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June 2012

Measurement Space Code of Best Practice (CoBP)

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This document is intended to guide the analyst in problem definition and systematic development of focused and efficient methodologies to analyze the problem in order to weigh and distinguish the optional courses-of-action offered to solve it.

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Purpose and Table of Contents

Purpose: Define the concept of analytic measurement space and provide guidance to apply it to complex problem solving.

Table of Contents

This guide provides a systematic way to think about a problem and then develop the most appropriate method to analyze it. This guide is not meant to impose a prescriptive or formulistic "cook book" approach.

Purpose & Table of Contents

This scripted brief provides a code of best practice (CoBP) for analysts and the community of practice (CoP) to use as a guide to problem definition and the systematic development of methodologies to analyze problems. These methodologies enable analysts to weigh and distinguish the optional courses-of-action (COAs) offered to solve the problem. It is intended to stimulate thinking about the problem, especially the conditions that led to the problem vis-à-vis the attributes of the potential COAs or solutions, and the most appropriate methods to distinguish those COAs or solutions as they pertain to the problem itself. The CoBP describes the concept of analytic measurement space (MS) and illustrates its role in the study planning process.

The CoBP is divided into three major sections. The first section describes the decision analysis environment. Although the environment did not directly influence the development of this CoBP, the prevailing conditions in the current decision analysis environment prompted this emphasis on deliberately thinking through the problem at the front-end, and developing the right methodologies to the problem's offered solutions in the most efficient and effective way.

The second section describes measurement space thinking. This section further defines MS by introducing a theoretical approach to addressing complex problems. An understanding and practical appreciation of the key elements of measurement space, their interrelationships, and the thought processes are essential to applying this concept to each unique and challenging problem.

The third section explains how to relate MS to study planning. In the case of operational problems, the analysis components of scenarios, data and methods, models and tools (MMT) are the means by which measurement space is instantiated. Effectively applying measurement space enables tailoring and properly accounting for those components in order to answer the right question; but more importantly, it helps ensure the right methodology is developed and implemented to solve the right problem.

This CoBP is not meant to be prescriptive or a formulistic guide to developing MS. Instead, this CoBP encourages the analyst to think first before doing anything.

Terms of Reference

- **Measurement Space is the set of problem-inducing conditions, that when adequately accounted for in analysis methods, will most likely distinguish between two or more optional solutions based on their attributes.**

- **Tipping point issue**. The principal issue or question faced by the decision maker that when answered, causes him/her to select a particular course-of-action or solution over another.
- **Attribute**. A quantitative or qualitative characteristic of an element or its actions. (CJCSI 3170.01G, JCIDS, 1 Mar 09) In this CoBP, it pertains to a course-of-action or solution.
- **Dynamic scenario**. A version of an operational or study scenario that is modeled in a simulation. (TRADOC Reg 71-4)
- **Method**. A *systematic procedure*, [analytic] *technique*, or *mode of inquiry* employed by or proper to a particular discipline or art. (Merriam-Webster's Online Dictionary)
- **Model**. A physical, mathematical, or otherwise *logical representation of a system*, entity, phenomenon, or process. (AR 5-11, 1 Feb 05)
- **Operational scenario**. A graphic and narrative description of the operational variables, political, military, economic, social, information, infrastructure plus physical environment and time; it concerns events of a future hypothetical operation. (TRADOC Reg 71-4)
- **Tool**. Something (as an instrument or apparatus) used in performing an operation or *necessary in the practice of a vocation or profession*. (Merriam-Webster's Online Dictionary)
- **Study scenario**. An operational scenario that is applied in modeling, simulation, or other gaming tool to serve as a base case for a particular study. (TRADOC Reg 71-4)

Terms of Reference

The chart offers definitions (and associated references) used in this CoBP. Most importantly, this CoBP defines measurement space as:

> **"The set of problem-inducing conditions, that when adequately accounted for in analysis methods, will most likely distinguish between two or more optional solutions based on their attributes."**

The other terms of reference used in this CoBP might have multiple meanings or usage across the analytic community of practice. They are specifically called out here for purposes of this CoBP because it is intended to represent a broad perspective with applicability to many classes of problems.

The definitions on the chart suffice for several of the terms which are self explanatory (dynamic scenario, method, model, operational scenario, tool and study scenario). However, two terms may deserve further clarification.

A tipping point issue is referred to as the principal question held by a decision maker that when answered, causes him to choose one solution over another. Within a given study, there are typically a number of issues that tip the analysis in the favor of one particular solution, or set of solutions. These issues often tend to sway the decision maker's opinion of the analysis one way or another. The proper due diligence put forth up front increases the odds of identifying these issues early in the study process.

The term "attribute" merits elaboration. As the JCIDS manual defines it, an attribute is a quantitative or qualitative characteristic of an element or its actions. In many studies, we define the individual prospective solutions by the characteristics, or attributes each displays. More importantly, analysts will attempt to isolate those attributes that distinguish one solution from another.

Why Renewed Interest?

