An Approach for Strategic Planning of Future Technology Portfolios

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Overview

• Traditional resource allocation approaches
• Foundation of approach
• Summary of previous execution of approach
• Overview of the Technology Prioritization Calculator Process
Traditional Resources Allocation Approaches

Due to limited Research and Development (R&D) monies available, the decision-maker desires to know where to direct scarce resources to maximize technological payoffs or substantiate strategic competitive decisions. Five traditional approaches are (Cetron [1972]):

1) **Squeaking Wheel**: cut resources from every area and then wait and see which area complains the most. Based on the loudest and most insistent, then restore budget until ceiling is hit.

2) **Level Funding**: budget perturbations minimized and status quo maintained; if this approach continues within a rapidly changing technology field, the company, group, or agency will end up in serious trouble.

3) **Glorious Past**: "once successful, always successful". Assign resources solely on past record of achievement.

4) **White Charger**: best speaker or last person to brief the boss wins the money or whichever department has the best presentation.

5) **Committee Approach**: a committee tells the manager or decision-maker how to allocate resources.
Foundation of Approach

• The Strategic Prioritization and Planning (SP2) process is an expert-based series of decision (or planning) matrices that are related qualitatively through different levels of abstraction and is the detailed process for program planning

• The subjective qualitative relationships may then be mapped to quantitative scales to allow for a rapid prioritization based on the level of abstraction desired

• The process is an evolution of accepted quality engineering methods (i.e. Quality Function Deployment) and incorporates various dynamic aspects to form a portable and powerful decision making environment
Applications of SP2

- A Congressional study for an integrated 5 year R&T plan for U.S. aeronautics (NIA)
- The NASA Space Exploration Systems Architecture Study
- The NASA Vehicle Systems Program (VSP)
- The Office of Naval Research Science and Technology
- A Homeland Defense technology application for America’s Shield Initiative (SAIC)
- An upgrade prioritization for the next generation Bradley vehicle (BAE)
- AIAA Strategic Planning for future activities
- MITRE Center for Advanced Aviation System Development
- Navy Ship and Ship Systems Product Area Technology Prioritization
- Army Aviation S&T Strategic Plan
- Lockheed Martin AMC-X Technology Planning
Overview of the Aeronautics Calculator

**Final product objective:**
Develop and deliver to Congress an aggressive 5 year investment plan as a first step to restore aviation and aeronautics technology capabilities to a robust level commensurate with a global leadership position.

**With guidance that:**
The plan should uniformly seek to mature high-risk, potentially high-payoff technologies to a readiness level sufficient for NASA to transition out of government-sponsored status for adaptation by private industry.
National Strategy Team

• The purpose of the NST was to:
  – set the Strategic Agenda for the overall analysis, planning and integration activities
  – define 6 over-arching National Needs which were based on the blue-ribbon documents
  – set the research scope and priorities for each of the aviation sectors, including target budgets so as to frame the scope of research
  – provide oversight of the planning activities
  – provide guidance for the preparation and roll-out of a final product

• Members included:

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bob Krieger*</td>
<td>President</td>
<td>Phantom Works, The Boeing Company</td>
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<tr>
<td>Simeon Austin</td>
<td>Dir of Advanced Prgs</td>
<td>Pratt &amp; Whitney</td>
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<tr>
<td>Mike Benzakein</td>
<td>General Manager</td>
<td>Advanced Technology Operations, GE Aircraft Engines</td>
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<tr>
<td>Earl H. Dowell</td>
<td>J. A. Jones Professor</td>
<td>School of Engineering, Duke University</td>
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<tr>
<td>Ed Glasgow</td>
<td>Technical VP</td>
<td>Advanced Development Programs, Lockheed Martin Aeronautical Company</td>
</tr>
<tr>
<td>Norris Krone</td>
<td>President</td>
<td>University Research Foundation, Maryland Advanced Development Laboratory</td>
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<tr>
<td>Robert G. Loewy</td>
<td>Chair</td>
<td>School of Aerospace Engineering, Georgia Institute of Technology</td>
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<tr>
<td>Walter O'Brien</td>
<td>J. Bernard Jones Prof</td>
<td>Mechanical Engineering, Virginia Polytechnic Institute and State University</td>
</tr>
<tr>
<td>Kevin J. Riley</td>
<td>VP for Technology</td>
<td>Raytheon Company, Network Centric Systems</td>
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<tr>
<td>Bob Rosen</td>
<td></td>
<td>Crown Consulting</td>
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<tr>
<td>Rande Vause</td>
<td>Executive Director</td>
<td>Rotorcraft Industry Technology Association</td>
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</table>

