Multi-Criteria Decision Making for Financial Managers – 26A
Professional Development Institute
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Naval Postgraduate School
• **DRMI Policy (DOD Instruction 5010.35 p.2)**
  – Conduct resources management courses that enhance the understanding, competence, and capabilities of U.S. military and civilian personnel... [and]
  – Provide such courses for foreign countries and international agencies as may be required.

• **Course Goals for all DRMI courses**
  – To develop a broad-based analytical framework for defense decision makers emphasizing the economic and efficient allocation of scarce defense resources to competing mission areas.
  – To provide an environment for the comparative exchange of ideas related to the management of national security
How do you make decisions?
“In business, the single, overriding purpose is to make a profit. Government, on the other hand, deals with a vast number of legitimate and often potentially competing objectives — for example, energy production versus environmental protection, or safety regulations versus productivity. This complexity of goals brings a corresponding complexity of process.”


_In an Uncertain World: Tough Choices from Wall Street to Washington, p. 147_ (with Jacob Weisberg)
Agenda for MCDM modules 26A and 26B

Part 1: Identify and Structure objectives
Part 2: Build and use a quantitative preference model
Learning Goals

• Know what an objective is – and be able to distinguish it from an alternative, constraint, task, etc.

• Be able to engage in and/or facilitate an objectives-identification process

• Be able to structure objectives, separating means from fundamental objectives, as a first step towards further analysis
What?
Example: Tomorrow’s Navy

- CBO in 2001 did a study requested by the Navy
- How to Structure tomorrow’s Navy with today’s funding levels?
Tomorrow’s Navy: Alternatives

New Surface Combatant Structure

Aircraft Carrier Strike Group

Marine Corps

Submarine Strike
Tomorrow’s Navy: Battle Scenario
What’s the Navy’s Goal?
Tomorrow’s Navy: Outcomes

What the Navy needs to achieve Victory

1. Sea Control
2. Strike Operations
3. Forcible Entry
4. Forward Presence
5. Flexibility
Definition: Objectives

- Outcomes/consequences/criteria that you want to influence – based on your values
- Directional: maximize or minimize
- Examples
  - Maximize effectiveness
  - Maximize speed
  - Reduce risk
  - Minimize cost

An objective is a noun. Direction of preference may be specified with verb, e.g. minimize/maximize, but must be known.
Tomorrow’s Navy: Preferences

What the Navy wants in order to achieve Victory

1. Maximize Sea Control
2. Maximize Strike Effectiveness
3. Maximize Forced Entry Capability
4. Maximize Forward Presence Capability
5. Maximize Flexibility
U.S. Navy Force Structure

Battle Scenario

Alternatives:
- Aircraft Carriers (forward presence)
- New Surface Combatants (forward presence)
- Submarines Strike (strike)
- Marine Corps (amphibious support)

Objectives:
- Sea Control
- Strike Operations
- Forcible Entry
- Forward Presence
- Flexibility

Goal:
Maximize Overall Effectiveness

More MOE

Max. Strike Ops. Effect.
Max. Forced Entry cap.
Max. Forward Presence cap.
Max. Flexibility

Budget/Affordability and other Constraints

Less MOE
Roles

- Decision Maker
- Analyst
- Stakeholder
- Subject-Matter Expert (SME)
“You’ve got to be very careful if you don’t know where you are going, because you might not get there.”
Two approaches

Alternative-Focused Thinking
1. A problem occurs
2. Search for (often just accept) alternatives
3. Use differences among alternatives to determine criteria (objectives)
4. Evaluate the alternatives using these criteria and choose

Value-Focused Thinking
1. Look for decision opportunities
2. Identify and structure objectives
3. Generate alternatives
4. Evaluate alternatives using fundamental objectives and choose
How?
A set of fundamental objectives
Possibly organized in a hierarchy
Minicase: Renting a Home

Imagine that you have decided to do a two-year master’s degree at NPS. You will move to Monterey for two years, with any family members that you live with now. You are in Monterey to choose a home to rent for two years.

Write down all the objectives (issues of concern) that you believe are important to consider in evaluating your alternatives.
Part 2: Think Harder

• Imagine your dream home (in Monterey for two years). Think about how you would spend your time, and in what ways you and your family would enjoy living there.

• Think of the worst living situation you have experienced. Think about the worst aspects of living there.

