, largely a qualitative concept, into units. A metric should be identified. Perhaps one way is to divide the number of NIST people estimated to produce the subject standard into the number of required NIST people to accomplish a set of deliverables on a similar standard. It would seem, then, that a result greater than 1.0 is more efficient than a result less than 1.0. Whether it is, depends on the funding climate at the time. Is doing more with less important, or is helping with many resources, perhaps in differing responsibilities more important? Another way is to separate the desired effect into deliverables, count the number of deliverables NIST has impact upon, and compare the result with a similar effort. The usage comments in the above criterion about the possible NIST position for using NIST resources also apply to this criterion. These issues must be resolved before attempting to rank a standard using this criterion.

Possible MSID position: Similar to criterion 9; however, MSID will apply NIST people to resolve industrial needs for standards--the more productively those resources can be applied, the better.

Assume: Impact can be quantified to provide a degree of impact per NIST people applied.

4.3 Interrelationships among the criteria

The criteria selected are not intrinsic or orthogonal. Appendix C has been developed to show that in certain contexts and with certain degrees of applicability, the presence of a certain amount of one criterion affects the impact or the existence of some of the other criteria.

4.4 Applying the criteria

4.4.1 MSID use of the criteria

Having the criteria and the standards activities the information must be navigated in such a way that MSID can extract meaningful decisions from the information. Making a decision requires that the information be as complete as possible. It is never possible or worth the time to get all of the information. Hence, having up to date standards information in the information resource will help a great deal to create confidence. Even more important are the assumptions and alternatives that must be considered when trying to navigate the criteria to assign a numerical score to a subject standard activity. A sample-navigation process is presented in 4.4.2. This process is intended to illustrate the complexity involved with ranking a candidate standard.

4.4.2 Combining assumptions and criteria

This list is intended to illustrate a process that could be used to evaluate a candidate standard and how the criteria must be navigated using the relation between criteria and assumptions using the composite-criteria breakdown. The items in the list are taken from the criteria breakdowns and from the assumptions presented in 4.2.

- i. Assume that NIST perceives a need for a standard(s) (criterion 1)
 - ii Assume that industry can perceive a current or future need (criterion 1)
 - iii Assume that a standard in subject area corresponds to MSID mission rather than another NIST mission or an industrial mission that is not in NIST purview. (criterion 4.2)
 - iv Consider and score each of the four alternatives below:
 - iv.a Consider if need is stated (criterion 4.2.1); if yes do criterion 1:
 - Classify the need as large or small; that is, the source of need: government, industry segment, industry in general
 - Decide, if need is not directly stated, whether NIST has anticipated the need.
 - Consider the immediacy of external need; that is, can NIST effectively respond to needer's time constraint:
 - In less than three years
 - In less than five years
- and**
- iv.b Consider if resources are available; that is, is NIST able to respond (criterion 4.2.2). If yes, do criterion 6:
 - Assume NIST is responding, not anticipating as covered by criterion 1

- Consider standard status (criterion 6.2); that is, degree of availability
 - Is standard needed quickly; say, in less than three years:
 - Does a Committee Draft exist
 - Is this a fast-track opportunity
 - Is there a longer time; say, in less than five years:
 - Has work started
 - Must NIST help generate consensus regarding need

And

- Consider whether qualified human resources are available (criterion 6.1); that is, can NIST respond effectively to need; that is:
 - Is there management backing
 - Is this within current NIST goals
 - Is current fiscal climate conducive
 - Is sufficient expertise available

and

- iv.c Consider the nature of the opportunity afforded (criterion 4.2.3); if acceptable do criterion 3:
 - Consider the nature of the opportunity afforded (criterion 3)
 - Assume that NIST has found a way to transfer technology effectively
 - Determine what is required of NIST:
 - Technical transfer, and/or (criterion 3.1)
 - Knowledge transfer, and/or (criterion 3.2)
 - Publicity (criterion 3.3)

and

- iv.d Consider the opportunity to make a difference (criterion 5); that is, the nature and size of anticipated impact (criterion 4.2.4). If positive, do criterion 2
 - Consider the nature of support needed to include:
 - Tools and/or
 - Standards development, and/or
 - Test and conformance and/or
 - Capability using standard and/or
 - Standards administration

and

- Consider the size of the impact; that is, how much of the stated need is addressed.
- v Determine the category of the standard (criterion 8)
- vi Estimate the resources needed (criterion 9)
- vii Compare with prior similar activity (criterion 10)