(1 of 2)

Today's decision analysis environment requires renewed emphasis on sound operations analysis techniques.

- **The decision analysis environment in which we operate is undergoing significant change and presenting new challenges.**
  - **Weapon System Acquisition Reform Act (WSARA).**
  - **Diminishing fiscal resources.**
  - **Increased scrutiny from leadership at all levels of government.**
  - **Compressed timelines for analysis to enable vital decisions.**
- **These challenges require the analyst to take a more disciplined approach to problem definition and study planning to focus and promptly home-in on key decision issues and answers.**
- **Measurement space development offers a valuable way to collaborate and reach shared understanding among:**
  - **Analysts.**
  - **Modelers.**
  - **Scenario Developers.**
  - **Warfighters.**
  - **Engineers/Developers.**
  - **Acquisition Managers.**

Why Renewed Interest?

(1 of 2)

The decision analysis environment in which analysts operate changes; however, the fundamentals of problem solving and sound operations research analysis techniques endure. Within the last several years, significant changes in the decision environment have impacted the way U.S. Army analytical organizations conduct analysis.

Enacted 22 May 2009, the Weapon Systems Acquisition Reform Act (WSARA) included guidance to the DOD for studies involving acquisition decisions and made specific changes to the Milestone A and B certification process.

Combined with the new legislation, constrained DOD budgets, fiscal resources and force structure, condensed timelines for analysis, and increased levels of scrutiny from all levels of leadership within the government have shaped the decision analysis landscape.

These challenges require analysts to raise their game with regard to their analyses. Analysts must take a more disciplined approach to front-end problem definition and study planning in order to more efficiently and promptly identify key decision issues to enable focusing analysis to reveal compelling evidence about the merits of potential solutions and courses-of-action (COAs) as early as possible. To achieve these aims, measurement space thinking and development are vital.

The tenets of measurement space development are not particularly new or unique, but rather a codification of a mental heuristic to decompose a problem into its relevant components and then tailor the analysis to answer the "right" question with the "right" methods.

Properly implementing measurement space development involves many individuals with different areas of expertise and knowledge about: the problem; the conditions that led to it; the potential COAs or solutions and their attributes; and the expedient methods to analyze the problem and solutions. The practice brings together the analysts, technical experts, acquisition experts, and the warfighters early in the study process. By bringing together the "right" individuals the study team at large gains a fuller appreciation of the study issues' complexity. Bringing together the problem owners and the solution offerers informs the study team members about how best to tackle the problem.

Experience to date in applying measurement space has demonstrated its tremendous value. Payoff is associated with reaching a shared understanding of the problem and offered solutions, and with avoiding the cost and delays of false starts, excessive scopes of effort, and unnecessary exploratory analysis.

Why Renewed Emphasis? (2 of 2)

- **Too often, the analyst leaps straight to problem solving (based on experience with problems that appear similar) without exercising due diligence to formulate the problem and tailor a relevant methodology.**
- **The analyst too often fails to adequately consider and account for all of the methodology components necessary to reveal the salient differences between potential solutions in ways most relevant to the problem's origins.**
- **Matching the right methodology to the right class of problem is fundamental to sound operations analysis.**
- **Without up-front consideration of measurement space, the analysis may eventually produce similar findings through discovery; no guarantee, but surely at a greater cost of time and resources.**
- **Measurement space development is learned behavior practiced by good analysts, and it should be codified and encouraged.**

The systematic consideration of measurement space focuses the analyst to "*think first, before doing anything else*."

Why Renewed Emphasis? (2 of 2)

Given the challenges posed by the decision analysis environment, analysts often face unique and highly complex problems that demand the application of sound operations analysis fundamentals and techniques. Even the most experienced analyst may at times encounter problems during the course of a study that originated with a failure to first think diligently about the problem and carefully match the methodologies to it.

The analyst must avoid leaping straight into solving a problem without applying the appropriate degree of due diligence; he/she must avoid the temptation to routinely apply previously developed methodologies to problems that might appear similar in nature. Bringing in the right people to collectively apply due diligence will enable the analyst to tailor the components of and fine-tune the most appropriate methodological approach to the problem.

