
# Practical Advice on Picking the Right Projects for an Appraisal

Bob Moore, Business Transformation Institute, Inc.
Will Hayes, Software Engineering Institute


# You may recall . . .

- At the 2005 NDIA CMMI and SEPG 2006, we presented "Building a Credible SCAMPI Appraisal Representative Sample".
- This presentation demonstrated how to apply Design of Experiment (DOE) techniques in choosing a "good" SCAMPI appraisal representative sample.
- Today's presentation builds on our previous work to:
  - Provide advice on how to select projects for a SCAMPI appraisal while following the rules of SCAMPI Method Description Document version 1.2.
  - Demonstrate applying the more mathematical of the project selection techniques using Microsoft Excel.


# Why Should We Care About Picking the Right Projects for an Appraisal?

- Choosing the right projects is the foundation of an appraisal that:
  - Is credible to anyone who was not part of the appraisal team or even part of the organization being appraised and
  - Maximizes the organization's understanding of its processes' strengths and weaknesses.
- These two benefits of choosing the right projects are mutually supportive because:
  - Choosing the right projects provides the most information gained per appraisal resource invested.
  - Other sets of projects could be examined, but would be inferior with respect to insights gained on process institutionalization.
  - Choosing a less-than-right set of projects invites suspicion that the appraisal results may reflect projects that are atypical of the processes used in the organization.
    - Atypical because only "good" projects were included or
    - Atypical because "bad" project were excluded.
- Bottom Line: picking the right projects maximizes the return on investment in the appraisal!


# What Does SCAMPI MDD 1.2 Say About Picking the Right Projects? (1)

- Section 1.1.3, "Determine Appraisal Scope":
  - The organizational scope of **the appraisal must include sample projects and support groups that are representative of the implemented processes and functional areas** being investigated within the organizational unit and that operate within a coherent process context. The **rationale for selecting** these sample projects and support groups as representative of the organizational unit **must be documented**.


# What Does SCAMPI MDD 1.2 Say About Picking the Right Projects? (2)

- Section 1.1.3, "Determine Appraisal Scope":
  - **Organizational unit size** (i.e., number of people and number of projects) and **sizes of projects and support groups** (i.e., number of people) in the organizational scope **must be documented** as well as the **percentage ratio of these two measures**:
    - **Population %**: the number of people in the organizational scope divided by the number of people in the organizational unit (x100)
    - **Project %**: the number of projects in the organizational scope divided by the number of projects in the organizational unit (x100)
  - **Critical factors that influence implementation of practices** in projects and functions within the organizational unit **must also be understood and identified**.


# What Does SCAMPI MDD 1.2 Say About Picking the Right Projects? (3)

- Section 1.1.3, "Determine Appraisal Scope":
  - **Sample projects and support groups** selected to form the organizational scope (i.e., the combination of focus and non-focus projects and support functions) **must represent all critical factors identified for the organizational unit** to which the results will be attributed. The **coverage of the organizational critical factors** provided by these sample projects and support groups in the organizational scope in relation to the organizational unit **must be documented, in quantitative terms, in the appraisal input and ADS**.


# What Does SCAMPI MDD 1.2 Say About Picking the Right Projects? (4)

- Section 1.1.3, "Determine Appraisal Scope":
  - Each sample project or support group in the planned organizational scope of the appraisal must be one of the three types listed below:
    - Focus projects must provide objective evidence for every PA within the model scope of the appraisal which addresses model practices applicable to those projects.
    - Non-focus projects must provide objective evidence for one or more PAs within the model scope of the appraisal which address practices performed on projects.
  - In appraisals where the reference model scope includes any project-related PA, the organizational scope must include at least one focus project.