* Chairman of the NST
Integrating the Aeronautics Plan

**ASDL Involvement:**
- Contracted to be the primary integrator of all the sector plans
- Interacted with each contractor to provide continuity amongst the teams on a daily basis
- Provided guidance and information when needed
- Provided a decision making tool to the NST to determine the final plan to be presented to Congress
- Collaborated with the production team on the final product to circulate on the hill

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**Integrated Planning Process**

<table>
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<tr>
<th>Sector Plans and Priorities</th>
<th>Target Annual Budget</th>
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<tr>
<td>Airspace Systems</td>
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<td>Aviation Safety &amp; Security</td>
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<tr>
<td>Hypersonic</td>
<td>$50M</td>
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<tr>
<td>Rotorcraft</td>
<td>$100M</td>
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<tr>
<td>Subsonic</td>
<td>$300M</td>
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<tr>
<td>Supersonic</td>
<td>$150M</td>
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<tr>
<td>Workforce/Education</td>
<td>$100M</td>
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</table>

**Increase Mobility**
- Support National Security
- Explore New Aerospace Missions
- Protect the Environment

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Integration Team Objective

Integrated Plan Calculator

Finalized subsector plans

Subsector goals

Integrated mapping

Integrated Aeronautics Plan to deliver to Congress

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NIA Aeronautics Calculator
The Aeronautics Plan

The final brochure was a 16 page document that highlights the plan and calls out for our government to re-establish aeronautical funding in the U.S. to a level commensurate with a global leadership position.

- The integrated plan was more than 1,100 pages.
- The brochure was distributed to congressional staffers for the past several months and stimulated hearings and awareness of the budget crisis.

This will be the future of American aviation without dramatic action by the U.S. Congress...
Technology Prioritization Calculator

• The process utilized for each of the previous “Calculator” concepts is generic in nature and may be tailored to the specific problem at hand

• The basic approach to the process require a decomposition of the problem down to the appropriate level per the decision maker’s needs

• The level of fidelity of the “Calculator” may be increased as more detailed information becomes available, such that a modular, reusable, and extendable product may be created
Process for Building the Calculator

• The process by which SP2 is developed is fairly generic and may be tailored for the specific problem at hand and is based on accepted Quality Engineering Methods

• The “Calculator” is the visual front end

• Regardless of the application, the following elements are necessary to execute the process:
  – Definition of top level needs or requirements
  – Description of the information desired to facilitate decision making, which may include:
    • Schedule, annual or total budgets, source of funding, sensitivity level of abstraction, risk, specific time frames, rack and stack of priorities, etc.
  – Decomposition of the needs to the appropriate level of abstraction
  – Qualitatively relate each level of the decomposition through a series of planning matrices
  – Definition of a quantitative scale for each level of decomposition and translation to quantitative scales
  – Identification of the appropriate domain area experts for each level of the decomposition to provide necessary information

• Elements needed for the process can be defined through various techniques and methods including brainstorming, workshops, affinity diagrams, voting methods, relevance trees, Delphi technique, etc.

• The only requirement placed on the process is that a link exists between each level of the decomposition
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Applying SP2

• This breakdown is for a single Attribute of a single vehicle for one Customer Need
• In order to fully capture the problem at hand, the structure is repeated for each Customer Need causing the dimensionality to increase tremendously
• SP2 reduces the dimensionality by removing non-contributing branches of this structure through a traceable process
  – Creates a direct link between technology sub-areas or options and the Needs
  – Identifies most significant technology sub-areas or options that contribute to the Needs
  – Depends on relationships established at every level of abstraction
Calculator Functional Background

- Much like the QFD Methodology, the Calculator process allows for multiple layers of abstraction to be combined.
- Final outcome allows technologies to be ranked based on impact to the overall needs when direct relationships are not clear.
- While the mapping between levels in a matrix can be qualitatively done, there must be a conversion to qualitative information before the data can be related at a different level.
Applying SP2

Customer Requirement

Vehicles or Sectors

Surface Ships

Unmanned Surface/Undersea Vehicles

Product Attributes

Interoperability Detectability/Stealth Workload Reconfigurability Mobility Sustainability Maintainability/Availability Reliability Payload Capacity Damage Tolerance/Survivability