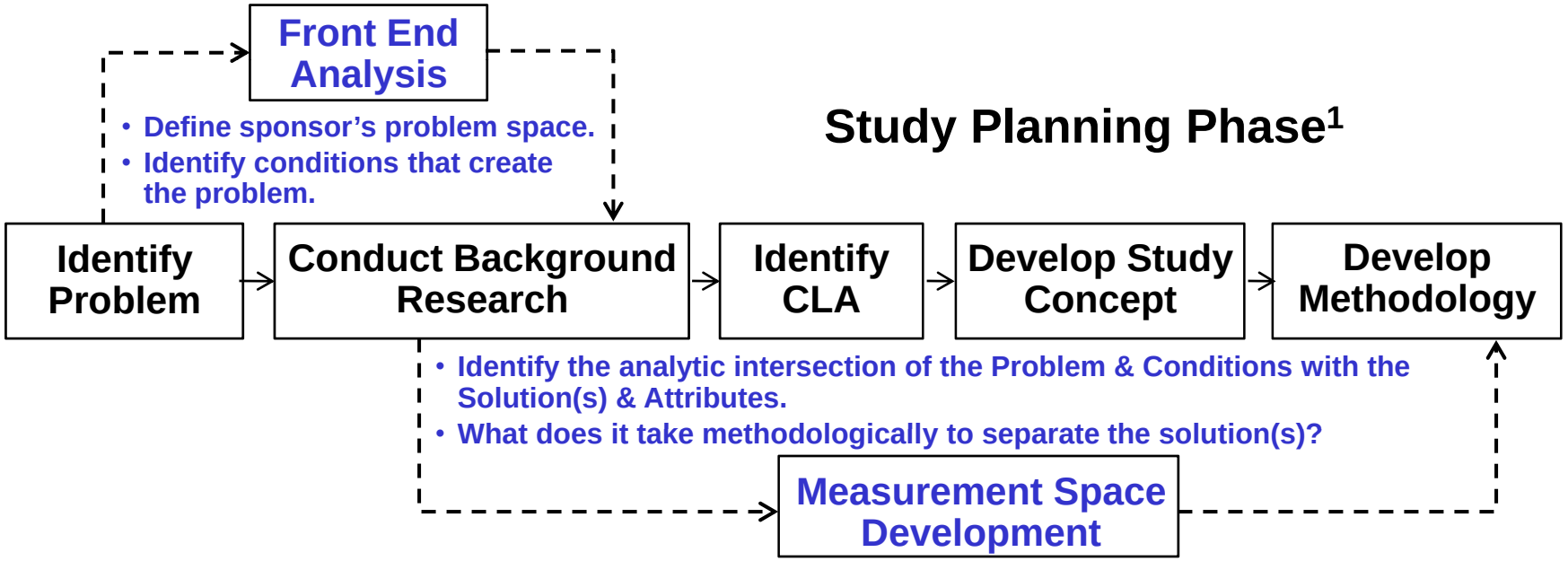
Developing MS allows the study team to adequately consider and collectively account for all of the methodology components necessary to reveal the salient differences between potential solutions in ways that are most relevant to the problem's origins.

Absent this practice of deliberate, up-front thinking, the analysts may eventually produce similar findings through exploration and discovery. There is no guarantee that will happen and if it does, it will most likely occur at a greater cost of time and resources. Today's decision analysis environment does not afford the luxury of missteps, redirection and do-overs. The analyst should strive to get it right the first time.

Matching the right methodology to the right class of problem is fundamental to sound operations analysis. This CoBP offers the MS development concept in a way that emphasizes and re-focuses the analyst and the study team on these fundamentals.

Measurement Space in Study Planning

- **Without strong due diligence, the study is likely to fail by not adequately addressing the sponsor's needs or inadvertently missing the "tipping point issues."**
- **Front-end analysis helps to inform the measurement space development by identifying and defining the "problem space."**



The measurement space concept is a way to think about the problem and how best to analyze it; it is not meant to be rigid, prescriptive or formulistic.

[1] Condensed from TRAC Study Director's Guide

Measurement Space in Study Planning

Consideration of measurement space should occur early in the study planning process. Although its development is an iterative process, it should begin as the study team is conducting early front-end analysis. Front-end analysis informs the MS by identifying and defining the problem space and the conditions that cause the problem; it enables the analyst to gain a deeper appreciation for the nuances of the sponsor's problem. Front-end analysis involves understanding the individual stakeholder positions, understanding the uniqueness and challenges associated with the problem, and conducting an extensive background research. In military parlance, this is the analytic equivalent of mission analysis.

By more clearly understanding the problem before beginning the MS development, the analyst can better focus the team. It better postures the study leader to identify the "right" stakeholders and who should be involved in the collaborative MS development efforts. To re-emphasize, bringing together the "right" individuals or organizations is critically important to establish and understand all aspects of and the diverse perspectives about the problem.

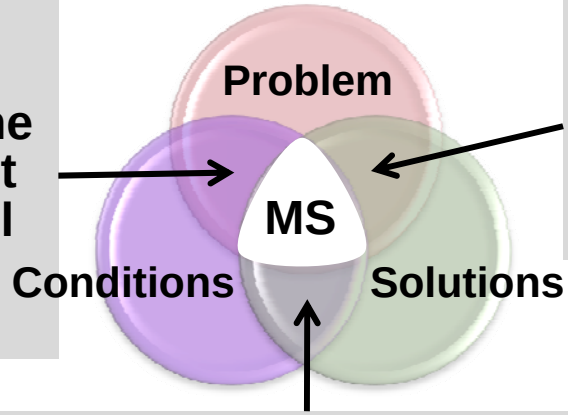
The graphic adapted from TRAC's study director guide highlights where the front-end analysis and MS development events occur during the initial study planning steps. The overlap of front-end analysis and MS development is deliberate. In fact, the MS development process must be iterative in nature and may be conducted and refined throughout the execution of the study.