• Write down any additional objectives that you can think of.
Part 3: Think Harder

Below is a list of some objectives (or issues of concern) that others have considered in choosing a home. **Check all that you feel are important to you.**

**Cost**
- rental cost
- utilities
- upkeep cost

**Environment**
- weather
- neighborhood attractiveness
- views from home
- ambient noise (e.g. neighbors, traffic)

**Location**
- distance to work
- distance to shopping/recreation
- distance to schools/spouse’s work
- traffic delays

**Size**
- square footage
- number of bedrooms
- number of bathrooms
- yard space

**Functionality**
- kitchen/counter space
- storage/closet space
- appliances
- laundry availability/convenience
- parking (covered/open)
- pet policies
- privacy (yard/fencing)
- care/upkeep (outdoor/indoor)
- floor plan (open/separate dining room)

**Recreational and social opportunities**
- appealing neighbors
- neighborhood organizations/activities
- availability/proximity of recreational activities
- neighborhood noise policies

**Schools**
- distance to schools
- quality of schools

**Safety**
- local crime (violent/non-violent/property)
- general safety (for biking/hiking/etc.)
- environmental safety (earthquakes/flooding/storms)
How good are people at identifying their own objectives?
Experimental Results
Number of objectives identified

MBA internships
Self-identified 7.4
Recognized* + 7.6

Importance of objectives:
Students missed:
1.4 of top 5, 4 of top 10


- MBAs – 10% did not self-generate most important objective and 71% didn’t generate all of top 5
- Second study, 3.8 of top 10 were recognized, 35% didn’t generate top objective, 79% did not generate all top give
- Objectives While A Student
- Academic Objectives After Graduating
- Personal Objectives While A Student
- Personal Objectives After Graduating
Rank from 1 (most) to 5 (least)

<table>
<thead>
<tr>
<th>Vehicle replacement</th>
<th>Gas Savings Rank</th>
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<tbody>
<tr>
<td>34 MPG to 50 MPG</td>
<td></td>
</tr>
<tr>
<td>18 MPG to 28 MPG</td>
<td></td>
</tr>
<tr>
<td>42 MPG to 48 MPG</td>
<td></td>
</tr>
<tr>
<td>16 MPG to 20 MPG</td>
<td></td>
</tr>
<tr>
<td>22 MPG to 24 MPG</td>
<td></td>
</tr>
</tbody>
</table>
**Meaning of MPG (miles per gallon)**

<table>
<thead>
<tr>
<th>Change in vehicle pairs* (old vehicle to new vehicle)</th>
<th>Perceived rank in gas savings (mean)</th>
<th>Actual rank in gas savings</th>
<th>Actual reduction in gas consumption per 10,000 miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>34 MPG to 50 MPG</td>
<td>1.18</td>
<td>3</td>
<td>94.1</td>
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<td>1.95</td>
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<td>198.4</td>
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<td>42 MPG to 48 MPG</td>
<td>3.29</td>
<td>5</td>
<td>29.8</td>
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<tr>
<td>16 MPG to 20 MPG</td>
<td>3.73</td>
<td>2</td>
<td>125.0</td>
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<tr>
<td>22 MPG to 24 MPG</td>
<td>4.86</td>
<td>4</td>
<td>37.9</td>
</tr>
</tbody>
</table>

* Vehicle pairs are listed in order from largest linear change (34 to 50 = a change of 16, to the smallest linear change (22 to 24 = a change of 2). Participants did not get to see the actual rank or the actual reduction in gas consumption when they were asked to rank the alternatives.

How good are people at generating alternatives?
Thinking about objectives helps generate creative alternatives.
1. Start with strategic objectives – for example, review planning and strategy documents
2. Identify the appropriate stakeholders and involve them in the process

Stakeholders include decision makers, other leaders, operators/customers, community, partner organizations, agencies or governments, maybe Congress...
stakeholder – a person with a legitimate interest in the outcome of a decision... or they can affect the implementation of the decision. Stakeholders' objectives should be taken into account in analyzing a decision problem. This contrasts with other actors who may have an interest but whose interests are outside the decision maker's scope of responsibility.
Why do we care about stakeholders?

- **Formulation**
  
  you need them to identify the relevant objectives

- **Implementation**
  
  you may need their buy-in, either formally or informally, for
  
  - implementation of selected alternative, and
  
  - participation in and support of the process.
Confusion between values and facts can be a problem on the part of both analyst and stakeholders. Sometimes an analyst may feel they have the right answer (position) because they studied the problem more...

Take-away: as an **analyst, stay on facts**; let **stakeholders state values**.