4.5 Strategic questions to allow MSID to use criteria effectively

The sample navigation of the criteria in 4.4 is an example of the process to evaluate a candidate standard and to design a numerical value to the activity. MSID should link this process to the division strategic- and tactical-planning activities. Through this link the division should be able to evaluate its current goals and vectors against the various different ways that the criteria can be interpreted, and to develop a more consistent path through the criteria-option possibilities. These paths should consider the issues and assumptions of 4.2 and the information in Appendixes B and C.

Following are some sample strategic questions MSID could ask to guide and establish this consistence. The items that follow are taken from the discussions in 4.2.

1. **Impact of answers:** How often should MSID ask the following questions and how much of the present structure will change as a result of the answers?

2. **Magnitude of need:** Given that there is a need, small or large, what is the relative importance to NIST or MSID considering the nature of the entity expressing the need; such as

- Nationwide mandate

- Another government agency
- Industry in general
- Industry segment
- Single company

3. **Immediacy of need:** Is it more important for MSID to anticipate a need than to wait until a need becomes immediate?

4. **Ability for MSID to respond in time:** Are sufficient NIST resources available in the expertise category and numbers to meet the need satisfactorily; that is, can NIST satisfy the need with the FTEs available?

5. **Availability of resources:** Given a definitive answer to question 2 and 4, what is the trade-off that would enable MSID to remove resources from one project and apply them to the next; that is when a new project comes in, are all projects reanalyzed or just the fringe projects.

6. **Immediacy and ability to respond:** Does the ability to respond match the immediacy of the need?

7. **Nature of the challenge:** What is the relative importance of the different kinds of standards work that needs to be done, such as:

- Administer standards
- Develop tools
- Develop standard
- Develop test suites, conformance material
- Develop a capability using the standard

8. **A pot of gold at the end:** If NIST were totally flexible and honest with the scoring process, will the resulting project assignments and reassignments be a good thing for standards, MSID, MEL, NIST, US?

9. **Bang-for-the-buck:** From the MSID strategic and tactical plans develop, and redevelop from time to time (item 1 above), the metric to evaluate criteria 9 and 10. This will involve the current NIST environment regarding the numbers of resources that can or should be applied (criterion 9), and determining the relative productivity and opportunity costs of applying a certain number of FTEs (criterion 10).

5 Computer-aided decision analysis

As a test of how these criteria might be used to make a decision, the authors tried a computer-aided decision analysis tool. The tool, Expert Choice [Expert95], is based on the analytic-hierarchy process developed at the Wharton School of the University of Pennsylvania. The tool allows pairwise comparisons of the criteria based on the user's understanding and experience. Using this technique, comparison of both quantitative and qualitative concepts can be done. At the end of the process the items being ranked, in this case each standard under consideration, are ordered according to whatever objective is selected.

Doing this is a long process, even with a few standards selected for review. Given the hundreds of standards that will be involved in an activity such as this, a considerable initial time investment is necessary. Subsequent analyses after the first can be based on a small portion of the standards set, perhaps an analysis comparing the lowest ranking few with the new standards to be considered.

Individual bias could be a problem with some of these tools. To continually make decisions favoring one's personal preferences will skew the results. Similarly, if a seemingly unbiased exercise does not produce the desired result the exercise can be easily repeated until the results are those sought. A well-designed tool will have some bias elimination (or identify that bias is present) designed into the process. If the preferences entered were based on a vote of interested participants, the individual bias would be replaced by the bias of the group--perhaps a better alternative.

Before using a tool such as this, the participants should have a common understanding of the meaning of each criterion and about the intended result. The meaning should include a scope of concepts that are included and those that are not included in each criterion. There should be agreement about whether a high score is favorable or unfavorable. In cases where the meaning of a score is ambiguous, the agreement should extend to some assumptions about the nature of the score.