To reiterate, this CoBP is not intended to be rigid, prescriptive or formulistic, but rather a way to think about the problem. Each study is unique and poses peculiar challenges to the analyst and study team; however, if the analyst deliberately aims to fully understand the problem, carefully applies the up-front thinking outlined in this CoBP, and plans accordingly, the study is more likely to meet the analytical needs to inform decisionmaking.

Measurement Space Thinking

1. What is the problem?
2. What conditions in the operational environment contributed to the problem in the first place?
3. What is it about the solutions that promises to remedy the problem?
4. Are the attributes that differentiate the potential solutions going to reveal themselves under the conditions most relevant to the problem?
5. Are those conditions prevalent enough in the operational environment to justify revealing (through analysis) the benefits that discriminate among the solutions?

Those conditions that contributed to the problem, but for which the solutions' attributes don't pertain, and therefore will not distinguish among the solutions.



Solutions that have attributes relevant to the problem but outside of those conditions that contributed to the problem.

Conditions that discriminate among those solutions' attributes but are not relevant to the problem.

Measurement Space Thinking

The thinking behind measurement space is straightforward. In the most simple terms, MS represents the intersection of the problem, problem-inducing conditions and the COAs or solution(s)'s attributes. Upon completion of MS development, there should be a clear understanding of the analysis necessary to weigh the relative merits of the COAs or solutions, and to differentiate them in ways relevant to the problem and the associated "tipping point" issues. Rarely should it be necessary to look anywhere else for answers to the questions posed by the sponsor.

Measurement space involves four primary elements: (1) the problem, (2) the conditions that cause the problem, and (3) the solution(s) as defined by (4) their attributes.

To understand the complexities of the problem, the analyst should decompose it into constituent sub-elements. Simultaneously, the analyst should consider and establish the conditions in the environment that have contributed to the problem in the first place. Fully explore these conditions, whether they exist in the physical, operating, fiscal, or political environments (to name a few). Judgments will be necessary as to the relevance of the conditions to the problem at hand which argues for collaboration with those who are most knowledgeable of the problem.

When weighing the solutions, the analyst must determine those specific attributes that are relevant to the problem and also most likely to distinguish among the potential solutions. Then the analyst must identify the conditions which will most likely reveal those attribute differences within the originating context of the problem. The conditions considered should be prevalent enough in the operational environment to justify revealing (through analysis efforts) the merits that discriminate among the solutions.

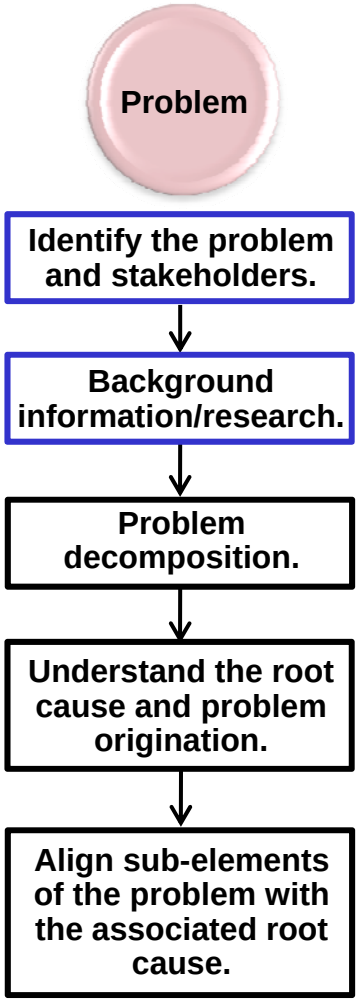
The intersection of the elements that fall outside of the central "MS region" can often create unique situations an analyst must consider within the study. He/she may have to treat separately the conditions that contributed to the problem, but for which the solutions' attributes don't pertain, and will not distinguish among the solutions. A case where the attributes do not distinguish among the solutions, might require sensitivity analysis or exploratory excursions to highlight the associated analytic insights.

Similarly there might be conditions that distinguish between the solutions' attributes, but are not relevant to the problem. The analyst must be able to isolate these conditions and treat them accordingly throughout the study. In some cases, the solutions' attributes will discriminate and are relevant to the problem but fall outside of the conditions that contributed to the problem. These situations also require independent treatment through sensitivity analysis and excursions.

The Problem

- **The analyst must:**
  - **Educate himself/herself on the basic facts/aspects of the problem.**
  - **Research previous efforts related to the problem.**
  - **Understand each stakeholders' point of view of the problem.**
  - **Visualize what the endstate(s) may be for a problem solution.**
- **Decomposing the problem into smaller, more distinct elements may provide additional insights into the problem.**

However, decomposing the problem too much or viewing the problem too narrowly risks becoming wholly congruent with a single condition or lesser subset of the conditions than should be accounted for.



= Front End Analysis

Problem

The first of the four elements of measurement space is the problem. A clear understanding of the problem is critical to delivering quality analysis and ensuring the methodologies and MS components are "fit for purpose."