# What Does SCAMPI MDD 1.2 Say About Picking the Right Projects? (5)

- Section 1.1.3, "Determine Appraisal Scope":
  - **Information about the organizational unit should be documented in a way that allows future appraisal sponsors to replicate (to the extent possible) the organizational unit appraised**. This information should be in the appraisal plan, and used (in summary form if needed) in briefing the appraisal team and appraisal participants. **Other examples of critical factors include**:
    - application domains (or lines of business)
    - geographical breadth
    - disciplines (e.g., systems engineering, software engineering, or hardware engineering)
    - effort types (e.g., development, maintenance, or services)
    - project types (e.g., legacy or new development)
    - customer types (e.g., commercial or government agency)
    - lifecycle models in use within the organization (e.g., spiral, evolutionary, waterfall, or incremental)


# Key Points of SCAMPI MDD 1.2, "Determine Appraisal Scope"

- The MDD does not advise us on how to pick projects, but it does provide conditions that our selected projects must fulfill to be acceptable:
  1. You must document the *percentage of the organization's people and projects* covered by the appraised projects and functions.
  2. The appraisal must use *representative* sample projects.
  3. Representative means that all *critical* (process implementation-influencing) *factors are covered* in the sample projects.
  4. The *relationship between the critical factors and the sample projects must be documented* in the ADS so that future appraisal sponsors.


# Paths to Picking the Right Projects

- There are two alternative paths to be considered before picking the right project in planning an appraisal:
  - **Alternative 1**: Define the organizational unit to be appraised. The choice of the organizational unit will influence the choice of projects.
  - **Alternative 2**: Pick the projects to be appraised. The choice of projects will define the organizational unit to which appraisal results apply.


# Advice on Picking The Right Projects

- The advice applies when following path 1.
- We'll discuss "reverse engineering" the organizational unit from the selected projects later (path 2).


# Categories of Advice

- Project Life Cycle Advice
- Project Visibility Advice
- Project Critical Factors Advice
- Project Size Advice


# Project Life Cycle Advice

1. Project Milestones and Appraisal Events:
   - Avoid choosing a project for an appraisal if the date for any appraisal event that requires the project's active participation would occur before a major product release or milestone.
   - Advice Rationale: The reason the project exists is to deliver its product(s). The project's progress towards delivering the product(s) is measured by reaching its milestones. Anything that interferes with releasing product(s) or meeting milestones will either:
     - decrease the project's likelihood of success or
     - be ignored by the project.

# Project Life Cycle Advice (2)

2. Projects Early in Their Life Cycle:
   - Avoid appraising a project if the project is early in its life cycle.
   - Advice Rationale: Projects that are early in their life cycle are likely to have:
     - Immature artifacts,
     - Sparse artifacts,
     - Staff that, as whole, may be uncomfortable with the project, the processes, or each other.

# Project Life Cycle Advice (3)

3. Projects Late in Their Life Cycle:
   - Avoid appraising a project if the project will end before or soon after the appraisal(s) is complete.
   - Advice Rationale: Any weaknesses discovered in a project that is late in its life cycle will give the project limited or no opportunities to fix the weaknesses. Consequently:
     - Future appraisals (e.g., a SCAMPI A following a SCAMPI B) using this project will find the same weaknesses as the current appraisal.
     - The project itself won't benefit from the appraisal's findings because the project may not be able to change or have too much invested in its existing process implementation to warrant changes (other projects may benefit, of course).


# Project Visibility Advice

1. Important Projects:
   - Avoid appraising projects that are highly visible or important.
   - Advice rationale: An important or highly visible project may have too many distractions or pressures that will limit its ability to cooperate in preparing for an appraisal or limit the benefits it receives from appraisal results.
2. Trivial Projects:
   - Avoid appraising projects that are of trivial or marginal importance to the organization.
   - Advice rationale:
     - A trivial project may be cancelled, terminating its participation in an appraisal.
     - A trivial project may be viewed by the organization as not providing relevant process insights for other, more significant projects.


# Project Size Advice

- Projects with Large Staff Sizes:
  - If project staff size is not a factor that influences processes in the organization, then select at least one large staff-sized project for the appraisal.
  - Advice Rationale: SCAMPI 1.2 requires that the appraisal population and project percentage must be documented. Larger projects will make the appraisal population percentage increase rapidly. Larger projects are also better able to accommodate the work required to prepare for an appraisal.
    - Hint: the SEI is looking for higher population and project percentages!


