Best Practices for Systems Engineering in Science and Technology

Air Force Research Laboratory (AFRL)
Low Altitude Small Unmanned Aircraft System (SUAS)
Military Utility Study

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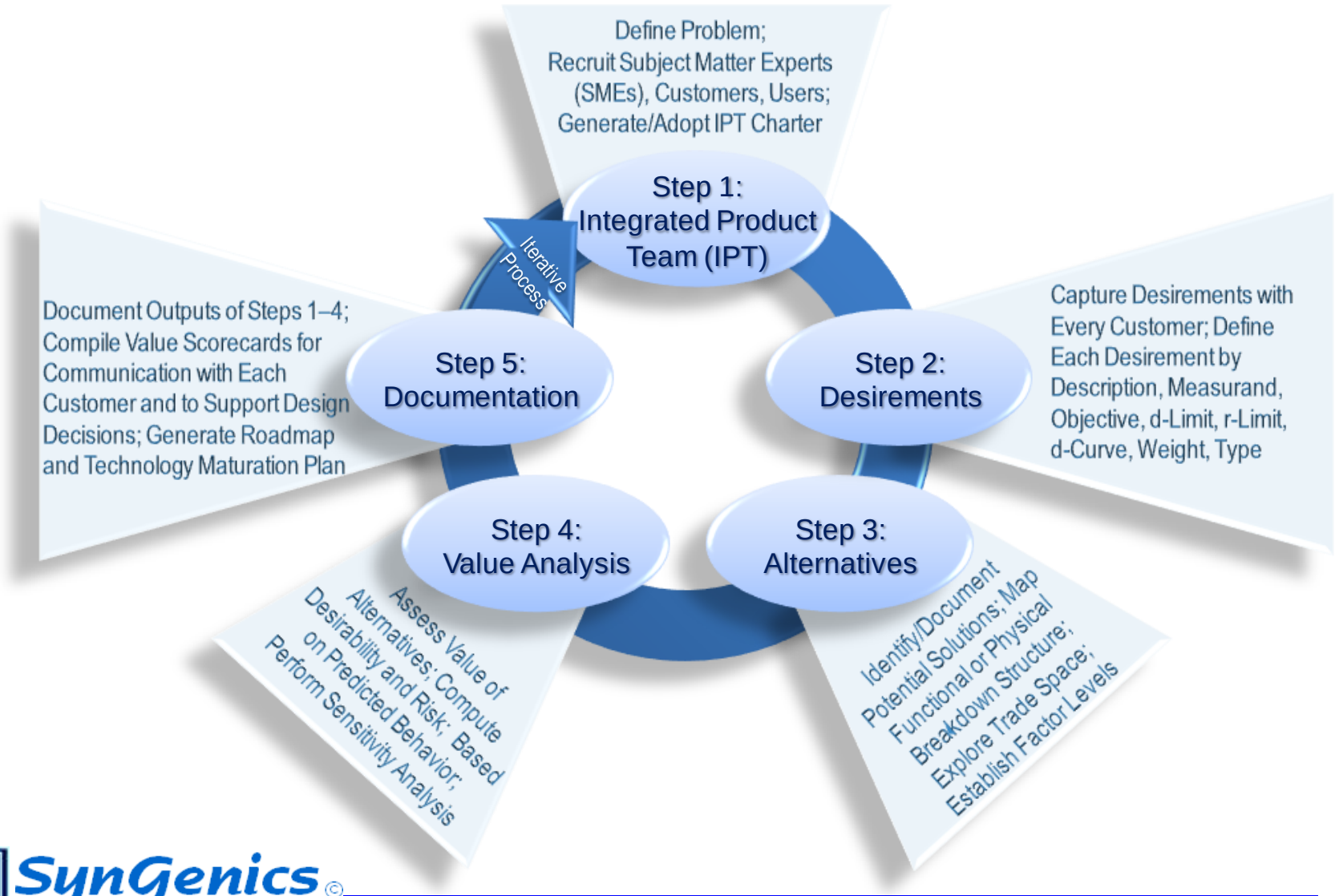
Air Force Focus on Systems Engineering in Pre-Decisional Acquisition Phase (SE in S&T)

- ***Perceived to Support Translation of Capability Statements into Families of Concept Designs/Approaches***
- ***Pre-Acquisition Systems Engineering***
  - ***Affords Trade Study Processes***
  - ***Provides Key Ground Rules/Constraints***
  - ***Determines Decision Criteria***
  - ***Offers Methodology for Populating Knowledge Base***
  - ***Affords Ability to Migrate Knowledge Base Forward to Programs***
  - ***Drives Linkage of Concepts to Operational Architectures***
  - ***Serves as Investment to Reduce Risk in Later Program Phases***
  - ***Must Start in Earliest Stages of Concept Development***
  - ***Provides Operators Tools for Informed Choices***
  - ***Gives S&T Community Collaborative/Vetted Guide to Investment***
  - ***Fulfills Operator/Lab Responsibility to Manage Expectations of S&T***
  - ***Focuses Resources on Essential Technology Products***

SynGenics Support for Air Force Research Laboratory S&T Systems Engineering

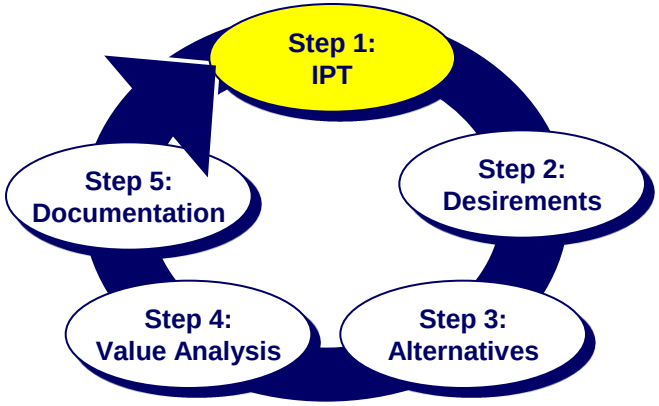
- ***Developed and Refined the Systems Engineering Tailored for Science & Technology (SETFST) Process***
  - ***Structured Approach to Generate Optimal Solutions to Complex Problems***
  - ***Can be Applied to Emerging Technologies***
    - ✓ ***Contributes to Sound SE over Life Cycle of Resulting Products***
  - ***Defines and Clarifies Requirements***
  - ***Supports Good Decision Making Even in Absence of Complete Information***
  - ***Identifies "Desirements" and Alternatives that Might Satisfy Customer Requirements***
    - ✓ ***Evaluates/Compares/Ranks them in Consistent Framework***
    - ✓ ***Enables SMEs/Managers to Capture/Negotiate/Evolve Alternatives***
  - ***Affords Highest Probability of System Success***
  - ***Reveals Sensitivities and Quantifies Risk***
  - ***Is Easily Updated when More Information Becomes Available***