These tools should not be applied with the intent to supplant human judgement for the individual comparisons. Managers will still have to use considerable judgement to manage their resources. The primary function of the tool is bookkeeping; that is, to do the math, keep one's place, apply the attributes of the decision in an orderly way, and to record preferences. The result will have used judgement and bookkeeping to allow managers to combine analysis, relevant information, knowledge, and experience into a higher confidence-level result than intuition alone could produce.

6 Conclusions

The criteria are adapted to manufacturing situations from the priorities set forth in *Setting Priorities and Measuring Results at the National Institute of Standards and Technology* [BELLO94]. There are two types of criteria.

- Applicability criteria help assess the standard in question with respect to MSID work. Applicability criteria arrange into three categories: applicability to the NIST mission, the relevance for MSID involvement, and the usefulness of the standard to NIST.
- Decision criteria lead directly to a decision about whether MSID should apply resources, how much resources, and about the ability of NIST to apply resources effectively.

Quantifying the criteria requires careful planning regarding what a particular ensuing score might mean.

The criteria, once restated in a manufacturing context, must be analyzed to assure understanding about what a high score means, what a low score means, and what is the significance of different scores.

Most of the criteria can be broken into subcriteria. Before applying the criteria, certain assumptions must be made about the environment. These assumptions are then used with each sub criteria. This process should be organized to form a road map for navigating the criteria that will ultimately lead to a strategic decision about assigning a priority to a standard.

The goal of applying the criteria is to be able to bring more structure to this aspect of the division strategic-planning process and more knowledge about the relative value of particular standards activities. Therefore, for the strategic-decision process relative to standards to be more effective, MSID should insert some strategic questions into the strategic-planning process to provide a current context for the decisions.

A computer-aided decision tool will help analysts to manipulate the amount of variables that arise when evaluating the standards using the criteria and assumptions.

7 References

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- [ISO90] International Organization for Standardization, *Reference Model for standardization and methodology for identification of requirements*, TR 103 14 1, 1990-October.
- [ISO91] International Organization for Standardization, *Reference Model for standardization and methodology for identification of requirements*, TR 103 14 2, 1991-June.
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- [THOM97] Kristy D. Thompson and Cynthia K. Montgomery, NIST, *Program of the Manufacturing Engineering Laboratory*, NISTR 5968, 1997-February, page 182.
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Appendix A: Listing of criteria for the standards road-map project
Sample values added for illustrative purposes

Criterion name	Values	Explanation of criterion
Applicability criteria		
1. Industrial need	Within 3 yr. 5 Within 5 yr. 3 Not Stated 1	Magnitude and immediacy of industrial need
2. MSID impact	Direct 5 Indirect 3 Slight 1	Nature and size of anticipated impact resulting from NIST participation
3. Technical transfer	Topical 5 Average 3 Not relevant 1	Nature of opportunities afforded by recent advances in science and technology
4. Relevance	Direct 5 Indirect 3 Slight 1	Degree of correspondence between a particular industrial need and NIST mission to develop infrastructure technologies
5. SOTA	Direct 5 Indirect 3 Slight 1	Opportunity for MSID to affect the state-of-the-art of the technology or the standard
6. Response	Anticipatory 5 With Tech. 3 Reactive 1	NIST capability to respond in timely fashion with high-quality solutions
7. NIST use	Yes No	Is it relevant for NIST to use the standard, and does NIST use it
Decision criteria		
8. Approach	Standard Test Cases Test Certify Tools	Nature of the effect desired or required
9. NIST FTEs	Yes No	Should NIST assign resources and how many
10. Bang-for-buck	>5 5 1-5 3 None 1	Number of FTEs required to achieve desired effect

Appendix B: Interpretations possible when evaluating the criteria with respect to the standards