# Project Critical Factors Advice Before We Get Started: A Little Necessary Math (1)

- Balanced designs are selections of projects for appraisals where there are an equal number of projects selected for each combination of critical factors.
- Orthogonal designs are selections of projects for an appraisal so that the critical factors balance out across the projects being appraised.


# Project Critical Factors Advice Before We Get Started: A Little Necessary Math (2)

- Experimental resolution helps us to understand the degree of our "known unknowns" in an appraisal.
  - Resolution I = we gain no insight from an appraisal
  - Resolution II = we cannot tell the difference between the influence of main critical factor effects (why bother?)
  - Resolution III = Main factor effects can't be distinguished from two-factor interactions.
    - e.g., If the customer type, project size, and project type are all thought to influence process institutionalization, then a resolution III experiment can't tell the difference between the influence of customer type vs. project size and type combined.
  - Resolution IV = No main factor effects get confused with two-factor interactions, but two-factor interactions can't be distinguished from each other.
  - Resolution V = No main effect or two-factor interaction is confused with any other main effect or two-factor interaction, but two-factor interactions can't be distinguished from three-factor interactions.


# Constructing A Project Factors Table: Step 1

- We will use this technique several times in the subsequent discussion.
- Create a table in Microsoft Excel.
  - The column headings will be the names of the factors that influence process institutionalization in the organization being appraised.
  - The row headings will be the names of the projects that are participating in the appraisal.


# Table Construction Example Setup

- Factors that influence processes in the projects:
  - Project customer: commercial or government
  - Project location: domestic or international
  - Project type: development or maintenance
- Projects being considered:
  - Project 1: government, domestic, maintenance
  - Project 2: government, domestic, development
  - Project 3: commercial, international, development
  - Project 4: commercial, domestic, development


# Table Construction Example: Step 1

| | Customer | Location | Type |
|---|---|---|---|
| Project 1 | | | |
| Project 2 | | | |
| Project 3 | | | |
| Project 4 | | | |


# Constructing A Project Factors Table: Step 2

- Fill in the table with the factor levels for each project
  - Consistently convert factor levels to values of “1”and “-1”.
  - For each project row, fill in a “1” or “-1” depending on how the project is characterized against the corresponding factor column.

# Table Construction Example: Step 2

| | Customer | Location | Type |
|---|---|---|---|
| Project 1 | 1 | 1 | -1 |
| Project 2 | 1 | 1 | 1 |
| Project 3 | -1 | -1 | 1 |
| Project 4 | -1 | 1 | 1 |


# Constructing A Project Factors Table: Step 3

- Add additional columns to the table representing all possible combinations of factors
  - Examples:
    - If there are two factors (F1 and F2), add a column to the table and label it "F1*F2".
    - If there are three factors (F1, F2, and F3), add columns to the table labeled "F1*F2", "F1*F3", "F2*F3", "F1*F2*F3".
  - Compute the values for the cells in the additional columns by multiplying the values of the rows together according to the column headings.


# Table Construction Example: Step 3

| | Customer | Location | Type | Customer* Location | Customer* Type | Location* Type | Customer* Location* Type |
|---|---|---|---|---|---|---|---|
| Project 1 | 1 | 1 | -1 | 1 | -1 | -1 | -1 |
| Project 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Project 3 | -1 | -1 | 1 | 1 | -1 | -1 | 1 |
| Project 4 | -1 | 1 | 1 | -1 | -1 | 1 | -1 |


# Project Critical Factors Advice (1)

1. Higher Resolution Appraisals:
   - Select projects for the appraisal in sufficient numbers and diversity to get a resolution III or better appraisal.
   - Advice Rationale: Resolution I and II appraisals can't distinguish between the effect of main factors on process institutionalization. Resolution I and II appraisals yield no information.