SETFST Process



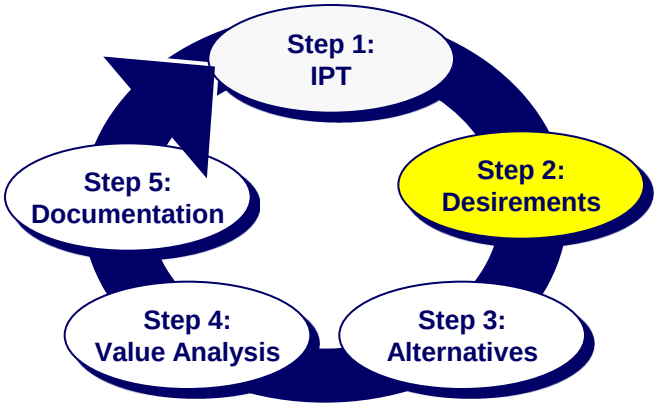
SETFST Step 1: Form Integrated Product Team (IPT)

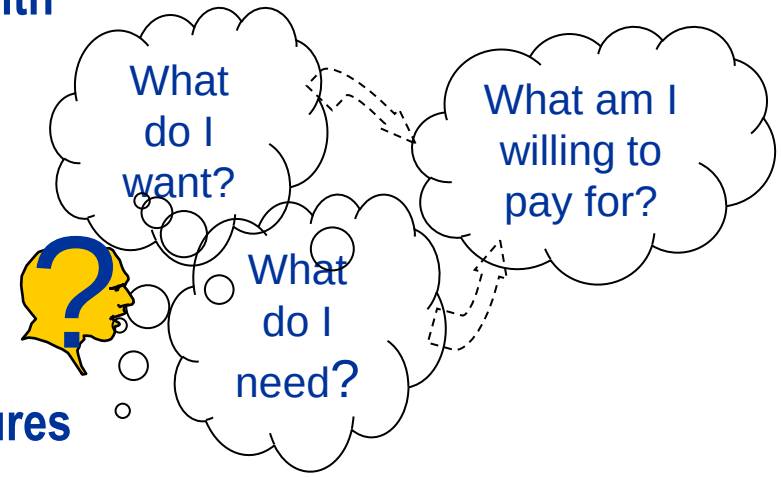
- Define Problem
- Recruit Subject Matter Experts (SMEs), Customers, Users
- Generate/Adopt IPT Charter
- Complete When
  - Full IPT Formed
  - SMEs Agree to Participate
  - Customers Sign On
  - Charter Adopted
  - Team Functions Productively
- Products: IPT Charter



SETFST Step 2: Negotiate Desirements

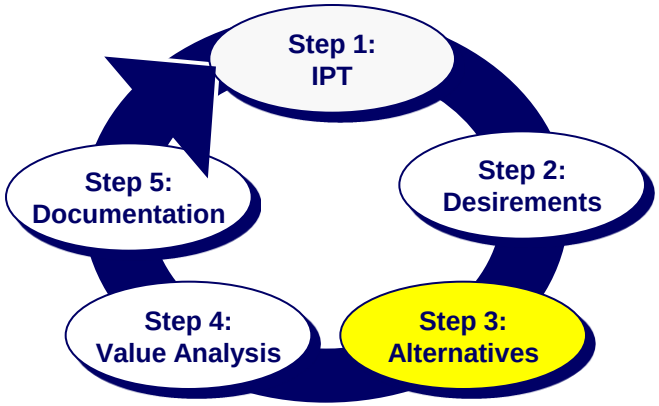
- Develop Evaluation Criteria (Desirements) with Each Customer
- Define by Description, Unit of Measure, Objective, Limit(s), Desirability Curve, Weights
- Categorize by Type
- Establish Definition of Program Success
- Refine Desirements Based on Interaction with Customer
- Complete When Desirements Are
  - Captured
  - Quantified
  - Approved
- Products: Desirements, Quantifiable Measures of S&T Program Success





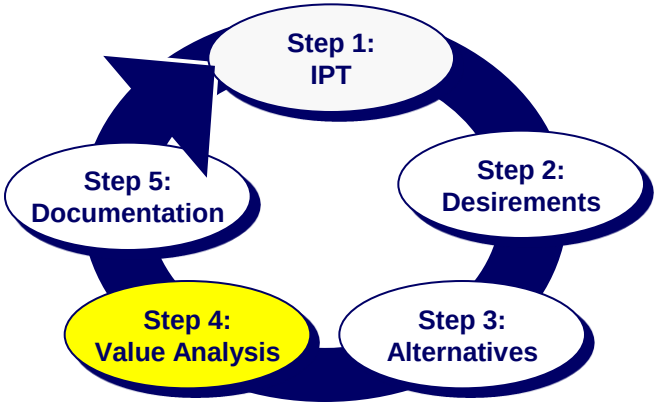
SETFST Step 3: Generate Alternatives

- SMEs Identify/Document Potential Solutions
- Define Solution Space
  - Set Context for System
  - Complete Functional or Physical Decomposition
  - List Subsystem Options
- Explore Design Space
- Establish Design Factor Levels
- Complete When
  - Initial Set of Alternatives Defined
  - Strengths and Deficiencies Noted
  - Design Factors Documented
  - Trade Space Explored
  - Alternatives Refined



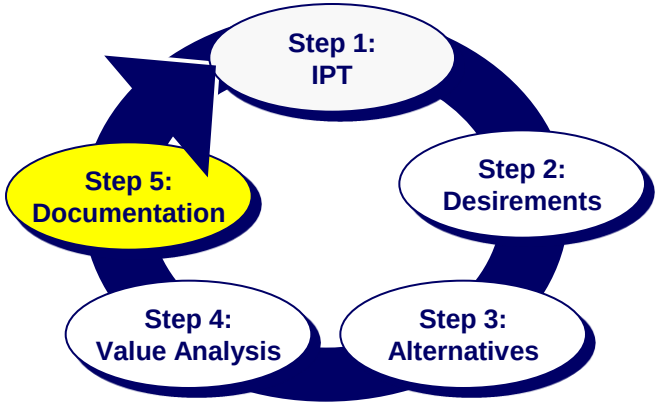
SETFST Step 4: Perform Value Analysis

- Assess Value of Each Alternative
  - With Respect to Each Desirement
  - In Terms of Predicted Response Values
- Compute Desirability and Risk for Each Customer
- Analyze Results; Perform Sensitivity Analysis
- Provide Feedback to Customers and SMEs
- Reiterate
  - Refine Alternatives
  - Regenerate Value Scorecards
- Complete When
  - Scoring Done
  - Desirability and Risk Assessed
  - Best Alternative Chosen
- Products: Value Scorecard for Each Customer or Application



SETFST Step 5: Prepare Documentation

- **Document Outputs of Steps 1–4**
  - Desirements, Definition of Success
  - Descriptions of Alternatives
  - Scores/Assessments
    - ✓ Of All Alternatives
    - ✓ Against All Desirements
- **Compile Value Scorecards to**
  - Communicate with Each Customer
  - Support Decisions
  - Generate Roadmap and Technology Maturation Plan
- **Provide Details of Recommended Alternative(s)**
- **Characterize Design Space (Feasible Solution Space, Desirability, Risk, Trade-offs)**