The analyst must thoroughly learn the facts and nature of the problem. This effort begins early in front-end analysis and continues throughout the development of MS. Understanding the problem often focuses on understanding its origination. Various stakeholders may be very familiar with the problem. Because they may also be 'too close' to the problem, it is critical for the analyst to conduct thorough research and firmly establish the origin of the problem, especially from respective vantage points of the range of stakeholders. This will assist the analyst in identifying potential "tipping point" issues.

The analyst must research previous efforts related to the problem. Prior analysis might shed additional light on the issues facing the analyst. This combined research effort helps the analyst visualize what the solution end state(s) may be.

This research directly feeds problem decomposition. The analyst must break down the problem into constituent sub-elements. Decomposing the problem into smaller, more distinct elements may provide additional insights. As the decomposition occurs, the analyst should understand the root cause(s) of the problem and its sub-elements. At the same time, consider the particular conditions that caused the problem with regard to its sub-elements.

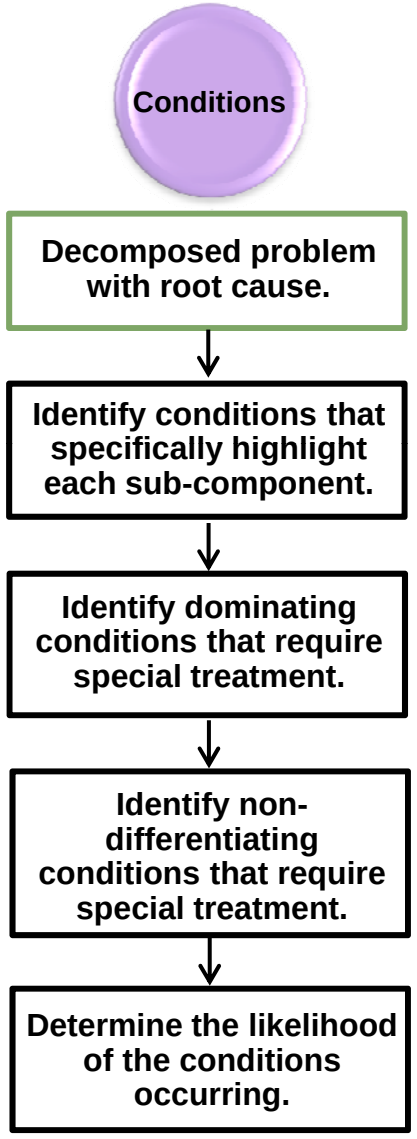
The analyst must take care to avoid decomposing the problem too much. If the problem is decomposed too narrowly then the analysis may become wholly congruent with a single condition or small number of conditions that don't necessarily account for all of the conditions that cause the problem. Conversely, if the analysis is too narrowly focused, it may not be able to reveal the synergistic effects of the solutions' attributes under multiple conditions.

The Conditions

- **The analyst must identify the conditions under which the problem exists.**
  - **Understand and acknowledge the prevalence or likelihood of the conditions.**
  - **Identify dominant conditions.**
  - **Identify non-differentiating conditions that are still required for appropriate operational context.**

  ! Dominant conditions that can suppress or obscure a legitimate distinction between solutions may need to be controlled in order to fully consider all potential solutions.

- **Conditions that are unable to or are not expected to differentiate among solutions may still be analytically useful to consider in order to reveal the degree to which the offered solutions address the problem.**



= Informed by Problem Decomposition

Conditions

As the decomposition of the problem occurs, the analyst should simultaneously identify under what conditions the problem exists. Fully considering the root cause or origination of the problem accomplishes this. The analyst should determine under what conditions the problem might exist and the persistence and/or prevalence of their occurrence.

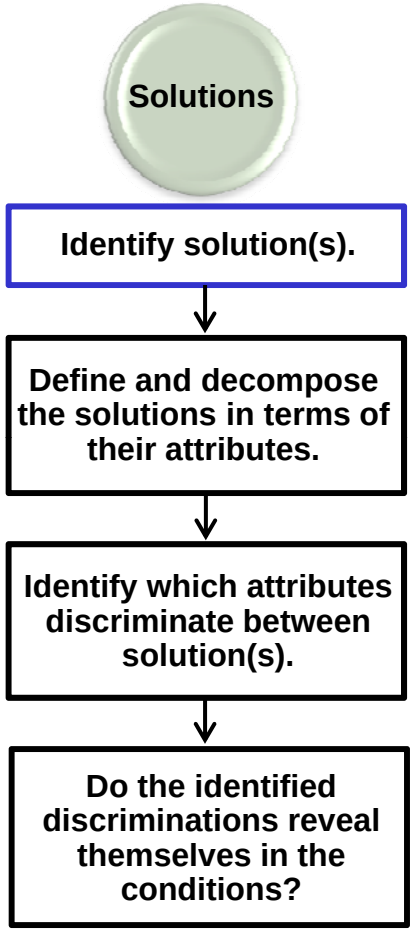
As the analyst identifies conditions, it is important to understand how those conditions might manifest themselves and might reveal a potential distinguishable difference between solutions based on their respective attributes differences. The analyst should identify early and treat carefully the conditions which may dominate a distinguishable difference. Such conditions are key to obtaining potentially valuable evidence. There may be conditions which do not appear to reveal a distinguishable difference, but which may be necessary for an adequate context for studying the problem. These type of conditions may be analytically useful in order to reveal the degree to which the offered solutions address the problem.