Emphasis: unbiased description; words like interpretation, evaluation, even summary may be more values, than facts.
Positions vs. Objectives

A position is a commitment to a specific alternative or course of action.

Early commitment to a position can prevent

• consideration of solutions and common values that could lead to results preferred by everyone

• Implementation of consensus solutions

Objectives ≈ Interests ≈ Values
What Is Important?

Building an objectives hierarchy

- Where do you start?
- What do you mean by that?

Max. overall effectiveness

Max. performance

Max. availability
Identifying objectives: first steps

3. Set up the process

• First, allow for expansive generation of objectives (pruning and structuring comes later)
• Solicit others’ ideas, but avoid group work initially
• Brainstorming – solicit potential objectives from stakeholders, without evaluating them (yet)
  • You may or may not want stakeholders in a room together;
  • Try to focus on objectives not positions or alternatives
• Approaches include Delphi-like processes
Generating objectives: tricks & triggers

- What is your goal?
- Why is there a decision to be made?
- What is your ideal outcome of the decision, and what makes it so ideal?
- What is your nightmare scenario and what makes it so bad?
- Consider objectives and categories of objectives relevant in other contexts
- Ask others – even non-stakeholders
- Build on existing objectives, asking
  - Why does this matter?
  - What does this mean?
Objectives relevant in many defense applications

- mobility
- speed
- survivability
- stealth /signature
- range
- payload
- agility / maneuverability
- reliability / availability
- communications
- resource consumption

- lethality
- autonomy
- persistence / dwell
- weight
- detection
- ease of replacement
- perishability
- sustainability
- vulnerability
- durability
Identifying Structuring

A set of fundamental objectives
Possibly organized in a hierarchy
Ultimately, you want a hierarchy. In the process, you may need to build a means-ends network.

**Fundamental (Ends) Objective**: an objective that defines a basic reason for caring about a decision.

**Means Objective**: an objective whose importance stems from its influence on achieving other objectives.

Use fundamental whenever possible, means if necessary. Means objectives at one organizational level may be fundamental at a lower level.
Ways to Structure Objectives

• Top-Down ("objectives-based")
  • Best for strategic decisions
  • Best when dealing with ideas / abstract concepts

• Bottom-Up ("alternatives-based")
  • Best for tactical/operational decisions, especially given a fixed, known set of alternatives
  • Often good for acquisition, choosing hardware

• Combination
Cost as an objective

Monetary cost is typically excluded from objectives hierarchy in managerial decisions.

If you will be comparing costs across multiple effectiveness analyses

In this case you want to be able to consider trade-offs between cost and effectiveness in each analysis, and therefore must know the incremental cost associated with each alternative within each analysis

Currently the subject of some debate.
HOW do you proceed?

Using a “Bottom-Up” approach - Proceed upward to higher levels of decreasing detail by asking “Why is that there?”
Constructing hierarchies: Bottom-up

To move up the hierarchy start with important objectives (or attributes), then ask:

• Why is this important?
• Does it relate to other attributes (and how)?
• How does it support an objective?

Look for hidden objectives
HOW do you proceed?

Use a “Top-Down” approach - Proceed downward to lower levels of increasing detail by asking “What do you mean by that?”
Constructing hierarchies: Top-down

To move *down* the hierarchy, start with the overall objective, then ask:

- What do you mean by that?
- How do you define that?
- How could you achieve that?

The overall objective is usually something generic, such as:

“maximize overall effectiveness”
An Objectives Hierarchy

Overall Objective

Sub Objective 1  Sub Objective 2  ....  Sub Objective n

Sub Objectives 2.1  Sub Objectives 2.2  ....  Sub Objectives 2.m

Sub Objective 2.1.1  ....  Sub Objective 2.1.k

Sub Objective 2.1.k.1  ....  Sub Objective 2.1.k.r

Measurable attribute  Measurable attribute
• **Objective:** A consequence of a decision whose maximization or minimization is associated with value.

• **Attribute:** A measurable* quality or characteristic of an alternative that is associated with an objective.