Systems Engineering Analysis Decision Support (SEADS) Toolkit

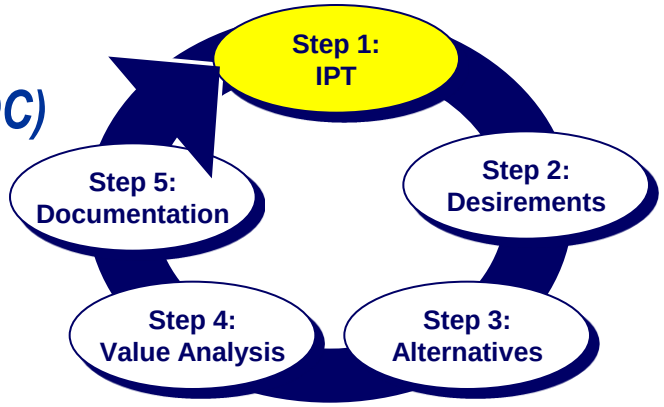
- ***SEADS Toolkit Used in Performance of SUAS Military Utility Study***
  - ***Leads User through SETFST Process***
  - ***Facilitates Capture of Data Generated during Each Process Step***
  - ***Performs Analysis of Data***
  - ***Generates Reports***
    - ***Desirements***
    - ***Worksheets***
    - ***Scorecards***
  - ***Facilitates Making Rational Decisions***
  - ***Software Enables Making Changes and Regenerating Results as Needed***
  - ***Built-in Traceability Makes Decisions Defensible and Progress Visible***
  - ***Quantifies Desirability, Risk, and Tradeoffs***
  - ***Ideal for Pre-Milestone A Leading to Selection of Preferred System Concept***
  - ***Provides Content for Strong Business Case***

Phase I SUAS Military Utility Study

- ***Phase I Plan – Define Air Force Missions that Might Benefit from SUAS Technologies***
  - ***Agree upon Evaluation Criteria for Mission Selection and Prioritization***
  - ***Brief AFRL Senior Leaders on Progress and Plans***
  - ***Define SUAS Missions***
  - ***Conduct Independent Review Board (IRB) Meetings***
  - ***Evaluate Missions Against Evaluation Criteria for Each Case***
  - ***Prioritize Missions for Potential Benefit of SUAS Capability***

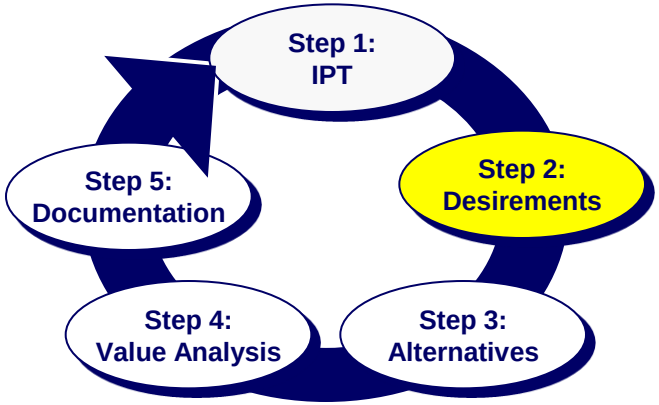
SETFST Step 1 Application to Phase I SUAS Military Utility Study

- ***Identified Customers***
  - ***Air Force Special Operations Command (AFSOC)***
  - ***Air Combat Command (ACC)***
- ***Formed Utility Study IPT***
  - ***Program Management Core Team***
  - ***Independent Review Board (IRB)***
    - ✓ ***AFLCMC, ACC, AFSOC, AFMC, AFRL HQ, DARPA, IARPA, US Army***
- ***Concurred with Customers on Definition of the Problem***
- ***Explored Customer Capability Needs***
  - ***AFSOC Capability Gap Analysis***
    - ✓ ***Each Mission Area***
    - ✓ ***SUAS Potential Roles in Operations***
  - ***ACC Urgent Capability Needs***



SETFST Step 2 Application to Phase I SUAS Military Utility Study

- *Analyzed Characteristics of Capability Needs*
- *Classified Characteristics as Types of Desirements*
- *Captured 5 Mission Evaluation Desirements*
  - *Military Importance*
  - *Improvement in Mission Capability*
  - *Assets Held at Risk*
  - *Mission Cost Reduction*
  - *Availability of Non-SUAS Solutions*



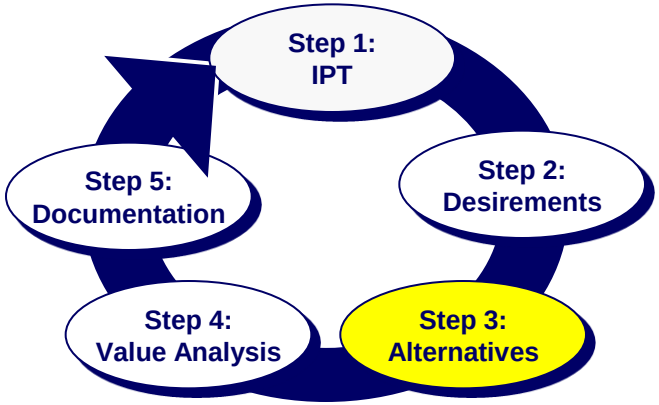
- *Defined Associated Measures*
  - *Generated Desirability Functions for Each Desirement*
    - ✓ *Objective Values*
    - ✓ *Risk-Limit Values*
    - ✓ *Desirability Limits*
- *Revalidated Desirements*