Technology Areas


Technology Sub-areas

Reconfigurable LEAPS TsSa 1 TsSa 2 TsSa 1 TsSa 2 TsSa 2 TsSa 3 TsSa 1 TsSa 2 TsSa 1 TsSa 2 TsSa 2 TsSa 3

Technology Options

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Calculator Approach

• The steps necessary to complete the process include:
  – Problem definition:
    • The overall needs must be established first to drive the lower level assessments
    • Identification of Vehicle Attributes and other intermediate goals
    • Identification of applicable technologies
  – Matrix Population:
    • Completion of planning matrices with qualitative mappings
    • Determination of the scale for converting qualitative mappings to quantitative rankings
  – Technology Data:
    • Compilation of budget profiles and timeframes for the technologies of interest
• These tasks are best achieved by utilizing experts familiar with the technologies in order to bring as much accuracy to the process as possible
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Notional Calculator Overview

Technology Data (Budget Profiles, Timeframes, Risk)

Customer Requirements

Program Data
( Program Budget, Mission Timeframes, Priorities)

Vehicle Attributes

Technology Options

Vehicle 1

Vehicle 2

Vehicle 3

Vehicle 4

Technology Data (Budget Profiles, Timeframes, Risk)
NASA Space Calculator

Key Features:
- Budget and schedule optimization
- Funding by centers
- Degree of difficulty (risk)
- Time phased development
- Funding profiles
**AIAA Calculator**

**Key Features:**

- Visual prioritization
- Confidence of information
- Metric filters
- “Basketball” rankings
- Activity information provided by AIAA VPs
- Dynamic linkage to activity data

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**AIAA Vision Elements**

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**Relative Prioritizations of Goals**

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<tr>
<th>Goal</th>
<th>Priority 1</th>
<th>Priority 2</th>
<th>Priority 3</th>
<th>Priority 4</th>
<th>Priority 5</th>
<th>Priority 6</th>
<th>Priority 7</th>
<th>Priority 8</th>
<th>Priority 9</th>
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<td>3</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>6</td>
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**Ranking of Activities**

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<tr>
<th>Activity</th>
<th>Priority 1</th>
<th>Priority 2</th>
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<th>Priority 4</th>
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<th>Priority 6</th>
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**Mapping Confidence of Tabled Activities to Each Goal**

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<thead>
<tr>
<th>Metric Drivers</th>
<th>Number of Votes</th>
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<tbody>
<tr>
<td>M1: Cooperative Interactions</td>
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<tr>
<td>M2: New constituent membership</td>
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<tr>
<td>M3: Reengaging members and technologies</td>
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<td>M4: Awareness of AIAA by members</td>
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<tr>
<td>M5: AIAA representation on committees</td>
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<tr>
<td>M6: Participation with on-line interaction</td>
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<tr>
<td>M7: Indirect member contributions</td>
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<tr>
<td>M8: Member satisfaction</td>
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<tr>
<td>M9: Corporate Member satisfaction</td>
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<tr>
<td>M10: Retention of students to professionals</td>
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<tr>
<td>M11: Membership</td>
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**Mapping Scales Vision to Goals**

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<th>Scale</th>
<th>Description</th>
<th>Value</th>
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<td>W2</td>
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**Mapping Scoring to Goals**

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ONR Calculator

Key Features:
- Visual prioritization
- Confidence of information
- Metric filters
- “Basketball” rankings
- Expert voting employed for qualitative mappings
- Dynamic linkage to option data
- Categorization of technology area impacts
- Scenario saving capability
From Vision to Roadmap

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ASDL Visualization Research Facilities

Collaborative Visualization Environment (CoVE)

- An 18’x10’ “war room” type display wall with 12 PCs at operator consoles
- Comprised of a “seamless” 4x3 matrix of 67” rear-projection LCD screens
- Facilitates research in advanced engineering data visualization techniques
- For use in critical reviews by design decision-makers and stakeholders
In the absence of a quantitative physics-based approach, SP2 provides a structured, traceable, and transparent process for planning and technology prioritization.

The process can be tailored to any desired level of detail to enhance the decision making process for investment strategies as more information becomes available.

Experts are involved at all phases of the process.

Various solicitation schemes are utilized to reduce bias.

The end product will allow for “what if” games to be played through a dynamic and interactive environment.

The results of the process can be the foundation for detailed strategic road mapping and quantitative technology assessments and tracking.

SP2 is a living process that should guide strategic planning and be continuously updated as a program evolves.