# Project Critical Factors Example

- The organization being appraised has two factors that are thought to influence process institutionalization:
  - project location (California or India) and
  - project customer (US Navy or insurance companies.)
- The appraisal looks at two projects:
  - Project #1 is in California that has the US Navy as a customer and
  - Project #2 is in India that has Mega Big Insurance as a customer
- Project #1 has some weaknesses in requirements management and some strengths in technical solution.
- Project #2 has some weaknesses in technical solution and some strengths in requirements management.
- What is the right conclusion about this organization's requirements management and technical solution process implementations?
- Answer: we can't draw any fact-based conclusions!

# Determining Minimum Number of Projects from Resolution and Number of Factors

| | | Resolution | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Factors (all with 2 levels) | 1 | | | | | | | | |
| | 2 | | | | | | | | |
| | 3 | | | 4 | | | | | |
| | 4 | | | | 8 | | | | |
| | 5 | | | 8 | | 16 | | | |
| | 6 | | | 8 | 16 | | 32 | | |
| | 7 | | | 8 | 16 | | | 64 | |
| | 8 | | | 16 | 16 | 64 | | | 128 |


# Project Critical Factors Advice (2)

2. Critical factors versus number of projects :
   - Choose projects that maximize the number of factor settings in the fewest number of projects.
   - Advice Rationale: One of the principal appraisal cost drivers is the number of projects involved in the appraisal. Maximizing the number of factor settings covered in the fewest number of projects will maximize the information gained from the projects, and hence the coverage of the organizational unit, while minimizing cost.


# Constructing A Project Factors Table (Continued from Earlier Discussion)

- Look for patterns or "unbalanced-ness" or "non-orthogonality" in the table that indicates potential problems:
  - One factor never varies or only varies when all other factors are set to particular values.
  - Two factors are always "low" or "high" in tandem with each other across the projects.
    - Indicated by one of the product columns always being the same sign
  - One of the main columns (with a single factor heading) is the same as one of the multiple column columns

# Example 1: Factors Patterns

| | F1 | F2 | F3 | F1*F2 | F1*F3 | F2*F3 | F1*F2*F3 |
|---|---|---|---|---|---|---|---|
| P1 | 1 | -1 | 1 | -1 | 1 | -1 | -1 |
| P2 | -1 | -1 | 1 | 1 | -1 | -1 | 1 |
| P3 | 1 | 1 | -1 | 1 | -1 | -1 | -1 |
| P4 | -1 | 1 | -1 | -1 | 1 | -1 | 1 |

Factor 2 and 3 are always the opposite of each other. We never learn anything about when they are both “high” or “low” at the same time.

# Example 2: Factors Patterns

| | F1 | F2 | F3 | F1*F2 | F1*F3 | F2*F3 | F1*F2*F3 |
|---|---|---|---|---|---|---|---|
| P1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| P2 | -1 | 1 | 1 | -1 | -1 | 1 | -1 |
| P3 | 1 | -1 | -1 | -1 | -1 | 1 | 1 |
| P4 | -1 | -1 | -1 | 1 | 1 | 1 | -1 |

Factors 2 and 3 are is always the same high or low setting, so we learn nothing about their separate influences on the processes.


# Project Critical Factors Advice (3)

3. Critical factors and organizational unit scope:
   - If none of the appraised sample projects includes a particular setting for a particular factor, then the appraisal can't have any findings with respect to that factor setting.
     - Corollary: If your organization includes projects with a factor set to a particular value, then one of the sample projects must also include that factor with that value.
   - Advice Rationale: As an example, if an organizational unit includes commercial and government projects, then this factor influences process implementation. An appraisal that includes only government projects could not apply to the organization's commercial projects.

# Example 3: Factors Patterns

| | F1 | F2 | F3 | F1*F2 | F1*F3 | F2*F3 | F1*F2*F3 |
|---|---|---|---|---|---|---|---|
| P1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| P2 | -1 | 1 | 1 | -1 | -1 | 1 | -1 |
| P3 | 1 | -1 | 1 | -1 | 1 | -1 | -1 |
| P4 | -1 | -1 | 1 | 1 | -1 | -1 | 1 |

Factor 3 never varies—none of the appraised projects is telling us anything about the influence of factor 3 on process institutionalization. (This pattern is non-orthogonal!)