*predictable
Choosing a New Home

Max. Overall Effectiveness

Max. Size of House

Min. Maintenance/Repair/Upgrade

Max. Desirability of Location
Choosing a New Home

Max. Overall Effectiveness

Max. Size of House
Min. Maintenance/Repair/Upgrade

Max. Desirability of Location

Min. transportation needs
Max. quality of Public schools
Max. env. quality
Max. safety
Choosing a New Home

Max. Overall Effectiveness

Max. Size of House
Min. Maintenance/Repair/Upgrade
Max. Desirability of Location

Min. transportation needs
Max. quality of public schools
Max. environmental quality
Max. safety

Min. noise
Min. distance to parks/recreation
Max. beauty
Min. traffic

Max. green space
Max. dist. from industry
Min. house density

Stop when you know how to measure the bottom-level objectives. These become your measurable attributes.
Desirable properties: Each objective

• Controllable: affected by alternative selected
• Measurable: well defined and quantifiable
• Unambiguous
• Direct
• Comprehensive
• Operational
• Understandable
Desirable Properties of Measures

- **Unambiguous**: There is a clear relationship between the consequences of choosing an alternative and the value (numerical) of the attribute; not vague or imprecise.
- **Direct**: Attribute values describe the consequences with respect to the fundamental objective.
- **Comprehensive**: The values cover the full range of possible consequences and implicit value judgments are appropriate.
- **Operational**: The values must be easy to measure, practical to implement or observe.
- **Understandable**: The values must be understood by anyone interested in the analysis.
What’s the right level?

Minimize Injury
Maximize Survivability
Maximize Stopping Capability
Maximize Armor Thickness
Three Types of Attribute Scales

• **Natural**: in general use; have common interpretation; can be counted or otherwise directly measured

• **Constructed**: developed to quantify value when no natural attribute measure exists

• **Proxy**: scale in general use; can be counted or directly measured, does *not* directly correspond to the objective, but is **highly correlated** to the objective
Natural Scales

• Height/Range/etc.
  Feet, Meters

• Weight
  Pounds, Kilos

• Temperature
  Fahrenheit, Celsius

• Speed
  Miles per hour, kilometers per hour
Proxy Scales

- Valid
  - directly related to consequence of interest
  - highly correlated with objective
- Operational
  - possible to measure or assess, has natural scale
Defining a Constructed Scale

- Choose number of levels
- Define each verbally such that the definitions are unambiguous, i.e.
  - Analyst will be able to tell which level a given alternative fits
- Decision makers understand what the level means, and will be able to answer questions about their desirability

<table>
<thead>
<tr>
<th>Level</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Few display elements, users report task is easy</td>
</tr>
<tr>
<td>Medium</td>
<td>More than three display elements. Users report effort to concentrate and be aware of all information.</td>
</tr>
<tr>
<td>High</td>
<td>Many tasks to be performed near simultaneously. Display becomes crowded or confusing. Users become tired quickly, report difficulty performing task</td>
</tr>
</tbody>
</table>
*Reflex irritability in newborn*

<table>
<thead>
<tr>
<th>Reflex Irritability</th>
<th>Reaction to pinch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Red, no reaction</td>
</tr>
<tr>
<td>Level 2</td>
<td>Yellow, grimacing</td>
</tr>
<tr>
<td>Level 3</td>
<td>Green, grimacing and a cough, sneeze, or vigorous cry</td>
</tr>
<tr>
<td>Beaufort number</td>
<td>General description</td>
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<tr>
<td>-----------------</td>
<td>--------------------</td>
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<tr>
<td>0</td>
<td>Calm</td>
</tr>
<tr>
<td>1</td>
<td>Light air</td>
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<tr>
<td>2</td>
<td>Light breeze</td>
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<tr>
<td>3</td>
<td>Gentle breeze</td>
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<tr>
<td>4</td>
<td>Moderate breeze</td>
</tr>
<tr>
<td>5</td>
<td>Fresh breeze</td>
</tr>
<tr>
<td>6</td>
<td>Strong breeze</td>
</tr>
<tr>
<td>7</td>
<td>Moderate gale</td>
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<tr>
<td>8</td>
<td>Fresh gale</td>
</tr>
<tr>
<td>9</td>
<td>Strong gale</td>
</tr>
<tr>
<td>10</td>
<td>Whole gale</td>
</tr>
<tr>
<td>11</td>
<td>Storm</td>
</tr>
<tr>
<td>12</td>
<td>Hurricane</td>
</tr>
</tbody>
</table>

Table 3. Beaufort’s criterion 1832.
Desirable properties: Set of objectives

• Complete: collectively exhaustive
  nothing forgotten
• Nonredundant: mutually exclusive
  no double counting
• Frugal: use as few as possible (but no fewer)
• Value independent
  stakeholders can express values of levels of each
  objective without knowing level of other objectives
Desirable properties: Each objective

- Controllable: affected by alternative selected
- Measurable: well defined and quantifiable*