Phase I SUAS Military Utility Study Desirements

Desirement Name	Units	Obj	Limit	Desirement Description	Assumption, How Tested or Other Clarification	Objective Rationale	Limit Rationale
1. Military Importance	Scale: 0–K	20	1	A measure of the degree to which the mission addresses a military need. Evaluated on an integer scale.	Scale definition: 0 = no military utility (i.e., civilian mission); 1 = aids non-military agency (e.g., Homeland Security, CIA, NAS, DTRA) in protecting national security but not wrt a defined mission of any service; 2 = mission of a service other than USAF (e.g., Army, Navy); 3+n = fills an AF need, where n = score based on the number and priority of MAJCOM capability gaps relevant to successful mission completion. (See ScoreMissions workbook.)	Ideal is to support AF needs and fill MAJCOM high-priority capability gaps.	If there is no military utility, no investment is warranted.
2. Improvement in Mission Capability	10-Point Scale	10	1	The degree to which MAV/SUAS availability is expected to improve the probability of success in executing the mission. Evaluated using a relative scale reflecting estimated improvement of mission success with MAV/SUAS capability.	More credit is given to missions that are enabled by MAV/SUAS technology compared to those that can be accomplished quite well without it. 10 = totally new capability; 5 = no improvement with MAV/SUAS; 1 = cannot do mission with MAV/SUAS.	The preferred missions for this analysis are ones that cannot be accomplished without improved MAV/SUAS capability.	A reduction in mission capability is tolerable but only when other benefits accrue (e.g., lower cost, reduced risk to high-value assets).
3. Assets Held at Risk	PAV Score	10	0	A measure of the degree to which MAV/SUAS obviates the need to place high-value assets at risk for mission accomplishment. Evaluated as change in expected operational capability loss as a consequence of loss of assets due to excess risk associated with the mission. Considers the operational value of assets needed to undertake the mission and the risk to which these assets must be exposed, relative to the acceptable level of risk for that mission. Includes strategic assets and all risks consequent to mission execution. The intent is to assign a relative score, on a 10-point probability-asset-value (PAV) scale, to the missions being evaluated.	Assessed using 10-point scales reflecting the value of assets held at risk (V), the degree of risk to which they are exposed (R), and the exposure time (T). Assessment is performed for current capability and for future capability with MAV/SUAS in the timeframe under consideration. PVT score is the improvement provided by the assumed future MAV/SUAS capability. See ScoreMissions workbook for algorithm. High Value Asset = human, carrier, submarine, cruiser, JSTARS, AWACS, bomber, destroyer, frigate, tanker, Global Hawk, fighter Med Value Asset = ground asset, cruise missile, compromised human Low Value Asset = SUAS, MAV	Highest possible score.	Range of possible values is [-8,10]. No improvement or even a slight increase in PAV may be acceptable if other advantages accrue.
4. Mission Cost Reduction	Scale: 0–5	5	0	A relative assessment of the degree to which the mission can be accomplished at a lower cost with MAV/SUAS than with current capability.	Scale definition: 0 = same cost or no cost reduction 1 = save $0 to $20K per mission 2 = save $20K to $50K per mission 3 = save $50K to $100K per mission 4 = save $100 to $500K per mission 5 = save greater than $500K per mission or cannot currently accomplish mission	Highest possible score.	No cost reduction to mission execution may be acceptable if other benefits accrue.
5. Other Solutions	Scale: 1–5	5	1	The likelihood that some other solution will result in the same improvement expected through use of MAV/SUAS.	Scale definition: 1 = MAV/SUAS cannot help, 2 = MAV/SUAS can help, but another better solution is available, 3 = MAV/SUAS can do the job, 4 = MAV/SUAS can do the job and is cheaper than other means, 5 = MAV/SUAS is the only thing that can do the job.	Highest possible score.	If MAV/UAS cannot aid in mission execution, the mission should be ruled out for this analysis.

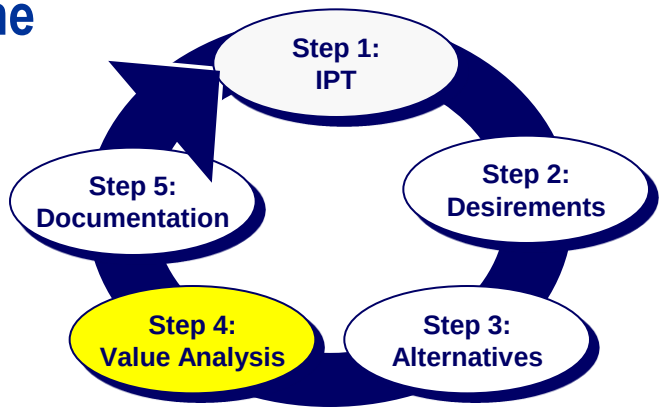
SETFST Step 3 Application to Phase I SUAS Military Utility Study

- **Included SMEs on IPT**
  - **From AFSOC and ACC**
  - **From AFRL Technical Directorates (TDs)**
  - **From AFRL Headquarters Plans and Programs**
- **Familiarized SMEs with Desirements and Measures**
- **Agreed on Approach to Generate Alternatives**
- **Listed Mission Types**
- **Documented Eight Tactical Vignettes**



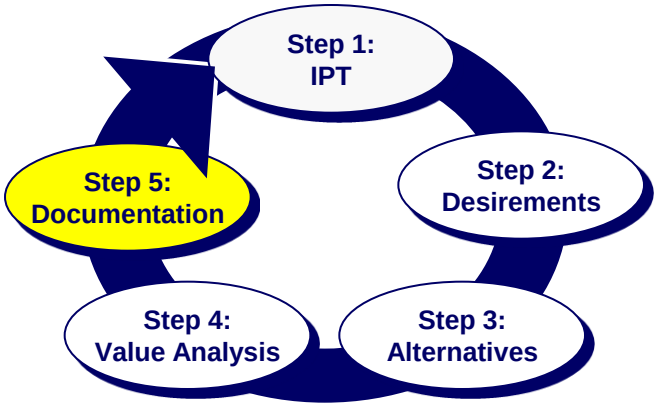
SETFST Step 4 Application to Phase I SUAS Military Utility Study

- Evaluated Tactical Vignettes
  - Worked Closely with AFRL SUAS Lead
  - Refined Vignette Evaluation Criteria
- Established Scoring Rules for Three Timeframes
- Generated Worksheets with Predicted Values
  - Scored Vignettes against Desirements
  - Mapped Scores to Desirability for Timeframe
  - Quantified Risk against Risk Limits
- Aggregated Metrics for Each Customer
  - Composite Desirability
  - Composite Risk
- Reviewed Value Scorecard
- Ranked Vignettes
- Recommended Those Most Likely to Be Aided by SUAS Use



SETFST Step 5 Application to Phase I SUAS Military Utility Study

- ***Products of Steps 1-4 Provided Basis for Recommendation***
- ***IRB Briefed***
  - *US Army and DARPA Joined IRB*
  - *Hosted by ASC Vice Commander*
  - *Endorsed Selection of Three Vignettes*
  - *Approved Initiation of Phase 2 Analysis*
    - ✓ *Based on Three Phase I Vignette Selections*



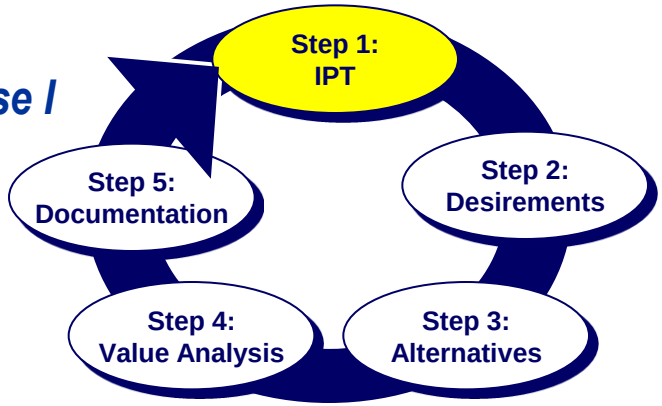
- ***AFRL/RQ Management Group Briefed 3 Feb 12***
  - *Also Approved Initiation of Phase 2 Analysis*
    - ✓ *With Value Analysis of SUAS and Non-SUAS Technology Alternatives*
- ***Phase 2 Initiation***
  - *Pursued All Three Vignettes in Parallel*
  - *Reiterated Two Purposes of Military Utility Study*
    - ✓ *Determine Whether Research Should Be Pursued*
    - ✓ *If So, Where Should Research Be Focused*

