



The Aerospace Performance Factor (APF)

*The Next Step In The Evolution Of Safety
Management*

Presented:
June 2010
Rome, Italy

Plan Overview: The Next Two Days.



- Day 1:
 - Overview of concepts. What the tool is & what it can do.
 - Introduction to mindmaps & AHP.
 - Understanding Weighting. Non-Aviation demo.
 - Building a mindmap.
- Day 2:
 - Review and Q&A from Day 1.
 - Build individual mindmaps.
 - Actual weighting session.

ICAO Requirements



- ICAO SMM Ed. 2 (2009) The International Civil Aviation Organisation (ICAO) Safety Management System (SMS) manual Ed. 2 (2009) calls for an airline's SMS to be *systematic*; where the SMS employs a range of safety tools within a 'toolbox' to support hazard identification and safety risk management.
- ICAO SMS manual defines a Reactive, Proactive and Predictive risk capability as:
 - The 'post-hoc' investigation of accidents and incidents;
 - The minimization of system failures by identifying safety risks in the system before it fails and
 - The aggressive seeking safety information by identifying emerging risks from a variety of SMS sources. "Practical drift"

The Challenge & Solution



- Assesses the impact of many different factors and events into a cohesive measurement tool. Find a reference point (a baseline) to measure “practical drift” via trending.
- Combine *tangible* and *intangible* elements to determine their *influence* on the overall system.
- APF Methodology- Aerospace Performance Factor: Presents a graphical representation of system data. “Translates” performance data for organizational decision making.

APF Methodology-What Is It?



- A graphical representation of performance over time based on *historical indicators (lagging) from multiple databases.*
- Presents a *macro, system-wide view of organizational performance.*
- Drills down into data to search for contributing factors.
- Can uses safety, operational, and/or equipment measures.
- Does not focus on a single measure to gauge performance.
- Incorporates organizational judgment and experience into equation. We all know not all things are equal-Your judgment makes that allowance.
- Allows for analysis and search for precursors.
- Can:
 - Support decision making.
 - Is expandable in size and scope.
 - Keep an organization “on track”
 - Will always “Follow the data”

How do we define
“Performance”?

A Concept of Small Incidents

Leading to Trends (The elementary version of precursors)



One concept of aviation safety....

- The worst event in aviation is an accident.
- The system has multiple checks and balances, “threads of safety” that help prevent accidents.
- Everything that is not an accident is an incident.
- Incidents represent “breaks” in the “threads of safety” and may represent gross precursors of safety.

One concept of neighborhood security...

- A policeman drives through a neighborhood and sees a broken window.
- Next day the window is not repaired.
- Following day, another broken window.
- History proves these small events are indicators of change in neighborhood.

The Role of Data: Measure What You Manage



- All organizations maintain data elements to gauge themselves.
 - Databases are lagging indicators but can infer future trends.
 - Data elements, used individually, are poor representatives of overall performance.
 - Presenting multiple data graphs to Leadership creates, “Death By PowerPoint” and does not answer the question, “So, how are we doing?”

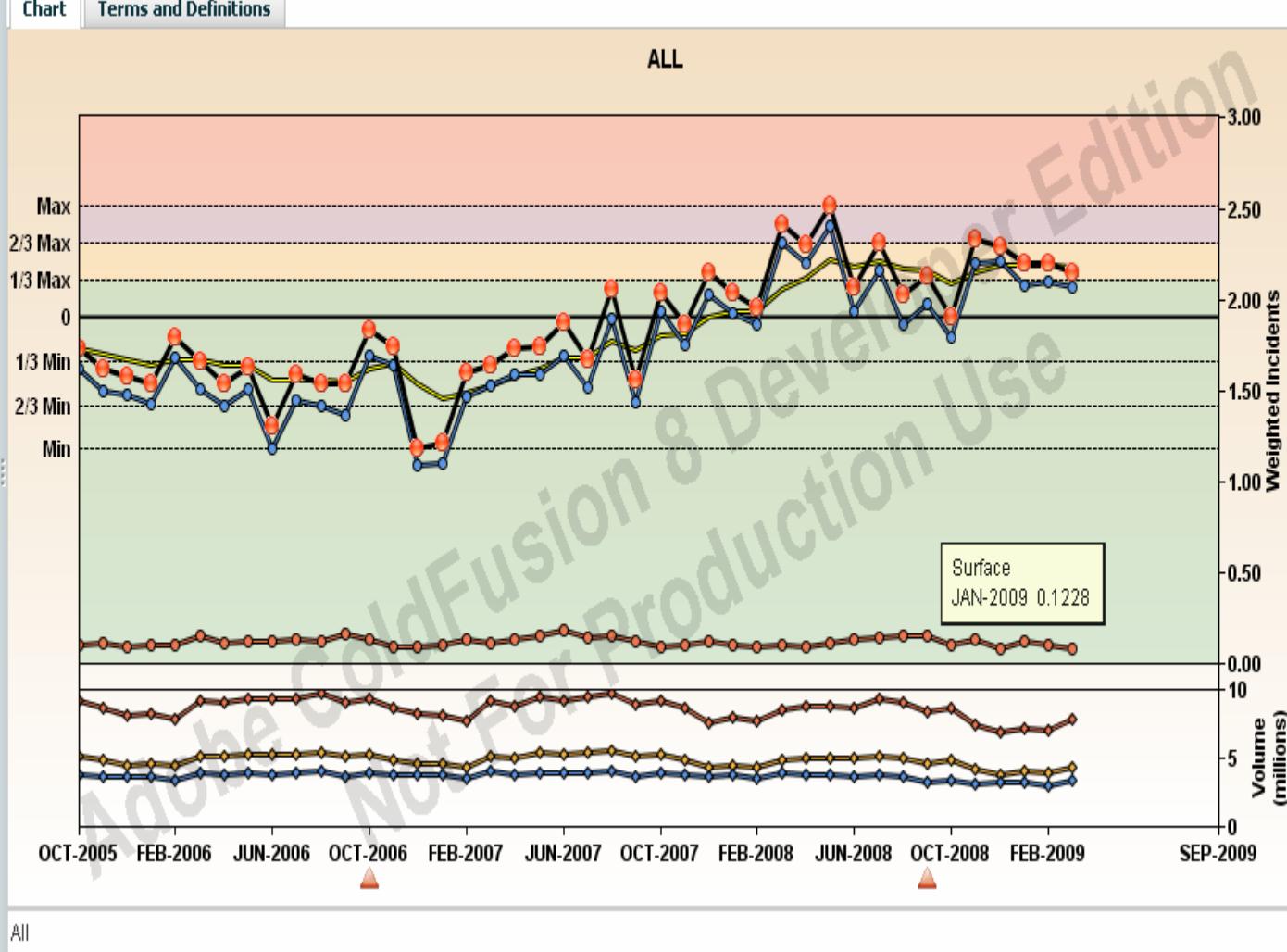
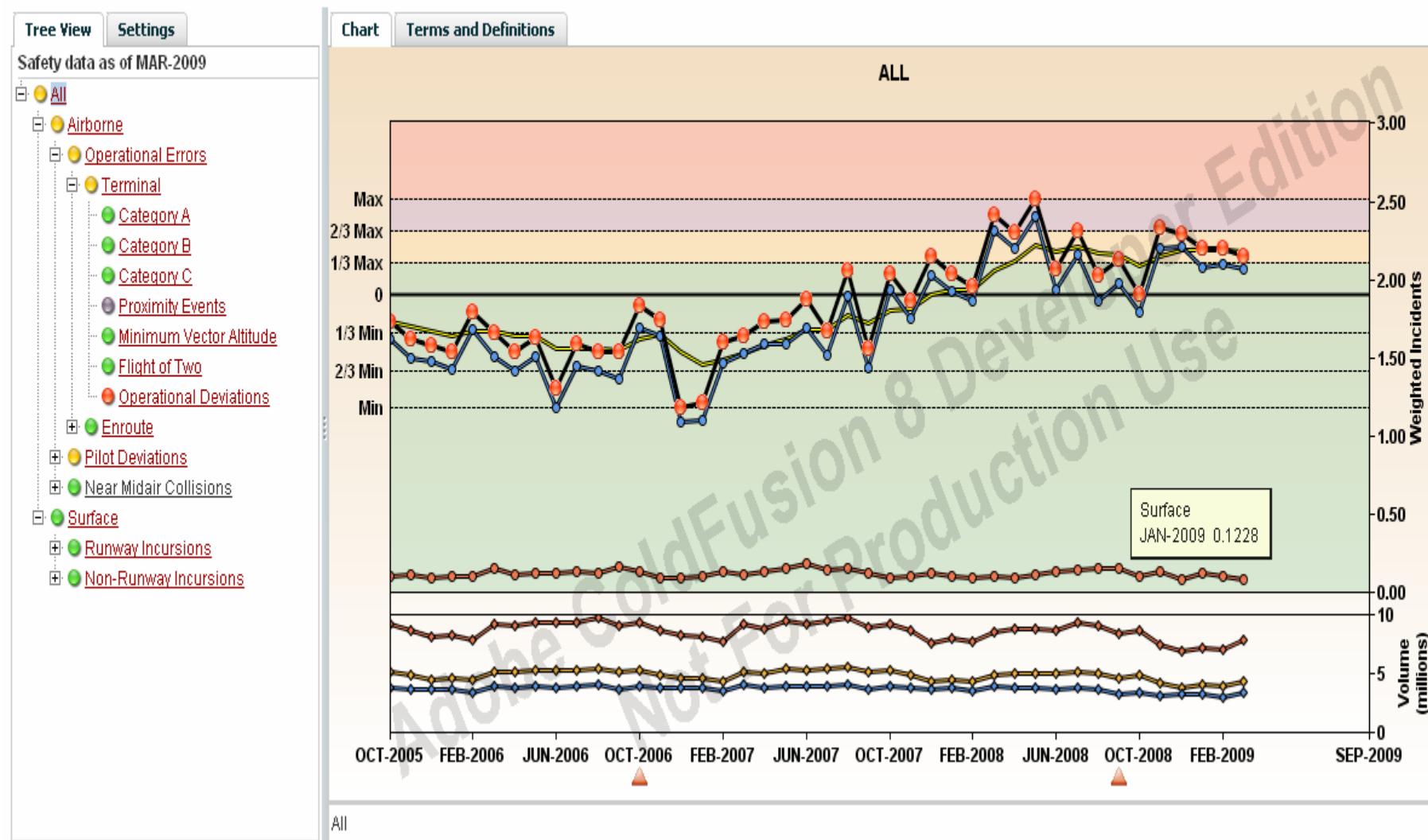
A Look At “Old” vs. “New” Data Displays Here, The “Classic” Data Presentation