# Project Critical Factors Advice (4)

4. Critical factors and multiple appraisals:
   - If the appraisal is considering three or more factors, perform "factor screening" SCAMPI B or C appraisal(s) before the SCAMPI A in order to discover and discard unimportant factors.
   - Use blocking techniques to divide one large appraisal into several smaller appraisals.
   - Advice Rationale: A full-factor appraisal that includes three factors each with only 2 settings each would need to examine 8 projects. (More factors would require even more projects.) The number of projects to be appraised in a single appraisal could be reduced by conducting lower-cost SCAMPI B or C appraisals to determine if some of the factors are inconsequential with respect to process implementation. (Alternately, use blocking techniques.)
   - Example: Suppose an organization includes commercial and government projects. A SCAMPI C appraisal that considered government and commercial projects (with the other factors allowed to vary) and found that the customer type yielded the same process strengths and weaknesses could be used to conclude that the "customer type" factor may be eliminated from consideration for future appraisals.


# Reverse Engineering the Organizational Unit from the Appraisal

- Obeying all of the rules of the SCAMPI MDD 1.2 may be challenging.
  - Note: in designing experiments for engineering, science, medicine, social sciences, etc. , the rest of the world does everything described in the MDD and more to reach acceptable results.
- One way of reducing the challenge of the MDD is to pick the projects to be appraised and then compute out the organizational unit to which the appraisal would apply.


# Reverse Engineering the Organization from the Appraisal

- Three SCAMPI MDD 1.2 rules drive the reverse engineering:
  - We must document the number of people in the appraisal's organizational scope divided by the number of people in the organizational unit (x100)
  - We must document the number of projects in the appraisal's organizational scope divided by the number of projects in the organizational unit (x100)
  - We must understand and identify critical factors that influence implementation of practices in projects and functions within the organizational unit.


# Reverse Engineering Assumptions

- In documenting the appraisal, we assume that:
  - Higher population and project percentages are desirable versus lower percentages.
  - Any factor setting that is NOT covered in the appraisal cannot be attributed to the organization.


# Reverse Engineering: Step 1

a. Write down a critical factors table, as discussed earlier, for the projects in the appraisal.
b. Select the "maximum desired organizational unit" to be represented with the appraisal.
c. Prune the "maximum desired" OU down to a "maximum possible" OU by checking the critical factors table for combinations of factor settings that are never examined—projects that contain these factor setting combinations must be excluded from the organizational unit.
   - For instance, if "customer type" could be "state government", "federal government", or "commercial", but the critical factors table includes only settings of "state government" or "federal government" then the maximum possible organizational unit CANNOT include "commercial" projects.
   - Note: there is a procedure to compute the organization from the factor settings. However, the procedure involves solving a set of linear equations modulo the number of factors and is too involved to discuss here.


# Reverse Engineering: Step 2

a. Determine the population and project percentages that you believe are acceptable for a SCAMPI A appraisal.

b. Given the maximum organization determined by the factors coverage from step 1, compute the population and project percentages for the actual appraised projects compared to this maximum organization.
   - If the computed population and project percentages from step 2b are greater or equal to the limits in step 2a, then the organizational unit may be set to the maximum organization for the appraisal.
   - If the computed population and project percentages from step 2b are less than the limits in step 2a, then reduce the scope of the maximum organization until the actual population and project percentages are greater than or equal to the limits set in 2a. The organizational unit for the appraisal is this reduced maximum organization.


# Summary

- We want to pick the right projects for an appraisal in order to:
  - Maximize the information gained about an organization's process implementation,
  - Minimize the cost and risk of the appraisal, and
  - Produce results that are credible to the larger process improvement community.
- We've discussed a number of approaches for achieving these goals based on our appraisal experiences and using mathematical techniques such as design of experiments.
  - The methods we've discussed require tools no more complex than MS Excel.


# Contact Information

- Bob Moore, Business Transformation Institute, Inc.
  - rlmoore@biztransform.net
- Will Hayes, Software Engineering Insitute
  - wh@sei.cmu.edu
- Additional information with respect to MS Excel computations and background material may be found at www.biztransform.net under "Publications".