Criterion 1: Magnitude and immediacy of industrial need

Issue	Possible interpretation	Solution or comment
Industry has no direct need for standards	<ul style="list-style-type: none"> No consistent answer re standards needs 	<ul style="list-style-type: none"> NIST must translate standards development into industry people's real need
Industry has no opinion, specific people do	<ul style="list-style-type: none"> People want solution to needs that reward them-- lower cost, higher quality 	<ul style="list-style-type: none"> NIST must translate standards development into an individual's real need--to make parts Also address the need for a balanced development
What if there is a "stated need"	<ul style="list-style-type: none"> There is a need and NIST can help It may be too late to help 	<ul style="list-style-type: none"> NIST must assume or analyze situations on a case-be-case basis and help where there can be impact Too late means that NIST cannot have timely response per criterion 6
What if there is "no stated need"	<ul style="list-style-type: none"> There is a need and solution is being sought There is no need There is no need yet The need has been met 	<ul style="list-style-type: none"> NIST must assume or analyze situations on a case-be-case basis and help where there can be impact
Comment		<ul style="list-style-type: none"> Needs should be those that are pre-competitive or infrastructural that does not preclude solution by private sector

Criterion 2: Nature and size of anticipated impact

Issue	Possible Interpretation	Solution or comment
Can interpret a value that indicates NIST could have: <ul style="list-style-type: none"> Slight impact 	<ul style="list-style-type: none"> A small effect on small problem A small part of key large problem 	<ul style="list-style-type: none"> Identify the domain and the value-added to the US industry as a whole that warrants NIST support
<ul style="list-style-type: none"> Major impact 	<ul style="list-style-type: none"> A large part of insignificant problem Large part of key large problem 	<ul style="list-style-type: none"> Identify the domain and the value-added to the US industry as a whole that warrants NIST support
To what degree is US government involved in US and international-standards making	<ul style="list-style-type: none"> Standard could become too government Problem is not general, hence it could benefit a few companies at a cost to others 	<ul style="list-style-type: none"> Identify the domain and the value-added to the US industry as a whole that warrants NIST support

Appendix B continued

Criterion 3: Nature of opportunities afforded for technical transfer

Issue
No issues except to design a technical-transfer methodology that works

Criterion 4: Degree of correspondence between industrial need and MSID mission

Issue
No issue except that we assume that industrial need is not in conflict with MSID mission

Criterion 5: Opportunity for MSID to make a difference.

Issue
No issue; however recommend that this criterion be combined with criterion 2: Nature and size of anticipated impact

Criterion 6: Ability to anticipate and respond in a timely fashion.

Issue	Possible Interpretation	Solution or comment
Assuming that there is a real need per criterion 1, can NIST help? <ul style="list-style-type: none"> NIST can respond in timely way 	<ul style="list-style-type: none"> NIST has the expertise Standard is in late stages of its development 	<ul style="list-style-type: none"> Standard in late stages of development may not permit NIST an acceptable size and nature of impact, per criterion 2
<ul style="list-style-type: none"> NIST cannot respond in timely way 	<ul style="list-style-type: none"> Standard is in early stages of its development NIST lacks the expertise 	<ul style="list-style-type: none"> Reevaluate the meaning of the criterion
Anticipation and response may be mutually exclusive <ul style="list-style-type: none"> Good anticipation 	<ul style="list-style-type: none"> Obviate stated need and need for response 	
<ul style="list-style-type: none"> Bad anticipation 	<ul style="list-style-type: none"> Opens opportunity for good response 	
<ul style="list-style-type: none"> Good response 	<ul style="list-style-type: none"> NIST is flexible, but not anticipatory 	
<ul style="list-style-type: none"> Bad response 	<ul style="list-style-type: none"> NIST is neither anticipatory nor responsive 	
General Issue: This addresses MSID human resource and organizational aspects that are related to the issues of criterion 1: Magnitude and immediacy of industrial need	<ul style="list-style-type: none"> Not being able to respond impacts the quality of response to criterion 1, immediacy of need 	

Criterion 7: Does or could NIST use the standard?

Issue	Possible Interpretation	Solution or comment
<ul style="list-style-type: none"> NIST uses the standard 	<ul style="list-style-type: none"> It is a good standard Good or not it suits NIST purpose It is the only standard of its kind available 	<ul style="list-style-type: none"> NIST use is not a determinant but non-use where the standard would apply could have a negative impact on general use.
<ul style="list-style-type: none"> NIST does not or cannot use the standard 	<ul style="list-style-type: none"> Not relevant to NIST work Not a good standard. NIST prefers a competitor 	<ul style="list-style-type: none"> NIST use is not a determinant but non-use where the standard would apply could have a negative impact on general use.
<p>Is it valid to assume that NIST would use a standard only if it added value to NIST mission?</p>	<ul style="list-style-type: none"> NIST use or non use does not translate directly into an industrial model. NIST use makes no statement about efficient applicability to industrial use. NIST has no explicit goal to improve its efficiency in this area. 	