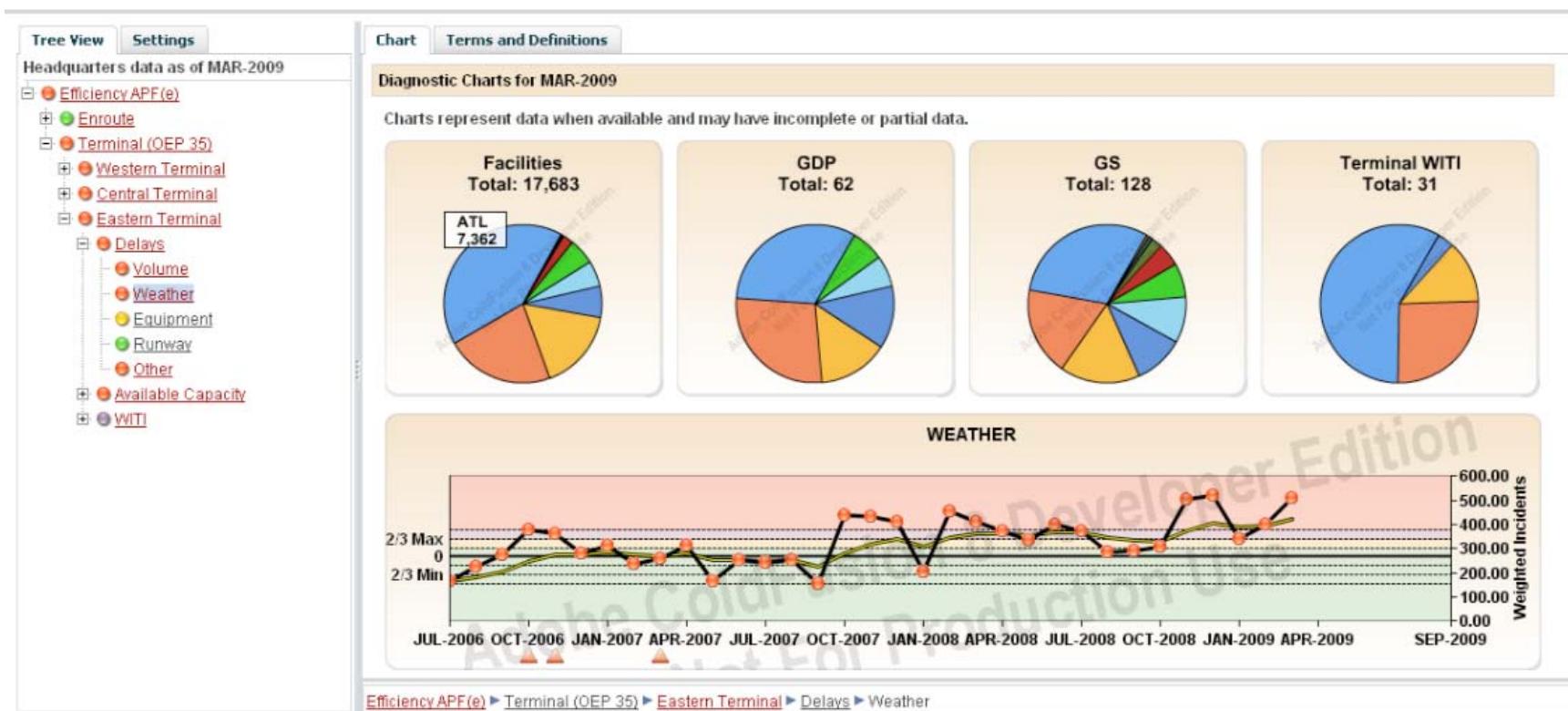
		2000	2004	Difference
Aircraft Accidents				
Air Carrier		56	29	-27
Air Taxi/Commuter		92	73	-19
GA		1835	1614	-221
NMAC		237	145	-92
PDs		1919	2628	709
OE		1139	1216	77
VPD		547	263	-284
Surface Incidents		1396	882	-514
Runway incursions		426	310	-116
Aircraft Operations				
		46,056,000	46,762,000	706,000
Air Carrier		25,080,000	24,278,000	-802,000
Air Taxi/Commuter		8,164,000	10,029,000	1,865,000
GA		8,634,000	8,374,000	-260,000
Military		4,178,000	4,071,000	-107,000
Aircraft Hours		318,000,000	273,000,000	-45,000,000

Can We Really Measure Total Organizational Change?