*more on this shortly
Example: Radar Station

Maximize Effectiveness

- Availability
- Performance
- Complexity
  - Inter-Operability
  - ECCM
  - Effective Range
  - Cognitive Load
  - Ease-of-Use
Example: Radar Station

Overall Desirability

Availability

Performance

Complexity

Inter-Operability

ECCM

Effective Range

Cognitive Load

Ease-of-Use

Natural scale: % of time available

With existing equipment

Proxy: number of data links

Natural Scale: Yes/No

Electronic Countermeasures

Constructed Scale: Low, Medium, High

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Example: Radar Station

Effectiveness

- Availability (probability)
- Performance
  - ECCM (Yes/No)
  - Effective Range (km)
- Complexity
  - Cognitive Load (Low/Med/High)
  - Ease-of-Use (L/M/H)

- Inter-Operability (number of data links)
Why?
Uses of objectives and hierarchy

- As basis for scalar Measure of Effectiveness (MOE) which may be used in optimization – including goal programming
- To inform data collection / predictive modeling effort
- To generate alternatives
- To communicate and to build consensus
- As framework for ongoing/repeated decision process
- Others’ objectives - anticipate adversaries’ behavior and negotiate effectively
Under certain conditions, there exists a value function that represents the decision maker’s preferences using a single number.

$$V(A_1)$$

$$MOE(A_1)$$

$$MOE = \text{Measure of Effectiveness}$$
Example: Radar Station

Maximize Effectiveness

Availability

Performance

Complexity

Inter-Operability

ECCM

Effective Range

Cognitive Load

Ease-of-Use
Example: Radar Station

Future Conditions

Alternatives
Example: Radar Station
Key Takeaway

Identifying and structuring objectives is powerful and critical.

Take the time, up front, in the middle, and, at the end, to get it right.
A good set of measurable attributes

• Reflects stakeholder values
• Tells everyone how an organization will measure and compare alternatives
• Represents your quantitative preference model
• Provides the springboard for a detailed quantitative analysis
Time to measure? – you make the call

Select an Objective

- Can you identify natural attribute?
  - Yes
    - Select the best
  - No
    - Can you decompose objective further?
      - Yes
        - Select the best
      - No
        - Can you decompose objective?
          - Yes
            - Select the best
          - No
            - Can you develop a constructed attribute?
              - Yes
                - Select the best
              - No
                - identify possible proxy attribute

Maximize Effectiveness
Lessons to Learn

- **Time Allocation**
  - **G** } 1/3\(^{rd}\) of your time
  - **O** } 1/3\(^{rd}\) of your time
  - **A** } 1/3\(^{rd}\) of your time
  - **M** } 1/3\(^{rd}\) of your time
  - **P** } 1/3\(^{rd}\) of your time

- Analysts tend to spend too much time on Alternatives (especially data) and Models
- Not enough time spent defining Goals and Objectives
- Not enough time spent on Preferences
- Too much time spent in the details of the models
- “It is not about a number. The primary role of any planning process is to stimulate critical thinking.” - Douglas Burton
Lessons to Learn (2)

• Objectives, Objectives, Objectives
• Bias is everywhere (Limits to Rationality Lecture)
• “All models are wrong, but some are useful” – George Box
• Good analysis is hard to do
• Put the Right Person in charge (horsepower)
• Analytical Aperture
• Make sure that the Thinking Process utilized has an inherent ability to Change and be Changed
• Unintended Consequences
• “Perfect is the Enemy of Good Enough” – Voltaire
• You are not alone, so synergize
• Make time to Think
What would you do?
What would you do?
Decision Support for Defense Management

Analytical Decision Making
- Systems Analysis
- Cost Issues
- Effectiveness and Evaluation Issues

Integrating Case Studies: Drmecia
Roles

Decision Maker

Analyst

Stakeholder

Subject-Matter Expert (SME)
• “Major decisions should be made by choices among explicit, balanced, feasible alternatives”
• “The Secretary should have an active analytic staff to provide him with relevant data and unbiased perspectives”
• “Open and explicit analysis, available to all parties, must form the basis for major decisions”
Who are we?

Defense Resources Management Institute (DRMI)

• Sponsored by Secretary of Defense
  ➢ Department of Defense (DoD) Instruction 5010.35

• Established in 1965 at the Naval Postgraduate School (NPS)
  ➢ Dr. Charles Hitch, OSD comptroller under SecDef McNamara, used NPS faculty to teach analytical and business approaches to make the best use of defense resources
Course Goals

• To develop a broad-based analytical framework for defense decision makers
  – emphasizing the economic and efficient allocation of scarce defense resources to competing mission areas.