Phase II SUAS Military Utility Study

- ***Phase II Plan – Evaluate Technology Alternatives***
  - ***Pursue All Three Vignette in Parallel***
    - ✓ ***(Initial Plan was to Pursue Lease Complex Vignette First)***
  - ***Explore Task Commonality Across Vignettes***
  - ***Respond to Warfighter Capability Needs***
  - ***Consider Technologies to Drive Solutions***
  - ***Conduct Another IRB Meeting***

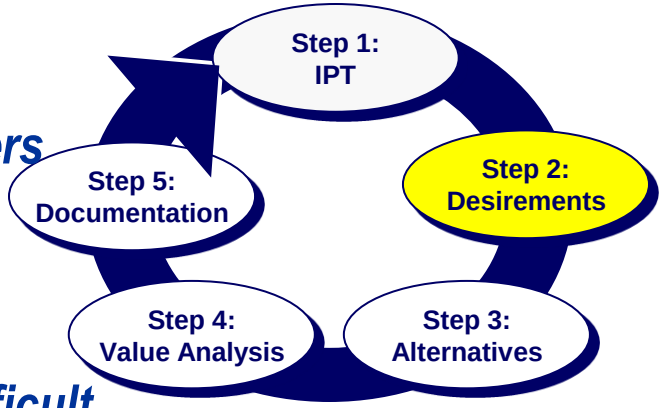
SETFST Step 1 Application to Phase II SUAS Military Utility Study

- *Same IPT*
  - *Customers: AFSOC, ACC*
  - *Program Management Core Team*
  - *IRB: AFLCMC, ACC, AFSOC, AFMC, AFRL HQ, DARPA, IARPA, US Army*
- *Aeronautical Systems Command (ASC)*
- *Air Materiel Command Liaison to ACC*
- *SUAS Core Team Began Capturing Desirements*
  - *First for Least Complex Vignette Selected in Phase I*
- *Core Team Began Documenting Alternatives*
  - *Soliciting Input on Pertinent Technology Options*
    - ✓ *Scope was to Contribute to AF Operations*
      - ~ *Operationally*
      - ~ *Cost Effectively*
    - ✓ *Objective was to Answer Question*
      - ~ *Is Maturing SUAS Technologies Best Way to Fill Warfighter Capability Gaps?*
    - ✓ *Overarching Goal*
      - ~ *Objective Value Analysis to Support AFRL Technology Investment Decisions*



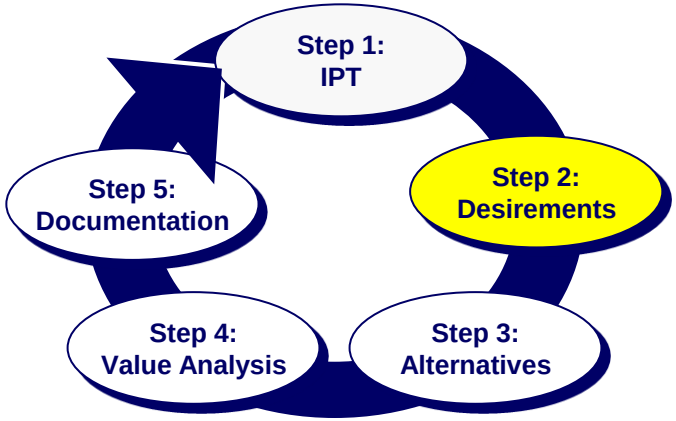
SETFST Step 2 Application to Phase II SUAS Military Utility Study

- *Captured Desirements as Wants/Needs of Warfighters Executing Vignettes*
  - *Missions Identified as Set of Operational Vignettes*
- *Preferred Capture Process Involves Discussion with Users*
  - *What Do Users Need to Do*
  - *What Capabilities Would Users Like to Improve*
- *Scheduling Time with Users for SUAS Study Proved Difficult*
  - *Instead Core Team Generated Draft Desirements*
  - *Started with 45 Desirements from Another AFRL Program*
    - ✓ *For Same Vignette as One of SUAS Phase I Vignettes*
    - ✓ *Enjoyed Intensive User Involvement*
    - ✓ *Served as Strawman Desirements for SUAS Utility Study*
  - *Negotiated 21 Desirements with Customer for SUAS Utility Study*



SETFST Step 2 Application to Phase II SUAS Military Utility Study (Cont'd)

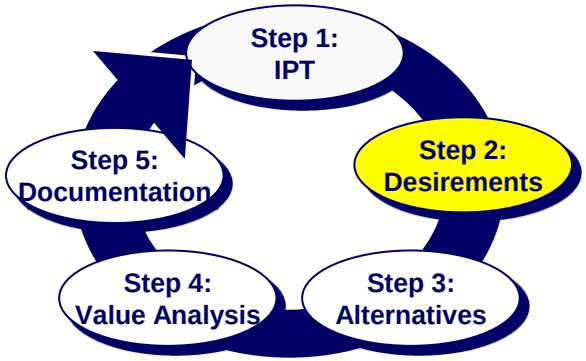
- ***Obtained User Feedback in Abbreviated Interactions***
  - ***Core Team Met at Hurlburt Field March 12 with AFSOC, AFRL/RQ, AFRL/RH***
  - ***Three SUAS Study Vignettes Covered***
    - ✓ *Corroborated Some of the Strawman SUAS Study Desirements*
    - ✓ *Provided Relative Importance of Desirements*
    - ✓ *Added Dimensions to Desirements Set*



- ***Basis for Strawman (Draft) Desirements***
  - ***Air Force Service Core Functions***
  - ***Potential Value of SUASs in Military Operations***
  - ***Focus on WHAT User Needs Not on HOW Capability Will Be Achieved***
  - ***Desirements Are Technology Agnostic***

SETFST Step 2 Application to Phase II SUAS Military Utility Study (Cont'd)

- **Defined Desirability Functions**
  - For Each Desirement for Each Vignette/Task
    - ✓ Objective Values
    - ✓ Risk-Limit Values
    - ✓ Desirability Limits



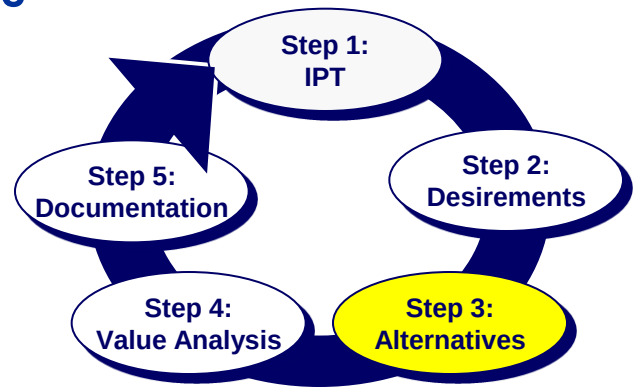
- **Created SEADS Toolkit Database for Phase 2 Analysis**
- **Created New Set of Desirements**
  - Revised to Include Information Provided during Workshop
  - Included Two Cost Desirements
  - Then Scrubbed to Reduce Set as Much as Possible
  - Led to Redefinition of Desirement Types as Well
- **Developed Set of Scoring Rules for Desirements**
  - To Allow Consistent/Rapid Scoring of Technology Alternatives
- **Created/Programmed Scoring Utility**
- **Revealed Need for More Complete Definition of Vignettes**