An Example Of The “New” Data Display Methodology



From Trending to Diagnostics & Drill Down: How the APF Presents Selected Raw Data



The Role of Data: Manage What You Measure



- APF Methodology requires certain data characteristics:
 - Known values;
 - organizations must be comfortable with the data.
 - Known definitions;
 - organization must know what it means.
 - “Decent” amount of data to support trending;
 - 1-2yrs worth only gets us started.
 - 3-yrs is a realistic minimum for initial trending.
 - More always better than less.

US Navy ORMAS Risk Tool: Based on APF Concepts

Flight Schedule

Command: HM-14 | Aircraft Type: MH-53E | Squadron: AWSTS | Assigned Aircraft: [dropdown]

Date: **August 2007** | **Today: 6/17/2008**

Schedule | Mission | **Personnel** | Weather | Execution |

	Position	Crew Assignment	Note			Signoff	1	2	3	4	5
1	HAC	Whetstone, David W., LT, USN (AWSTS)					✓	✓	✓	✓	✓
2	C/P	Pope, Joseph W., LTJG, USN (AWSTS Students)				TAC 155	✓	✗	✗	✗	✗
3	C/P	Gross, Joshua W., LTJG, USN (AWSTS Students)				TAC 155	✗	✓	✗	✗	✗
4	C/P	Snyder, Sean C., LTJG, USN (AWSTS Students)				TAC 154	✗	✓	✓	✓	✗
5						TAC 155	✗	✓	✓	✓	✗
6	C/P	Bahr, James D., LCDR, USN (AWSTS Students)				TAC 155	✗	✓	✓	✓	✓
7	CC	Lopez, Rodolfo, AWC, USN (AWSTS)					✓	✓	✓	✓	✓
8	Crew	Duchaine, Timothy J., AW2, USN (AWSTS)					✓	✓	✓	✓	✓
9	Crew	McCracken, Sharon E., AWAN, USN (AWSTS Students)					✓	✓	✓	✓	✓

Events

Rows: 2 | Columns: 3

A/C #1	A/C #2	A/C #3
1	2	3
4	5	
	6	
A/C #4	A/C #5	
7	8	

New | Delete | Duplicate

Reports

Timeline | Risk Report | Schedule | ODO Report

Risk Score

Crew Experience: 3 (Yellow) Human Factors: 2 (Orange)
 Crew Rest: 3 (Yellow) Mission: 4 (Blue)
 Crew Day: 5 (Green) Weather: 5 (Green)
 Last Flight: 1 (Red) Operating Area: 3 (Yellow)
 Recovery Time: 3 (Yellow) Mission Factors: 3 (Yellow)

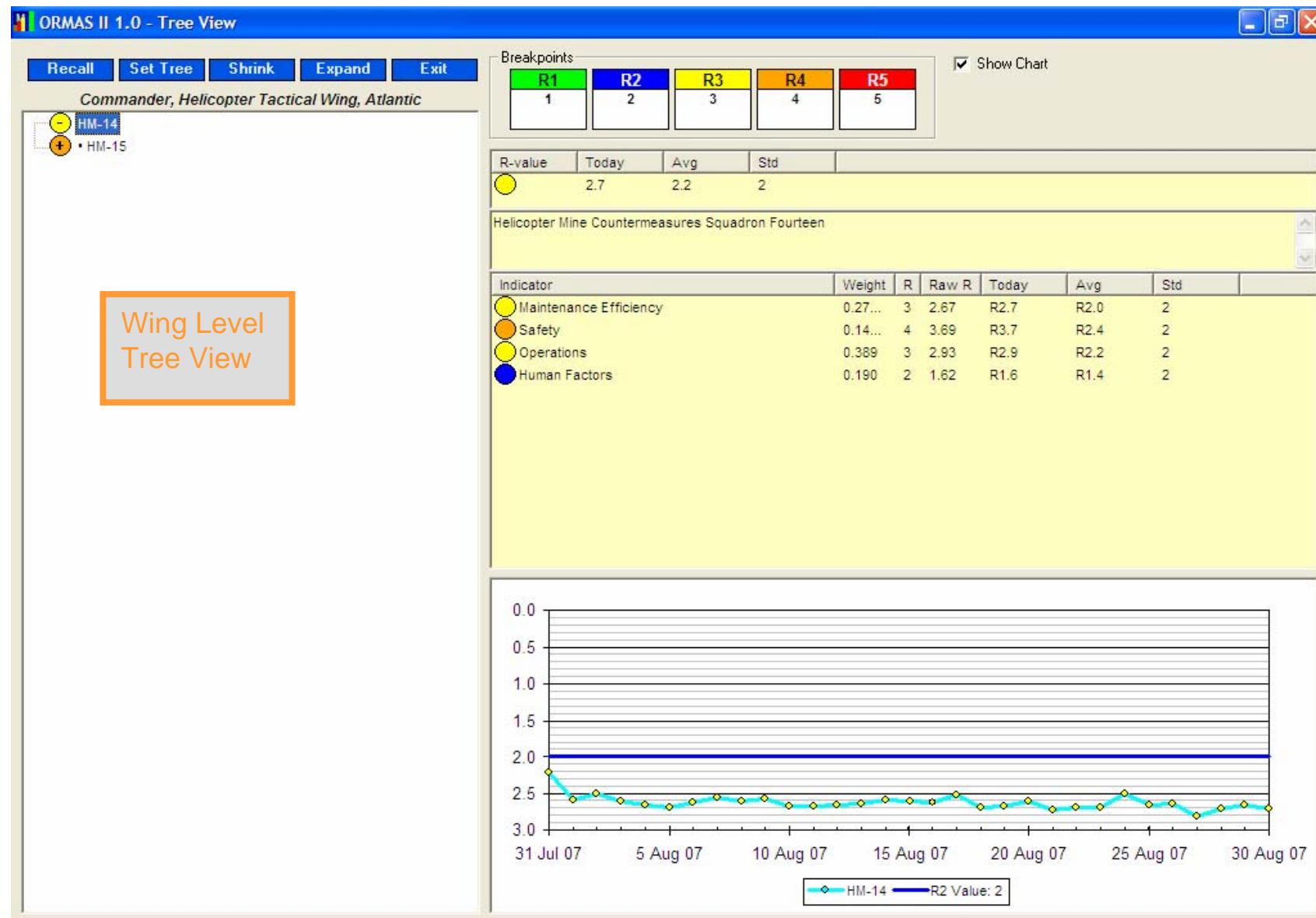
Overall: 1 (Red) **CO approval required**