• To provide an environment for the comparative exchange of ideas related to the management of national security
What do we teach?

**Resident Courses:**

- **General**
  - International Defense Management Course (IDMC)—10 weeks; 2 per year
  - Defense Resources Management Course (DRMC)—4 weeks; 4 per year
  - Senior International Defense Management Course (SIDMC)—4 weeks; once per year

- **Specific**
  - Multi-Criteria Decision Making—2 weeks
  - Introduction to Budget Concepts—8 days
  - Risk Management—2 weeks
  - Performance Management & Budgeting—1 week
  - Human Capital RM—2 weeks

**Non-Resident Events:**

- Mobile Courses—1-2 weeks
- Workshops—3-5 days
- Seminars—3-5 days

- Tailored to country’s specific needs
- Conducted in appropriate language
- Opportunity to quickly build a large cohort
More information

- **Target audience**: Military 0-3 or above; Civilian GS-9 or above
- **NO** tuition charged for DoD military and civilians
- Sending agency responsible for travel and per diem
- **Website**: http://my.nps.edu/web/drmi/
• Mission Statement
  – Provide relevant and unique advanced education and research programs to increase the combat effectiveness of commissioned officers of the naval service to enhance the security of the United States.
  – In support of the foregoing and to sustain academic excellence, NPS will foster a program of relevant and meritorious thesis and research experiences for NPS students that informs the curricula, supports the needs of Navy and Department of Defense, and builds the intellectual capital of NPS faculty.
  – To support the core Navy mission, NPS’ programs are inherently joint, inter-agency, and international.
Alternatives Are NOT Objectives

- **Objectives**
  - Related to the goals, and tell you how to accomplish the goals
  - Provide a way to measure progress toward reaching the goals

- **Alternatives**
  - Courses of action (COA) available to you
  - e.g. “Buy an iPad” is NOT an objective

- Make sure that your hierarchy does not mix objectives and alternatives
Trade-offs vs. constraints

• Trade-offs between attributes in hierarchy

• Constraints (absolute requirements) are for criteria that cannot be compensated by other objectives, e.g.
  • Specific compatibility
  • Minimum range

• Make sure the requirement is really absolute

If you’re willing to compromise on it, it’s not absolutely required
MPG versus GP10k miles

Heavy maneuver area

- Determines the installation’s ability to support training and maneuver of mechanized forces.

- Constructed Measure
  - Installation’s total acreage
  - Largest contiguous acreage
## Heavy Maneuver Area Constructed Measure

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<th>&lt;10</th>
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<th>&gt;100 - 500</th>
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<td>Label 7</td>
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<td>Label 9</td>
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<td>X</td>
<td>Label 10</td>
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<td>&gt;100 and &lt; = 500</td>
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<td>&gt;500</td>
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<tr>
<td>&lt; = 25</td>
<td>Label 1</td>
<td>Label 2</td>
<td>Label 3</td>
<td></td>
<td></td>
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<tr>
<td>25&lt; and&lt; = 100</td>
<td>Label 4</td>
<td>Label 5</td>
<td>Label 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100&lt; and &lt; = 350</td>
<td>Label 7</td>
<td>Label 8</td>
<td>Label 9</td>
<td></td>
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</tr>
</tbody>
</table>

SQ MI = square miles
AGL = Above Ground Level
General Instructional Facilities

• Measures the existing capability of the installation to conduct general instruction.
  • Includes both existing facilities and facilities that can be converted for instruction

• Constructed Measure
  • Square feet of instructional space
  • Quality of instructional space
    • Green, Amber, Red
• Measure is the weighted sum (by quality condition) of the square footage of general instructional facilities

• Quality factor = \[
\frac{\text{Cost of New (1sqft)} - \text{Cost of upgrade (1sqft)}}{\text{Cost of New (1sqft)}}
\]

• GIF Score = \[G*(1.0) + A*(0.71) + R*(0.36)\]
  where G, A, & R = SQ feet of Green, Amber, and Red space respectively.
Example: Comparing sustainment ships

Attributes:
- Capacity (square footage)
- Transit speed
- Ramp strength
- Draft
- Apron width
Example: Comparing sustainment ships

Max. overall effectiveness

Max. 30-day delivery capacity
= f(square footage, transit speed)

Max. number of ports in AOR accessible
= f(draft, apron width, ramp strength... ports in AOR)

Prediction vs. preference:
SMEs predict, but values come from stakeholders.