Phase II SUAS Military Utility Study Desirements Development

Des #	Desirement Name	Units	Obj	Risk Limit	Desirement Description	Assumption, How Tested or Other Clarification	Objective Rationale	Limit Rationale	Comments	Priority	Wt
Category: A. Performance/Effects											
A1	Endurance	Hours	8	0.5	Endurance of asset, i.e., it can remain on station doing whatever it is doing, measured as the maximum time from launch to recovery or termination.		Highly dependent upon what the task is.	Plan is usually to be in and out quickly.		High	4
A2	Reduction in Time Required to Accomplish Objective	Scale: 1–10	10	2	The degree to which use of the alternative is likely to reduce the amount of time required to accomplish the mission objective.	10 = Huge reduction; 5 = no change; 1 = huge increase			Scenario dependen: earthquake or natural disaster in an uncontested environment where IPs need to be located vs covert operation.	High	4
Category: B. Situational Awareness (SA)											
B1	Continuity of Communication	Scale: 1–10	10	2	Ability to maintain continuity of communications among ground teams, remote sensors, C2, and airborne fire support, measured on a scale that reflects the amount of time not in communication.	10= Ability to talk to anyone anywhere anytime; 9 = good comm with team and a/c in jungle 98% of time; 8 = good comm in canyon but not jungle; 5 = comm w/ team only 50% of time or no data relay; 1 = no comm	Complete continuity is ideal. Interruptions to communications when switching between line of sight (LOS) and SATCOM should be minimized.			Very High	5
Category: C. Cost											
C1	Relative Acquisition Cost	Scale: 1–10	10	2	A relative measure of the acquisition cost of full operating capability if the alternative is fielded.	10 = free; 5 = moderate, like Scan Eagle; 1 = very high, like Reaper + satellite				High	4
Category: D. Other											
D1	System Portability	Scale: 1–10	10	2	A measure of the change in the weight and volume of gear that SOF must carry if the alternative is employed.	10 = significant decrease in weight and volume carried; 7 = weight and volume same as current; 3 = (barely) acceptable increase; 1 = unacceptable increase	Goal is to reduce weight and increase commonality	They currently carry 120 lbs of gear, but if extra gear is relatively light and extremely useful, they will accept the burden.		High	4
Category: E. Environment											
E1	Operability in All Environments	Scale: 1–10	10	2	Ability to operate in any environment (e.g., hot, cold, wet, salt, desert, high/low pressure, shock/vibration, smoke, fog, jungle, urban) without equipment malfunction. Evaluated on a scale reflecting degree of survivability of equipment and its criticality.	Relates to ruggedization of gear against environmental effects. 10 = operates in all environments including icing; 9 = jungle but not water/salt; 8 = mountains/urban with obstacles/canyons; 7 = mountains/urban but not amongst obstacles; 6 = desert/sand; 5 = snow/wet (but cannot land in water); 4 = extreme temperatures, pressures, etc...; 3 = current capability 1 = any harsh environment causes hard failure.	Ideal is that all equipment is fully ruggedized.	Ability to medicate and extricate is mission-critical for PJs. Power, comms, sensors are mission critical for CCT; probably for all specialties.	Mission-critical can be divided into A,B,C criticality for all.	Very High	5

SETFST Step 3 Application to Phase II SUAS Military Utility Study

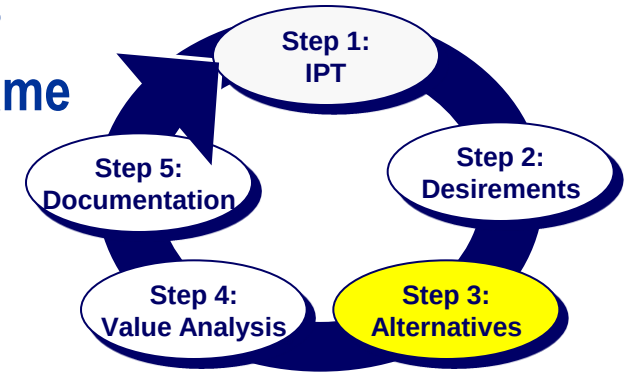
- ***Phase 2 Objective***
  - ***Identify/Recommend Beneficial SUAS Technologies***
  - ***Compare SUAS and Non-SUAS Alternatives***
- ***SynGenics Facilitated Meetings in Dayton***
  - ***To Generate Alternative Solutions***
  - ***To Capture Technology Options***
  - ***AFRL/RQ RD RI RW & AFWA Participated***
  - ***One-on-One Meetings with RY and RX***



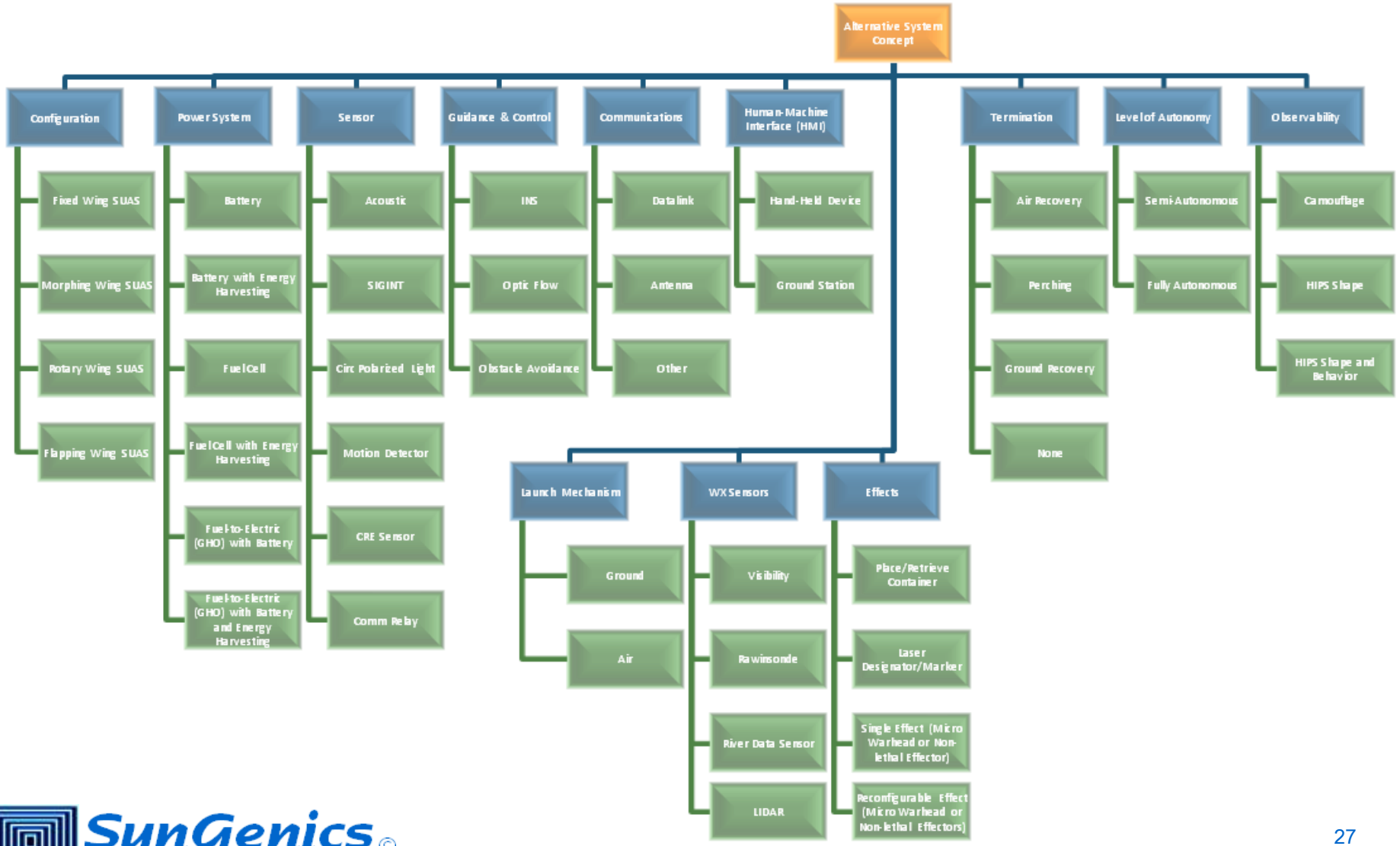
- ***Familiarized SMEs with Desirements and Measures***
- ***Request for Options Was Made and Accepted by SMEs***
  - ***Provided Structure for Submission of Option Information***
    - ✓ *Refined Quad Chart Format to Document Phase 2 Options*
  - ***Inputs Provided to AFRL/RQ SUAS Lead***