Criterion 8: Determine the nature of the standards activity.

Issue	Possible Interpretation	Solution or comment
<ul style="list-style-type: none"> This is an information-only criterion because the relevant standard organizations are perceived to be equal. Therefore it is not a criterion but a data item. 		

Criterion 9: Determine the need for NIST resources.

Issue	Possible Interpretation	Solution or comment
<ul style="list-style-type: none"> • Uses few resources 	<ul style="list-style-type: none"> • Efficient use of resources • Insufficient support--will not meet need in time • Sufficient or insufficient government/industry balance 	<ul style="list-style-type: none"> • These two issues must be evaluated with respect to NIST, MEL, and MSID funding and objectives that are in place at the time of analysis
<ul style="list-style-type: none"> • Uses many resources 	<ul style="list-style-type: none"> • Good and sufficient support • Sufficient or insufficient government/industry balance 	<ul style="list-style-type: none"> • It may be difficult to evaluate a standard based on whether or not many or few resources are used
<p>Availability of NIST standards experts will be a determining factor in all standardization</p>		<ul style="list-style-type: none"> • With or without the various interpretations, this consideration may be the ultimate and sole determinant of support for a particular standard

Criterion 10: Determine the bang-for-the-NIST buck.

Issue	Possible Interpretation	Solution or comment
<p>This is an attempt to quantify criterion 9: Determine the need for NIST resources</p> <ul style="list-style-type: none"> • Difficult to partition this into measurable units 	<ul style="list-style-type: none"> • Comparing one standard with another may give an impression that the process is totally meaningful (apples and oranges) 	<ul style="list-style-type: none"> • Could devise a metric such as: Divide the FTEs required to produce deliverables on the subject standard by the FTEs required to accomplish similar deliverables on a similar standard.
<ul style="list-style-type: none"> • Is high-ranked metric better or worse than low-ranked metric? 	<ul style="list-style-type: none"> • NIST can be evaluated highly or poorly by applying many or few resources per unit of output 	<ul style="list-style-type: none"> • Whether or not the indicators are good will depend on the climate as discussed on criterion 9

Appendix C: Interrelationships among applicability criteria (See 4.5)

	1 Industrial need	2 MSID impact	3 Technical transfer	4 Relevance	5 State-of-the-art (SOTA)	6 Anticipate or respond
1 Industrial need	X	Requires accurate account of need. Need may become more immediate if MSID can't respond.	Communicate anticipated needs to industry may create a new need and justify more support.	None direct, if assume industrial needs as stated to NIST are infrastructural in nature.	Improved SOTA will spawn new categories of need.	Requires accurate account of need. Need gets more immediate if MSID can't respond. Anticipation receives no statement of need.
2 MSID impact	X	X	Impact is achieved only through technical transfer. The weaker the transfer, the weaker the impact.	These should correlate for highest impact.	Impact will attract R&D to improve SOTA. These two should correlate.	Being able to anticipate may lessen perceived impact. A good response will improve perceived impact.
3 Technical transfer	X	X	X	Technical transfer is better when relevant to both parties.	Good technical transfer will impact SOTA.	Quality work improves receptivity for tech. transfer.
4 Relevance	X	X	X	X	These two should correlate.	Process improves with proper MSID resources
5 State-of-the-art	X	X	X	X	X	Good anticipation or response should improve SOTA.
6 Response	X	X	X	X	X	X

Appendix D: Criteria listing divided into their meaning segments

Applicability criteria

Category 1

1 Magnitude and immediacy of industrial need

- 1.1 Magnitude of industrial need
 - 1.1.1 Nature of entity expressing need
 - 1.1.1.1 Congress--new law
 - 1.1.1.2 Industrial--segment
 - 1.1.1.3 Industry--general
- 1.2 Immediacy of industrial need
 - 1.2.1 NIST anticipated the need
 - 1.2.2 Ability to respond
 - 1.2.2.1 Industry needs benefit in less than three years
 - 1.2.2.2 Industry needs benefit in less than five years