Personnel Risks

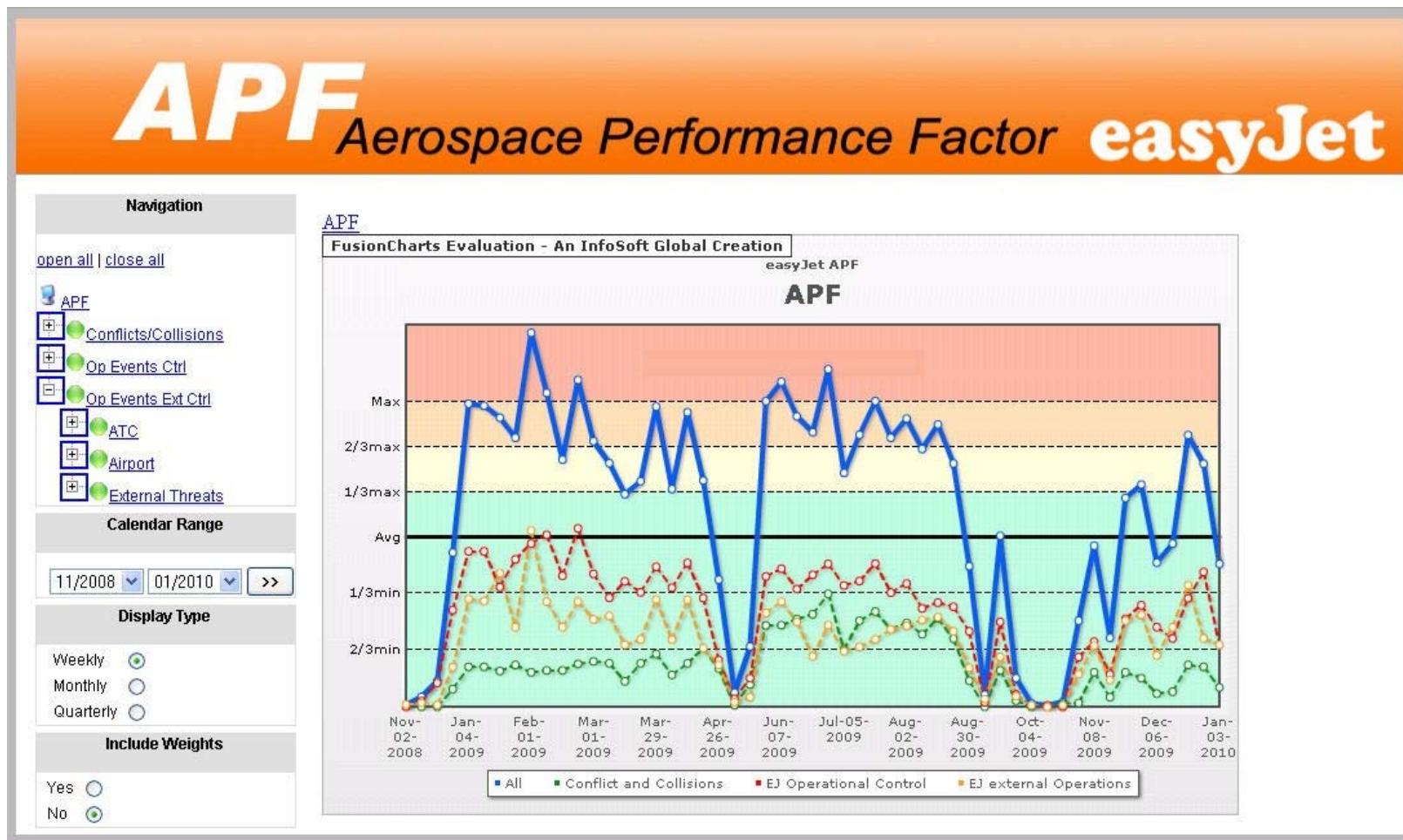
Name	MF	Total Hrs	TMS Hrs	DLQ	FCLP
Whetstone, David W., LT, USN	729.5	330.6	No data	9/09/04	
Pope, Joseph W., LTJG, USN	N/A	No data	N/A	N/A	
Gross, Joshua W., LTJG, USN	N/A	18.6	N/A	N/A	
Snyder, Sean C., LTJG, USN	N/A	No data	N/A	N/A	
Bahr, James D., LCDR, USN	DH	N/A	No data	N/A	N/A
Lopez, Rodolfo, AWC, USN		83.0	N/A	No data	No data

OK | Cancel | Apply | Revert

US Navy ORMAS Risk Tool: Based on APF Concepts



Airline Use of APF Methodology (Trial Data)



Can We Build Something Like That?

Yes! Here's How-



- Determine the goal. What are we measuring?
 - This is the foundation of the APF
- Determine what data we will use.
 - This is the “Clean Sheet of Paper Exercise”
- Construct a mindmap.
 - This is the magic part.
- Develop the weighting factors.
 - This is the science part.
- Put it all together.
 - This is the breakthrough.

Listing Elements: “The Clean Sheet of Paper”

Later: Determining Weighting Values



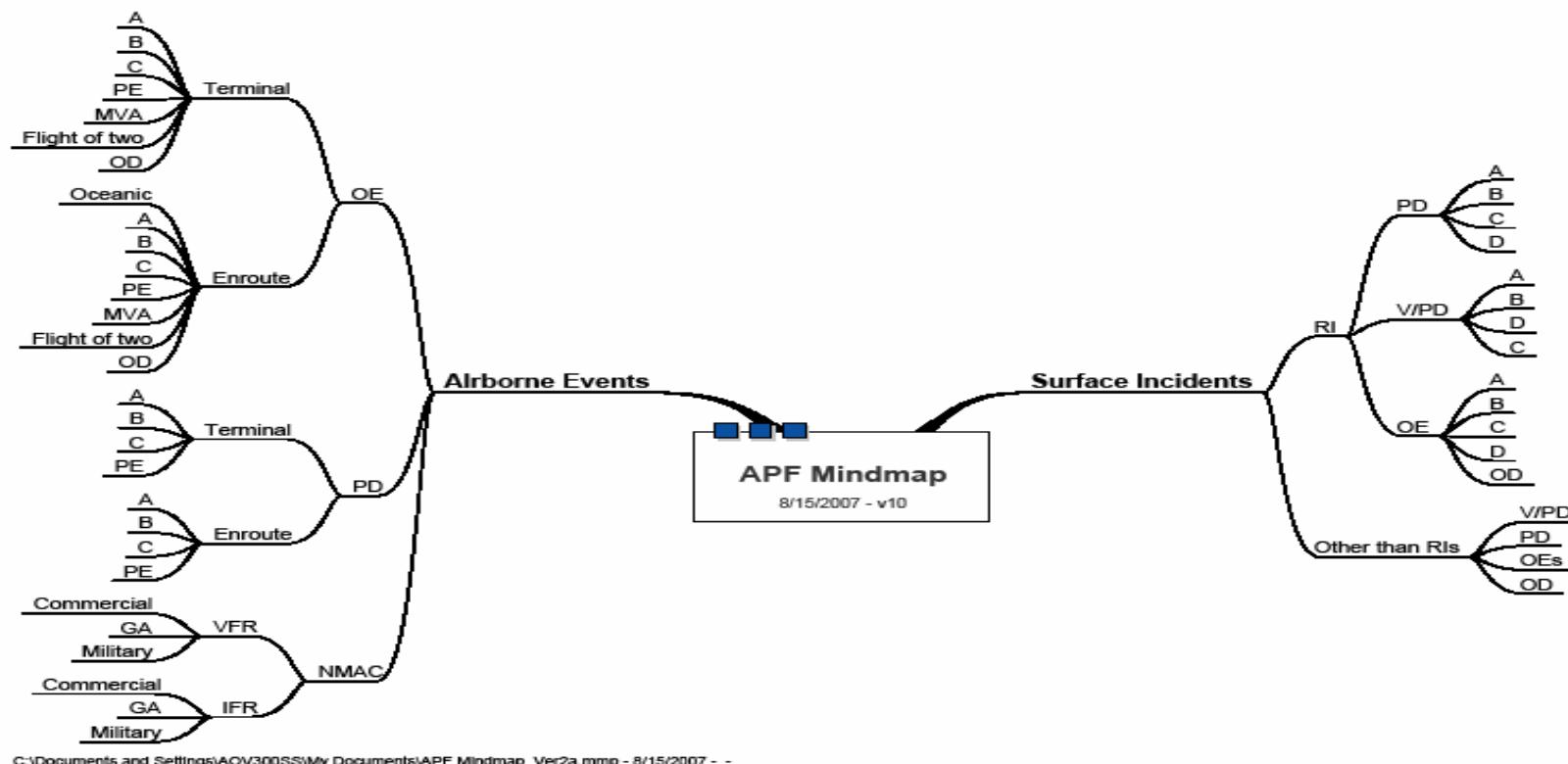
- Airprox
- Groundprox
- Wake Turbulences
- Birdstrike
- Movement
- Wind and Windshear
- Runway/Taxiway Excursion
- Separation Issue
- TCAS
- Crew Illness - Injury
- Unstabilized Approach
- Icing
- Propulsion - Engine
- Under-carriage
- Fuselage
- Vehicle and/or Pedestrian
- Infrastructure
- Take off or Landing Clearance Issues
- Level Bust
- Insufficient Visual reference
- Security
- Non-Movement area
- Lightning
- Flight Plan
- Company and Engineering
- Weather
- Weather/Other
- Procedures
- Communication
- Bird - Damage
- Crew Fatigue - Stress
- ATC Services Standard
- Violation
- Configuration/Automation/Manual Skill
- Runway Conditions
- Military and Other
- APU
- Pushback Clearance
- Limited or No Communication
- Other Animal Strike