In some cases, dominant conditions exist that may suppress or obscure a legitimate distinction between solutions. Analysts may need to control these conditions in a special manner in order to examine the potential interactions of the solutions. Sensitivity analysis or excursions may be useful to isolate a particular dominating condition(s).

Finally, the analyst should be able to determine the likelihood of occurrence for each condition and combination of conditions. Understanding the likelihood of occurrence helps the analyst to understand which conditions he may need to emphasize or handle differently within the methodology and measurement space components.

Solution(s) & Attributes

- **The analyst must:**
  - **Define and decompose the solution(s) to identify descriptive characteristics and attributes.**
  - **Identify which attributes discriminate between the solution(s).**
  - **Understand how the discriminating attribute(s) manifest themselves in the operational environment.**
- **The analysis can then be scoped/focused on the discriminating attributes.**
  - **Will the discriminating attributes of the potential solution(s) reveal themselves under the conditions most relevant to the problem?**



= Front End Analysis

Solution(s) & Attributes

The third and fourth elements of the measurement space are the solution(s) that will potentially remedy the problem and their respective attributes. Similar to problem decomposition, the analyst should define and decompose the solution(s) in order to identify the descriptive characteristics and attributes. Appropriately knowledgeable individuals must assist significantly in defining the solution(s)' characteristics. For example, if a study team is looking at specific technologies to be added to a materiel solution, the team must employ qualified technical experts to define and describe the specific technology.

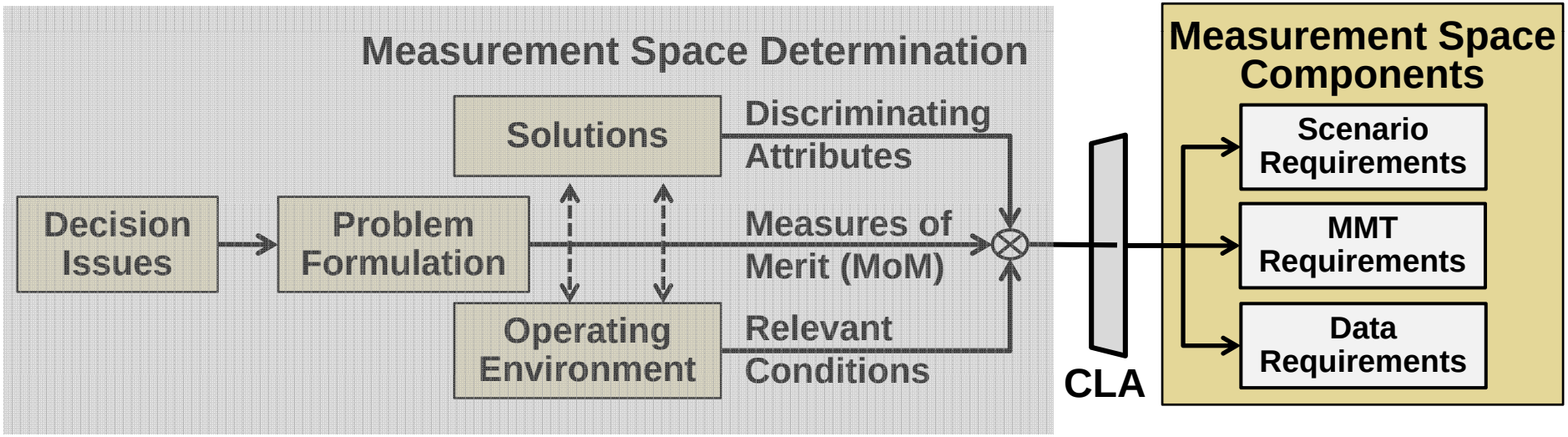
Following definition and decomposition of the solution(s), the analyst must identify the attributes that discriminate among the solution(s). This encourages the analyst to focus on the differentiating attributes and achieves an understanding of how they may manifest themselves in the operational environment. Though often challenging to do satisfactorily, leveraging the right expertise is critical to success during these steps.

Focusing on the discriminating attributes does not imply discarding the non-discriminating attributes; rather, it is intended to tailor the scope and focus of the analysis to ensure sufficient analytical coverage of those discriminating attributes. Understanding the solution(s) must be done simultaneously with understanding the conditions and problems. The analyst must ensure the distinguishing attributes of the potential solution(s) reveal themselves under the conditions most relevant to the problem.

Measurement Space Determination

"So what do we do with it?"

- **Measurement space identifies the analytic intersection of the problem, the operational conditions that contribute to the problem, and the attributes of potential solution(s).**
- **This intersection not only drives the analysis methodology but also informs the measurement space components (scenarios/vignettes/use cases, MMT, and data requirements).**



The components of measurement space enable the analyst to account for and instantiate the identified "problem space" in an operational and/or dynamic representation.