SETFST Step 3 Application to Phase II SUAS Military Utility Study (Cont'd)

- Agreed on Approach to Generate Alternative Solutions
- Performed Functional Decomposition of Capability Needs
- Solicited Potential Options to Help Enable Functions/Tasks
- Aggregated Sets of Options into Alternative Solution Concepts
- Recruited Additional SMEs from Other TDs
  - To Capture Other Options that Might Be Helpful
  - To Ensure No Important Technology Options Are Overlooked
- Considered Technology Availability Dates
  - To Compare Alternatives in Same Timeframe
  - Near, Mid, and Far Term

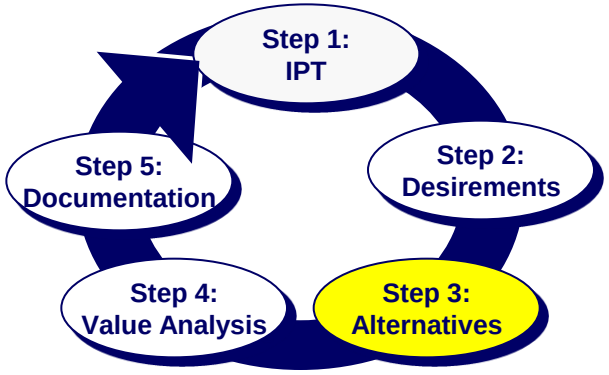


Phase II SUAS Military Utility Study
3 Level Architecture



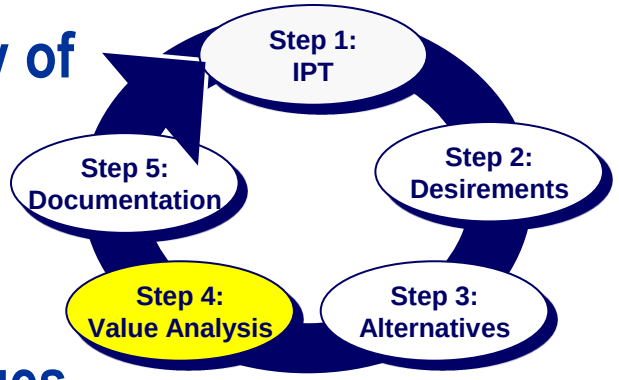
SETFST Step 3 Application to Phase II SUAS Military Utility Study (Cont'd)

- ***Revised Desirements Provided to the SUAS Core Team***
- ***Generated Alternatives through July–August 12***
- ***Produced Updated Architecture and Draft Alternatives in August***

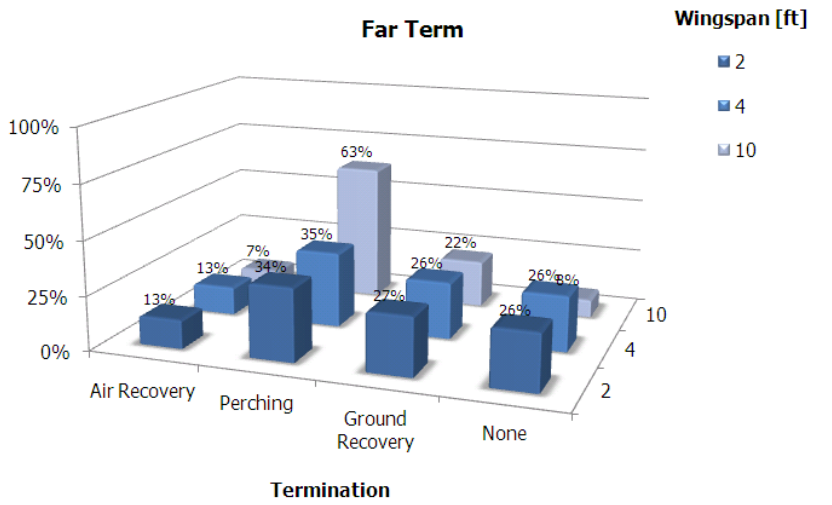


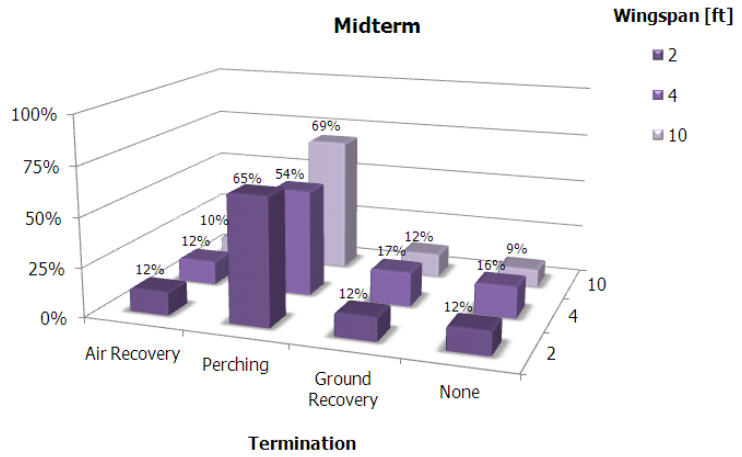
SETFST Step 4 Application to Phase II SUAS Military Utility Study