Mindmaps: The Magic Part



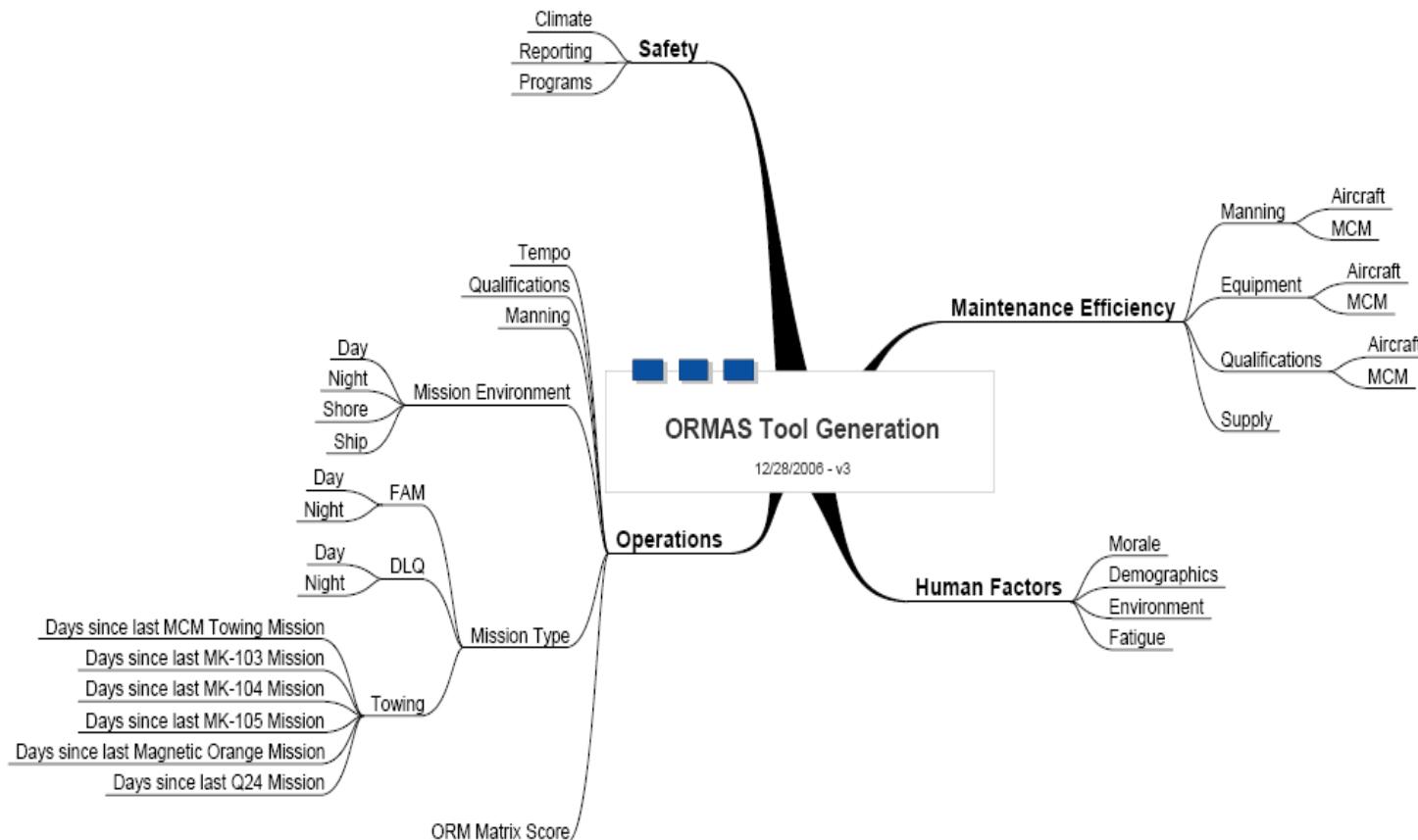
- This is where data is first grouped together.
 - Sort data based on relationships
- Relationships identified.
 - Based on goal of APF
- Underlining design of the APF is determined.
 - Establish format of how we want to see data
- Basic data vetting begins.
 - Is there enough data to trend or not?

First ANSP (FAA) Mindmap; Development Of A Simple Version



C:\Documents and Settings\AOV300SS\My Documents\APF Mindmap_Ver2a.mmp - 8/15/2007 - -

First US Navy Mindmap: More Complex

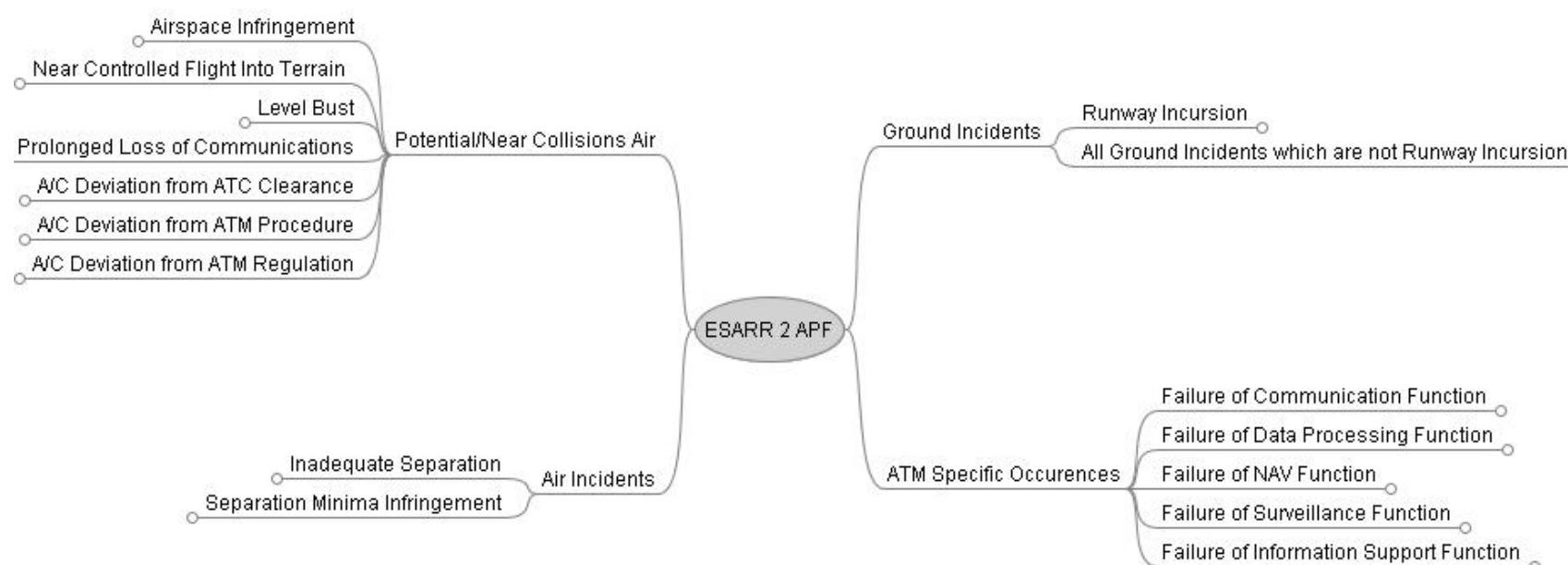


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Current EUROCONTROL Mindmap

Best Design To Date

Note The Symmetrical Shape:



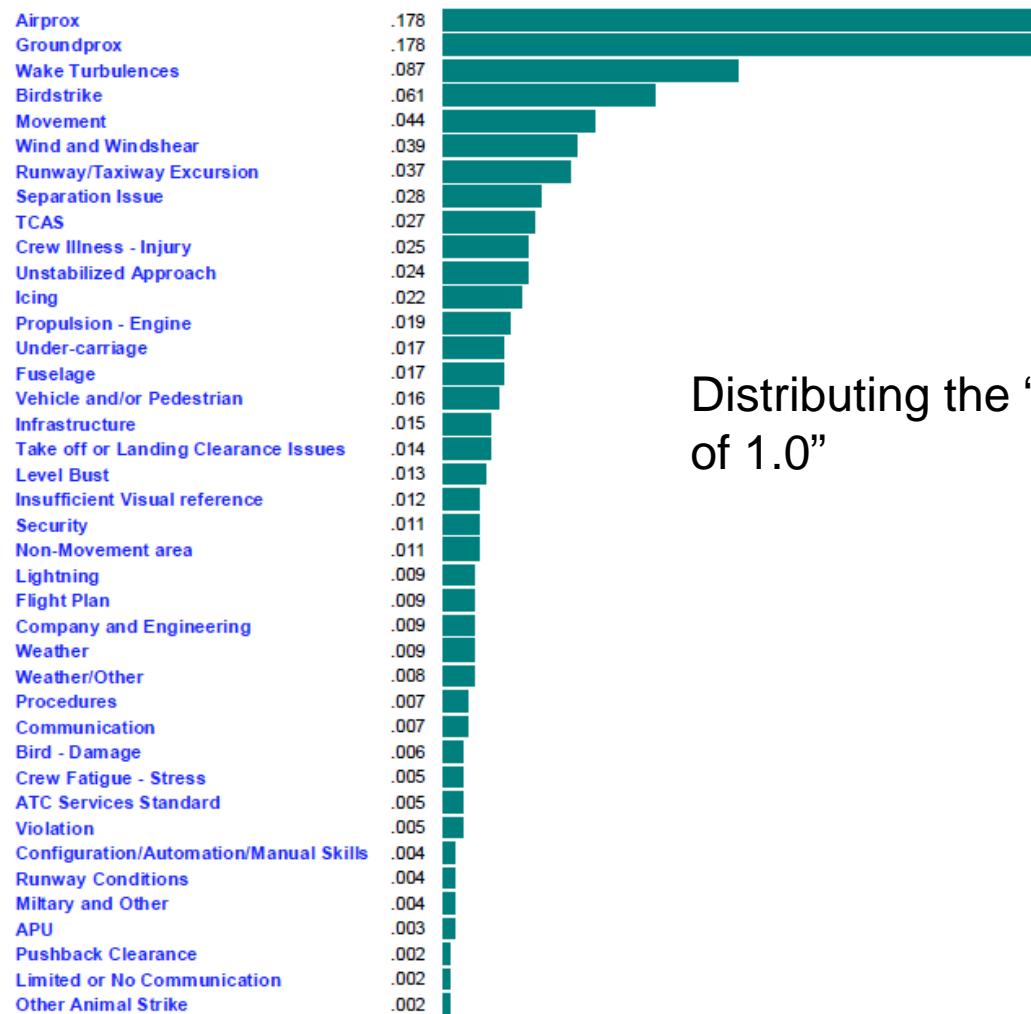
Develop Weighting Factors With Experts

This Is The Science Part



- Weighting of Factors:
 - Allows the organization to incorporate quantitative value of expertise and judgment.
 - Develops numerical value (that will be used as a coefficient) of “Importance” or “risk” or “influence” associated with a data element as judged by the organizations experts.
 - Distributes the “Value of 1.0” throughout the mindmap creating priorities (or weights). See next slide as example!

Subject Matter Experts Determine the Weighting Values



Distributing the “Value
of 1.0”

Weighting the Data Elements

The Analytic Hierarchy Process (AHP)



- AHP- Originally designed as a decision making process using input from many people.
- Developed by Dr. Thomas Saaty to use multiple factors involved in complex decisions.
- A “blend” of mathematics and the psychology of measuring intangibles.
- Uses a hierarchy (same as a mindmap) and pair-wise comparisons.
- For additional reading (easy versions) go to http://en.wikipedia.org/wiki/Analytic_Hierarchy_Process

The Analytic Hierarchy Process (AHP)



- APF uses a “simplified” version of AHP techniques to gather expert opinions for weighting.
- It is not used as a “multi criterion decision tool” but does use the pair-wise comparison process to determine weights within the hierarchy shown in a mindmap.
- Since no decisions are made, there is no assessment of “alternatives.”
- Examples to follow:

Example 1: Classic AHP



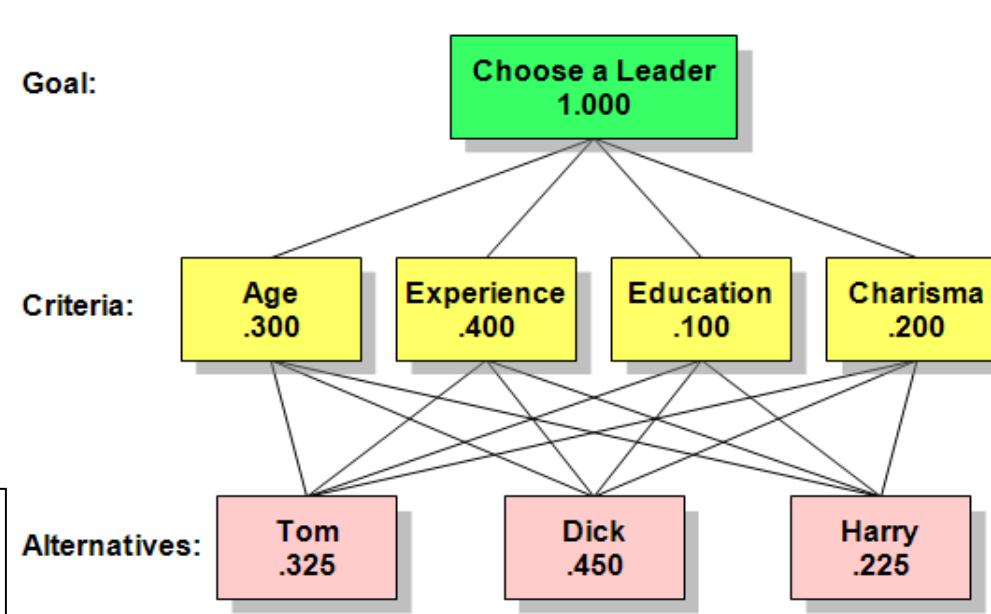
AHP: Selecting a Leader



Tom

Dick

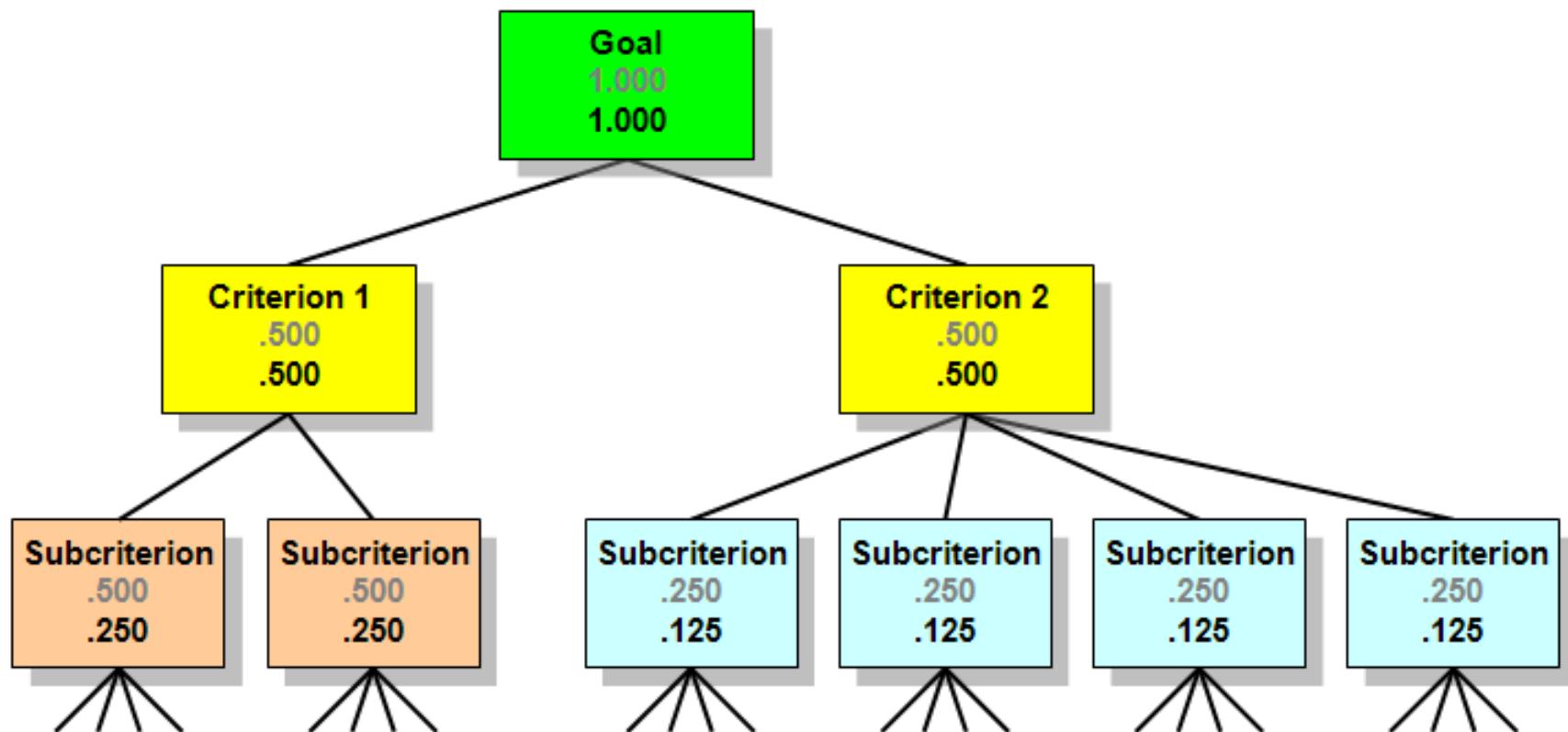
Harry



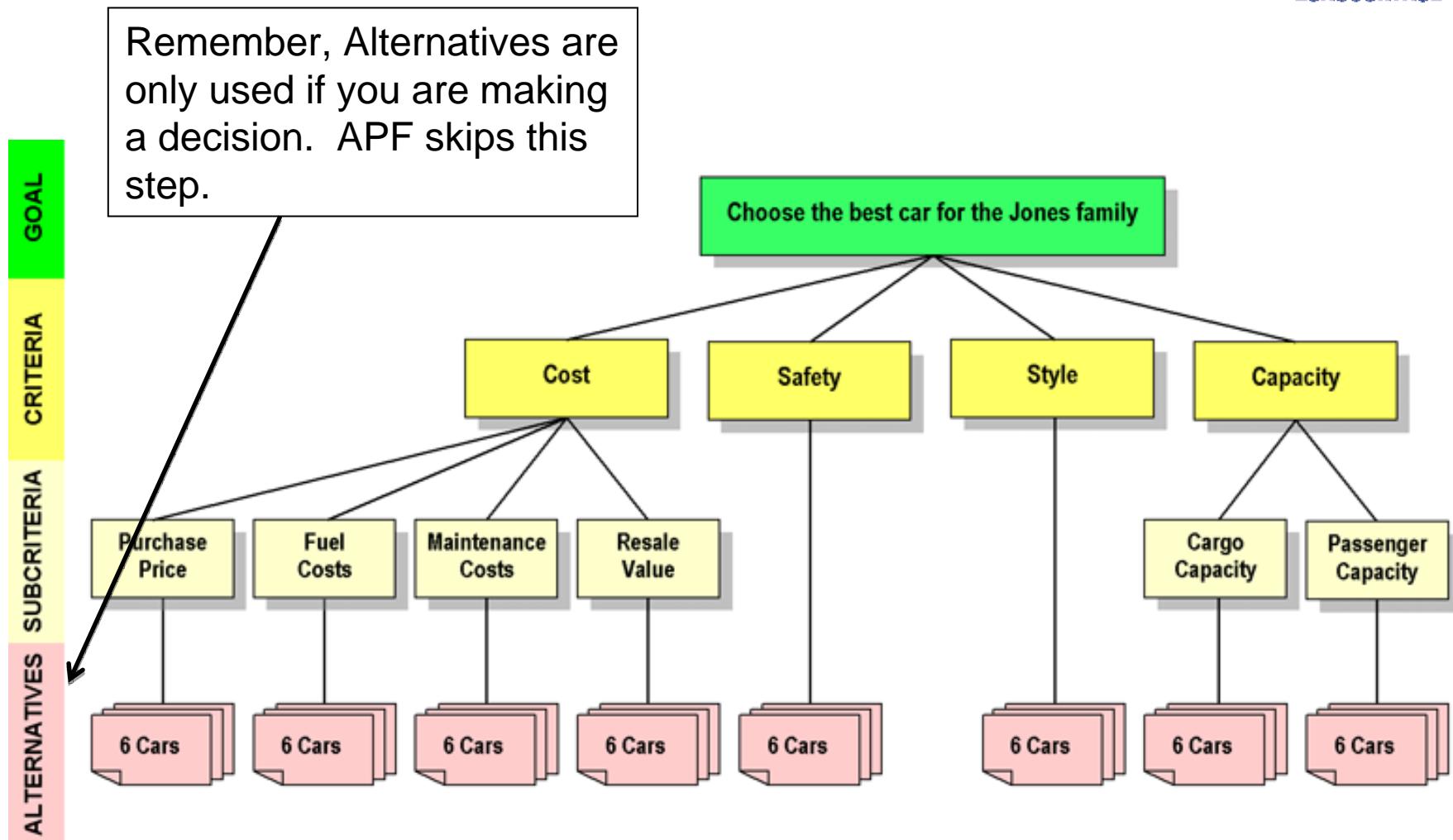
Example 2: More Complex Mindmap



Local Weights & Global Weights



The Classic Car Example



Subjective Terms vs. Numbers



The Fundamental Scale for Pairwise Comparisons		
Intensity of Importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values. Intensities 1.1, 1.2, 1.3, etc. can be used for elements that are very close in importance.		