MMT- Methods, Models, Tools CLA - Constraints, Limitations, Assumptions

Measurement Space Determination
"So what do we do with it?"

As the elements of measurement space combine to form the analytic intersection of the problem, the conditions that contribute to the problem and the attributes of the potential solution(s), the analyst must determine how to apply this acquired knowledge to plan for and create the appropriate methodologies, models and tools (MMT).

An important follow-on to developing MS is to tailor the MS components to ensure the study can adequately account for the MS intersection. While this is not a focus of this CoBP, this follow-up effort is essential, as well as done iteratively as the MS becomes defined with greater clarity and detail as a result of deliberation and interpretation of results emerging from the early analysis.

Its three main components dictate adequate instantiation of the MS: the conditions represented in the scenarios, vignettes or "use cases;" the MMT functionality being employed; and the input data for the MMT, most especially the data representing the attributes of the solutions.

The analysts are responsible to appropriately account for each solution within the MS components and to ensure the components can collectively generate adequate amounts and types of output data to satisfy the applicable measures of merit (MoM).

Applied correctly, the MS will dictate the scenario, MMT and data requirements. Constraints, limitations, and assumptions (CLA) may limit the degree to which the MS can be instantiated within the components. The analysts must clearly identify these CLA and address them by alternate means, such as sensitivity analysis, as necessary.

Identifying the MS is a key planning function and is a way to more critically examine the problem space in order to better focus analytic resources. When properly identified, the measurement space reveals how and to what degree to tailor the scenarios, the analytic method(s) or models/tools to be applied, and the data requirements.

Measurement Space Components
Scenario Requirements

- **The scenario, vignette or use case must uniquely incorporate the determination of measurement space (relevant conditions, distinguishing attributes, and measures of merit).**
- **The conditions in the operating environment generally fall within the METT-TC* and/or PMESII-PT** variables.**
- **The scenario must remain defendable and credible yet robust enough to stress the particular aspects of the measurement space.**
- **The scenario requirements inform the MMT and data requirements.**

Developing a tailored scenario is not "cooking the books," but rather a way to ensure creating the necessary conditions to observe a distinguishable difference between solution(s).

*** METT-TC – Mission, Enemy, Terrain, Troops Available, Time, & Civil Consideration.**
**** PMESII-PT – Political, Military, Economic, Social, Infrastructure, Information, Physical Terrain, & Time.**

Measurement Space Components
Scenario Requirements

The context in which the problem-induced conditions are accounted for may take the form of an operational scenario, a vignette, a "use case" or similar set of operational parameters. The MS development is critical to tailoring the scenario variables to ensure the conditions exist to reveal the salient differences that are relevant to the problem. In the case of military operations, the operational environment is a composite of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander[1]. Specifically, the operational environment contains both operational and mission variables that can be tailored according to the MS.

The operational variables in the environment consist of Political, Military, Economic, Information, Infrastructure, Physical Environment, Time (PMESII-PT). Similarly, the mission variables consist of Mission, Enemy, Terrain, Troops Available, Time, Civil Considerations (METT-TC). How these variables interact in a specific situation, domain (land, maritime, air, space, or cyberspace), area of operations, or area of interest describes a commander's operational environment but does not limit it[2].

Accounting for the enemy is often an important, if not the most important consideration when ensuring the "right" conditions exist in the scenario. TRADOC study teams establish valid enemy capabilities and behaviors in partnership with the TRADOC Intelligence Support Activity (TRISA). The TRISA team member assists the study team in visualizing and developing the enemy behaviors that will most likely create the necessary conditions in the scenario.

The scenario developers are vital to the development of MS, and also its instantiation. They include the operators who are often most knowledgeable of the problem being examined, as well as how the problem will reveal itself and the ways to recognize it, detect its presence and measure its impact. Scenario developers typically derive TRADOC standard scenarios from Office of the Secretary of Defense (OSD) approved scenarios. These scenarios cover the full range of military operations to include decisive action with offense, defense, stability, and defense support of civil authorities (DSCA).

By participating in MS development, the scenario developers better understand the conditions that contributed to the problem, and can assist in identifying those conditions that will most likely discriminate the differences in the attributes of the offered solution(s).

[1] Joint Publication (JP) 1-02 [2] Army Doctrine Publication (ADP) 3-0

Measurement Space Components
MMT Requirements

- **The methods, models, and tools (MMT) must contain the functionality to represent the desired measurement space.**
  - **This does not mean the MMT must represent all solution attributes with equivalent fidelity; the representation should focus on the sufficiency of the differentiating attributes and conditions.**
- **By understanding the differentiating attributes, the MMT specialists can tailor the specific MMT to meet their analytic needs.**
- **The degree to which the MMT might be tailored is driven by the operational conditions relevant to the problem.**
- **The CLAs determined by the study team further dictate (or prioritize) the desired updates to the MMT capability/ functionality.**

MMT should be flexible enough to be modified or tailored to meet the uniqueness of individual analytic problems.