2 Nature and size of anticipated impact.

- 2.1 Nature of impact
 - 2.1.1 Nature of support needed
 - 2.1.1.1 Develop tools
 - 2.1.1.2 Develop standard
 - 2.1.1.3 Develop test, conformance
 - 2.1.1.4 Develop capability that uses standard
 - 2.1.1.5 Standards administration
- 2.2 Size of impact
 - 2.2.1 Impact in small part (less than 20%) of problem (stated need)
 - 2.2.2 Impact in large part (more than 20%) of stated need

3 Nature of opportunity afforded

- 3.1 Technology transfer
 - 3.1.1 Seminars
 - 3.1.2 Documents
 - 3.1.3 Co-participation
- 3.2 Knowledge transfer
 - 3.2.1 Books
 - 3.2.2 Knowledgebase
- 3.3 Publicity
 - 3.3.1 Mass
 - 3.3.2 Focused

Category 2

4 Degree of correspondence between industrial need and MSID mission

- 4.1 Industry mission
- 4.2 MSID mission
 - 4.2.1 Stated industry need (criterion 1)
 - 4.2.2 Availability of resources (criterion 6)
 - 4.2.3 Nature of opportunity afforded (criterion 3)
 - 4.2.4 Nature and size of anticipated impact (criterion 2)
- 4.3 Other mission

5 Opportunity for MSID to make a difference (covered in 4.2 and becomes criterion 2)

6 Ability to anticipate and respond in timely fashion

- 6.1 Human resources available
 - 6.1.1 Degree of management support or commitment
 - 6.1.2 Current NIST goals
 - 6.1.3 Current fiscal climate
 - 6.1.4 Expertise level of resource
- 6.2 Standard status--Availability of standard
 - 6.2.1 Short time until use
 - 6.2.1.1 CD exists
 - 6.2.1.2 Draft standard prepared and balloted
 - 6.2.2 Long time until use
 - 6.2.2.1 Work not yet started--NIST to help generate consensus re need for standard
 - 6.2.2.1.1 NIST to generate consensus regarding need for standard

Category 3

7 Does or could NIST use the standard (No breakdown recommended)

Decision criteria

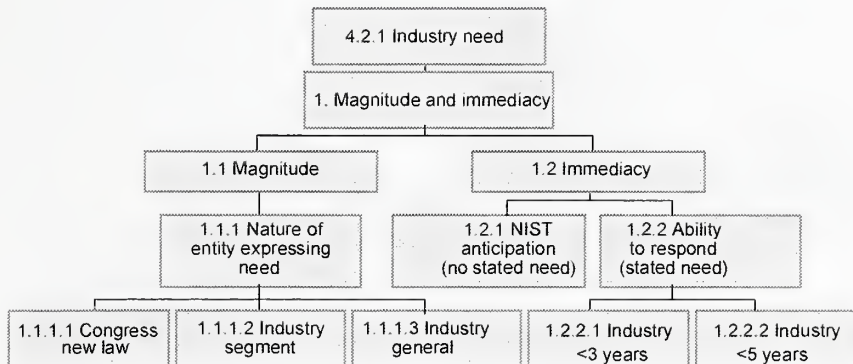
8 The nature of the standards activity (No breakdown recommended)

9 The need for NIST resources (No breakdown recommended)

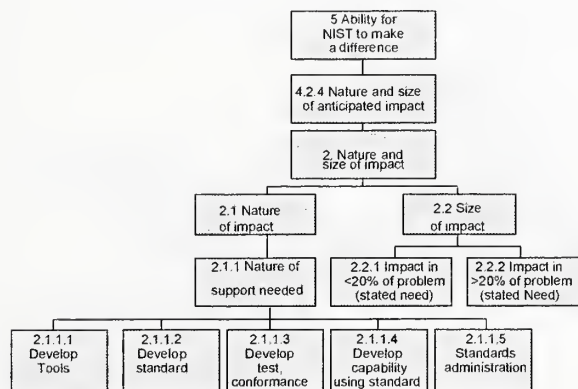
10 The *bang-for-the-buck* (No breakdown recommended)