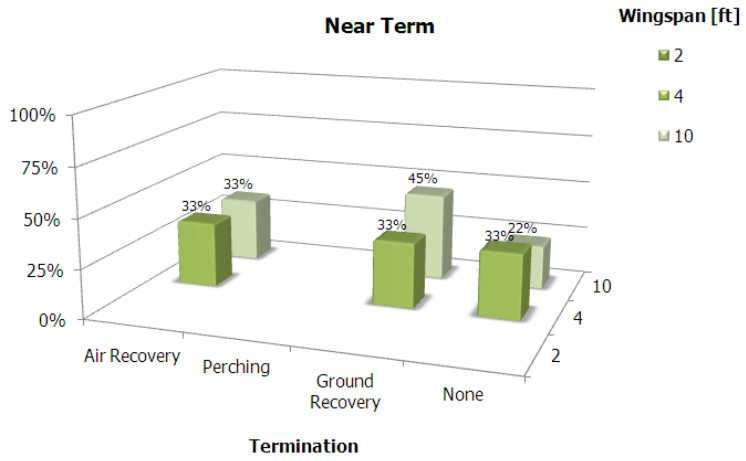
- **Scored Every Alternative**
  - **Assigned Numerical Value for Each Desirement**
- **Number of Alternatives Exceeded Capacity of SEADS Toolkit**
- **Mapped Scores for Each Alternative to Desirability for Each Vignette and Task**
- **Generated Worksheets with Predicted Values**
  - **For Each Type of Desirement**
  - **For Each Tactical Vignette and Task**
- **Aggregated Metrics for Analysis of Which Technologies to Pursue**
  - **Composite Desirabilities for Each of 3 Vignettes**
  - **Composite Desirabilities for Each of 9 Tasks**



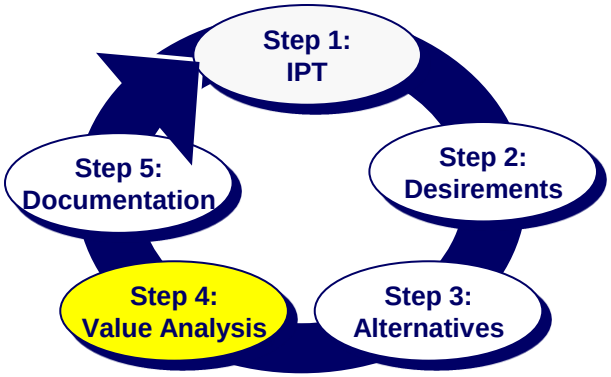
Phase II SUAS Military Utility Study
Examples of Best Options







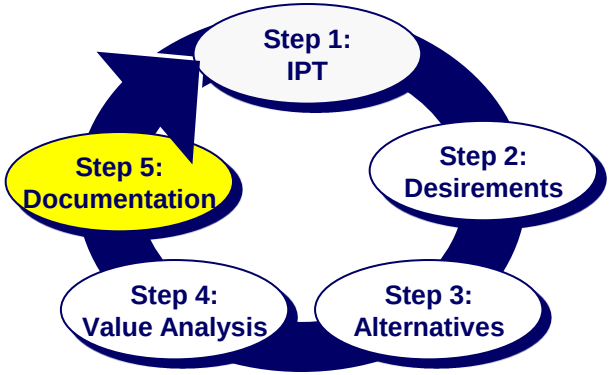
SETFST Step 4 Application to Phase II SUAS Military Utility Study (Cont'd)



- **Made Recommendations**
  - **Looked for Errors**
  - **Corrected any Found**
  - **Performed Sensitivity Analysis**
  - **Provided Feedback to Customers and Technologists**
  - **Fine-Tuned Desirements and Scoring Methodologies**
  - **Tweaked Alternatives (or Developed New Ones)**
  - **Rescored as Necessary**
- **Value Scorecards Reviewed to Support Investment Decisions**

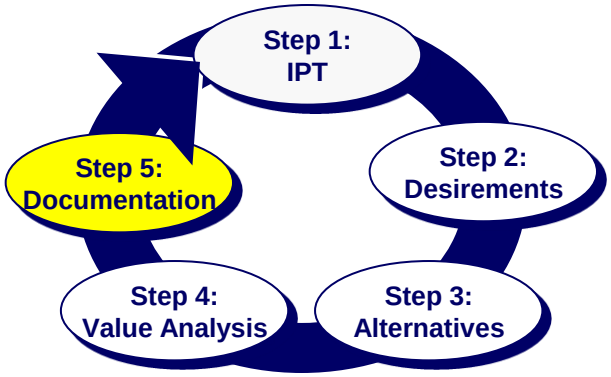
SETFST Step 5 Application to Phase II SUAS Military Utility Study

- **Products of Steps 1-4 Enabled Development of Baseline**
- **Served as Basis for Recommending AFRL Technology Investment**



Recommendations

- **Example SUAS Utility Study Findings:**
  - **Small and Very Small UAS Have Military Utility in AF Operations**
  - **This Utility Exceeds that of Available, Non-SUAS Solutions**
  - **S&T for Future Systems to Play this Role Is Not Being Pursued by the Other Services**
- **AFRL Should Pursue Development of SUAS-Related Technologies**
- **Focus Areas Should Be the Selected Options for the Subset of Subsystems that Rose to the Top in SETFST Value Analysis**



Lessons Learned

- ***Previously Recognized Need to Solicit User Involvement for at Least Two Days for Desirement Capture and for Evaluation of Alternatives was Reinforced***
- ***Difficulty of Obtaining Sufficient User Time in this Effort Extended the Study Timeline***
- ***Difficulty Related to Gathering SME Inputs***
- ***Difficulty Finding the Correct SMEs to Solve the Problem***
- ***Due to Limited User and SME Availability, the Core Team Scored the Alternatives***
  - ***Caused Concern that Technologists' Biases May have Caused Some Options to Score Better than if Viewed from a Broader Perspective or with the Checks and Balances of the Scrutiny by a Larger Group***
  - ***Lack of User Involvement in Alternative Evaluation Is a Common Problem***
    - ✓ ***Needs to be Addressed Organizationally***
- ***Recruiting/Scheduling Difficulties Meant No Time for Reiteration***

Benefits of SE in S&T

- ***Better Mutual Understanding of Needs and Possibilities***
  - ***Education of Customers Leads to Better Requirements***
  - ***Education of SMEs Leads to More Responsive Technologies***
- ***Documented Evaluation Criteria Lead to***
  - ***Clearer Direction***
  - ***More Accountability***
- ***Analysis Forms Basis for Establishing Requirements***
  - ***Measures of Merit Highlight Regions of Interest in Trade Space***
  - ***Risk Analysis Supports Risk-Mitigation Plan***
- ***Process Enables Corporate-Perspective Decisions***
  - ***Robust, Repeatable, Flexible Basis for Decision Making***
  - ***Recognizes Customer Desires***
  - ***Retains Ability to Address Each Customer's Issues***
- ***Complements the JCIDS Process***

Benefits of SE in S&T (Cont'd)

- ***Improved Performance of Defense Programs***
- ***More Capable, Interoperable, and Supportable Weapons Systems***
- ***Reduced Total Ownership Costs***
- ***Integration of New Technologies Will***
  - ***Improve AF Ability to Meet Changing / More Complex Security Environment with the Agility, Flexibility, and Readiness Required***

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