Measurement Space Components
MMT Requirements

Measurement space requirements underpin the selection and development of MMT. The MMT must contain the functionality necessary to account for the defined measurement space. The analyst identifies the combination of conditions and attributes that will reveal potential differences among the solutions, while the chosen MMT must be tailored in terms of functionality/algorithm/capability to be able to adequately account for (though not necessarily "mimic") those conditions and attributes and their expected interactions.

Typically, no single model or tool can effectively address the entire range of potential differences (performance, effectiveness, allocation, etc). The study team must consider a variety of MMT and with proper due diligence, make the call on which ones or combinations thereof acceptably fulfill MS needs.

The analyst must involve the MMT specialists early in the MS development so these experts can understand the conditions and attributes and their anticipated analytic value in the overall study. The MMT specialists should partner with the study team to prioritize the specific MMT functionality and capability changes and/or algorithm enhancements/modifications to ensure development efforts are IAW the study constraints, limitations, and assumptions, as well as fulfilling MS needs.

Specifically with regard to the constraints on time, the MMT specialists may not need to represent all discriminating attributes with equivalent fidelity to achieve the desired analytic end state. Ultimately, the conditions relevant to the problem drive the degree to which the MMT may be tailored.

Sometimes the MMT suite available to the study team cannot feasibly or adequately represent the distinguishing attributes required. These situations will impact the study methodology, perhaps requiring sensitivity analysis, and/or addressing in the study's CLA.

Measurement Space Components
Data Requirements

Input Data:

- **After the operational conditions are determined and the MMT selected, a tailored data package must be developed to support each.**
- **The measurement space development process points the analyst to multiple sources of data through organized collectors and agencies or by other expedient means.**

Output Data:

- **Measurement Space earmarks the data requirements needed to detect the consequences and measure the merits of the solution(s) in order to conduct the analysis – What am I looking for?**
- **Each analyst evaluates the data to some degree and is ultimately responsible for the analysis output.**

Measurement Space Components
Data Requirements

Input and output data are the two principal categories of data to be accounted for when developing the measurement space. The input data must be authoritatively sourced and subjected to standards and tests of validity and appropriateness. This data may exist in many forms in many data bases throughout the Army and DOD. Sources may extend beyond conventional characteristic and performance data. In some cases, it may be necessary to generate input data from unconventional sources and/or transform available data employing scientifically sound techniques.

Analysts must recognize the paramount importance of data to their analysis: its relevance to both the problem at hand and the methodology chosen to address the problem. The analyst must develop a complete and comprehensive understanding of the input data that drives a model or simulation in order to understand the results produced, and be aware of the parameters that are key drivers to achieving the desired measurement space. Understanding this relationship is critical to making necessary adjustments among the alternative solutions to ensure realistic representation of their relevant capabilities. The input data that feeds MMT are critical in determining if the results derived from the MMT will realistically discriminate between solutions.

Understanding the output data is essential to conducting quality analysis. Conducting a robust measurement space development process provides the analyst a clearer idea of what to look for when conducting the analysis. This understanding can assist in developing the MoM in terms of performance, effectiveness, sustainment, logistics, trade space, risk and growth, costs, affordability, etc. The analyst must be certain that the analysis will provide sufficient output data to attain these distinguishing metrics. Although a model may have sufficient algorithms and supporting input data to simulate the relevant discriminators of the study system, if the output is not sufficiently robust to illustrate how those attributes contributed to the performance or effectiveness of the outcome, it severely impairs the study team's ability to provide meaningful insights.

Determining the gaps in assessing the MoMs requires scrutiny of the expected feasible output data, up-front in the study planning phase. To ultimately calculate the necessary metrics for the analysis, the study team and supporting efforts must apply sufficient time and other resources during the conduct of the study to organize the output data generated by the MMT, and develop associated tools to data mine the output.

Summary

- **Measurement space:**
  - **Is a disciplined way to think about a problem and how best to analyze it; but is not meant to be rigid, prescriptive or formulistic.**
  - **Enables the stakeholders and the analysts to focus intently where the problem and offered solutions interact to clearly discriminate among the solutions.**
  - **Guides the planning, preparation and conduct of analysis to be as efficient as possible.**
- **Developing and applying measurement space is learned through collaborative application of codified best practices and is strongly encouraged.**

Summary

The measurement space concept is a way to think about the problem and how to analyze it; the concept is not intended to be rigid, prescriptive or formulistic. For this reason, this CoBP purposefully did not lay out a step-by-step "cook book" approach to developing measurement space, but instead described a mental heuristic the analyst should use to develop MS. Through trial-and-error and lessons learned in repetitive application, the analyst will become more proficient and continue to perfect the art and science of developing measurement space. The sound application of MS will promote a better shared understanding of the problem and offered solutions by the stakeholders and analysts, focus their respective efforts where the problem-induced conditions and solution(s)' attributes intersect to reveal the most meritorious solutions, and enable more efficient and timely planning and application of analytic resources.