Appendix E: Graphic organization of the criteria

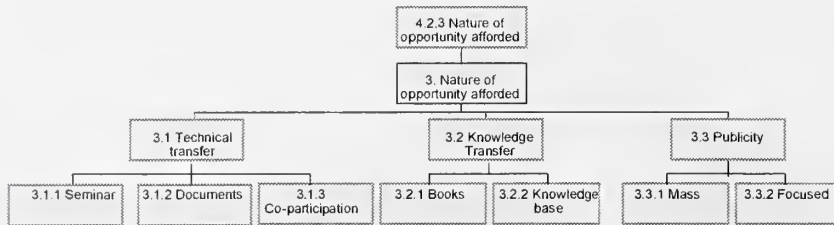
Criterion 1: Magnitude and immediacy of industrial need



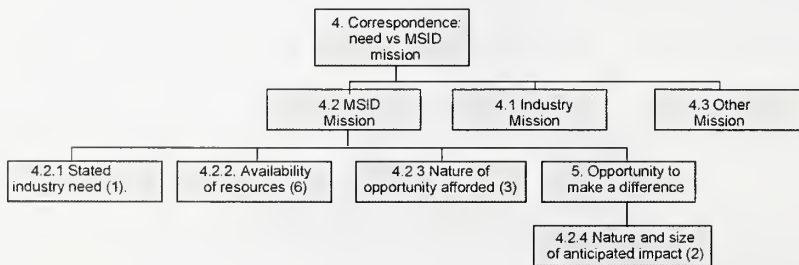
Criterion 2: Nature and Size of Anticipated Impact



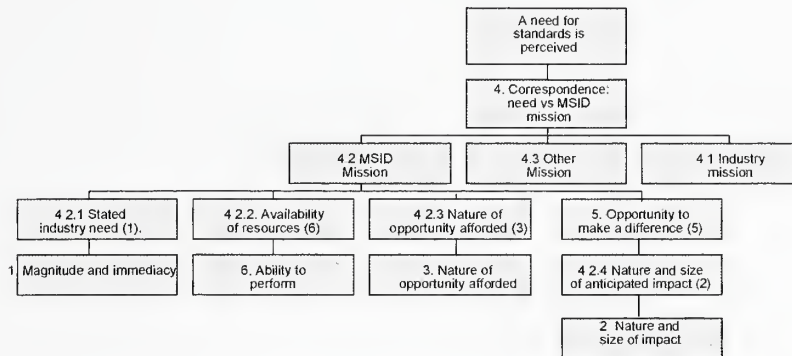
Criterion 3: Nature of Opportunity Afforded



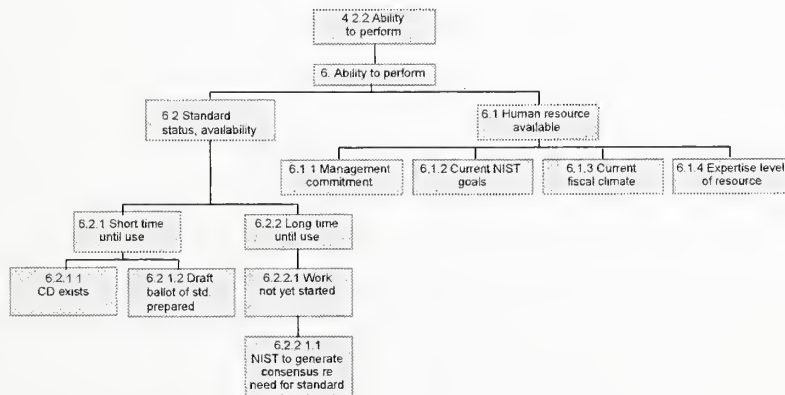
Criterion 4: Degree of correspondence between need and MSID mission



Composite: criteria 1, 2, 3, 5, and 6 positioned under criterion 4



Criterion 6: Ability to anticipate or respond in timely fashion



Criteria 7, 8, 9, and 10: Decision-criteria composite