Consistency vs. “Inconsistency”



- Consistency simply means your answers are following the same relative pattern:

Consistency = If $A > B$ and $B > C$, then $A > C$

Inconsistency = If $A > B$ and $B > C$, you answer $C > A$

- Inconsistency can happen for a number of reasons: (1) Getting “lost” in the mindmap; (2) “clicking” in the wrong direction, (3) unclear definition.

The Mechanics of How Experts (You) Use Pairwise Comparison



Evaluate Project — APF(ARTCC) [svs6km8h] - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Favorites Go

Address: https://core.expertchoice.com/Project/Evaluate/Default.aspx

comparion SUITE English

Navigation

Task: Consider "System Efficiency".

■ Which of the two objectives displayed, "Facility Resources" and "Facility Equipment", is more important with respect to "System Efficiency"?

System Efficiency

Facility Resources Facility Equipment

Extremely Very strongly Strongly Moderately Equal Moderately Strongly Extremely

Erase Judgment

Navigation Box

Steps: 1 2 3 4 5 6 7 8 9 ... 93 Evaluated: 77/77

Auto advance

Next Unassessed

Previous Next

Logged in as: Tom Lintner (Account Manager, FAA Workgroup)
Current project: APF(ARTCC) [svs6km8h]

Core version: 2009.3.0.523.2429
Powered by Comparion Suite © 2007-09 Expert Choice, Inc.

Done Internet

start Thomas Lintner - Inb... Evaluate Project — A... EC 1.bmp - Paint

Obtaining Feedback As You Go



Evaluate Project – APF(ARTCC) [svs6km8h] - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Stop Home Search Favorites Print Copy Paste Find Help

Address https://core.experchoice.com/Project/Evaluate/Default.aspx Go

comparion SUITE English Navigation

Task: Review your results

You have completed prioritizing your objectives with respect to "System Efficiency". Review your results below to ensure they make sense to you. If not, you may navigate back to the previous judgments to edit them.

Priority of Objectives for 'System Efficiency'

Name	Participant results	Graph Bar
Facility Resources	59.36%	
Facility Equipment	24.93%	
Facility Constraints	15.71%	

Inconsistency ratio: 0.05

Navigation Box

Steps: ... **7** ... Evaluated: 77/77

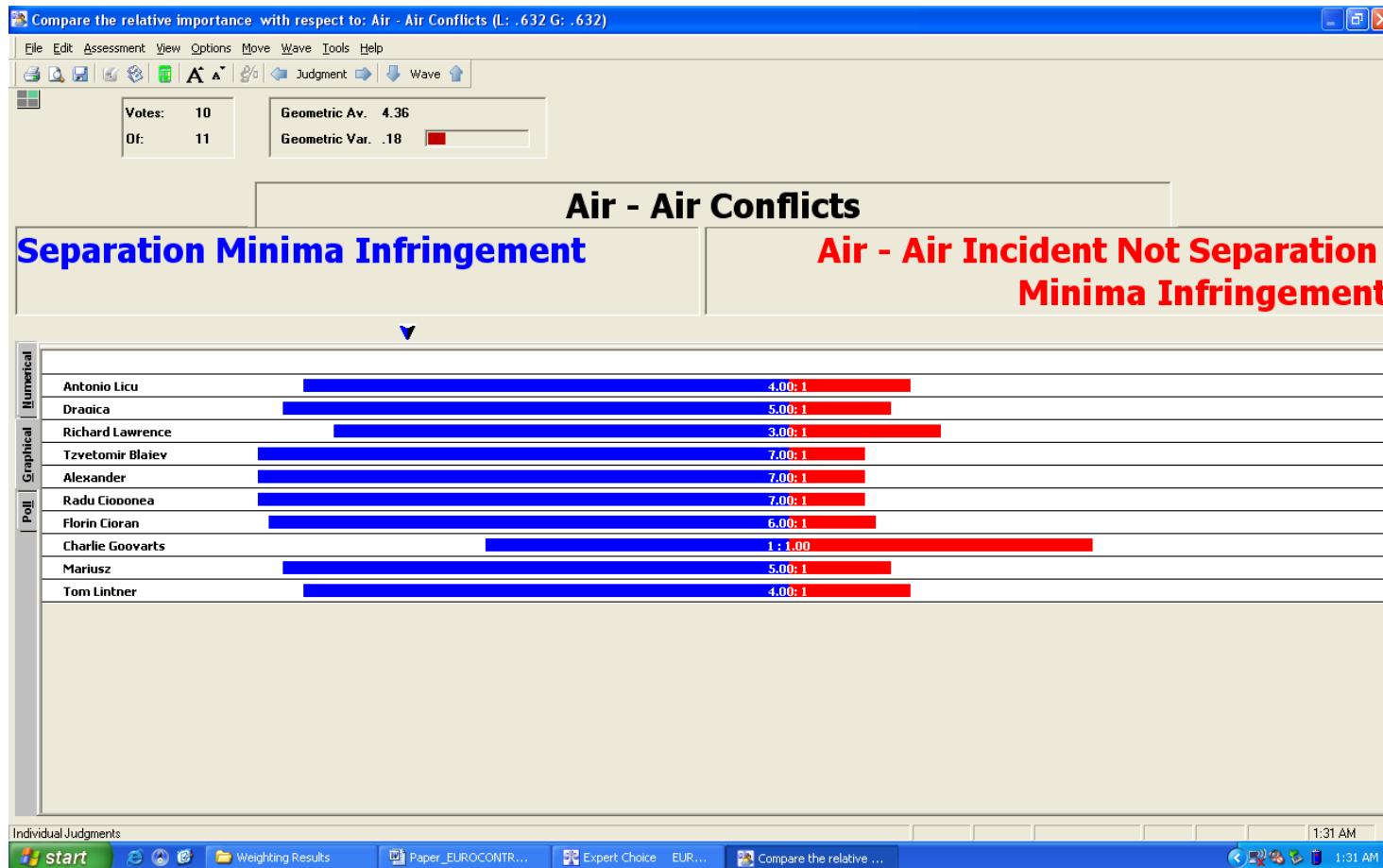
Next Unassessed Previous Next

Logged in as: Tom Lintner (Account Manager, FAA Workgroup)
Current project: APF(ARTCC) [svs6km8h]

Core version: 2009.3.0.523.2429
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Done Start Thomas Lintner - Inb... Evaluate Project — A... untitled - Paint Internet 10:24 AM

Group Results- A Combination of Expertise



Observations Before the Practice Exercise

Recall that....



- The APF is not a stand alone tool and current measurements must be maintained.
- The APF identifies “what” is happening, “where”, and “when” thru both trending and diagnostics:
 - **This allows for focus of resources to identify problem area.**
 - **As additional metrics, with greater granularity, are introduced into the APF, it will enable the quest for “why.”**
- The APF *is not* a direct indication of risk.
 - **But does reflect the organizations assessment of relative risk within the operation.**

Starting the Practice Weighting Exercise



- Determine the goal question.
 - The group develops and agrees on question.
- Review the mindmap (keep a copy close by).
 - You will get “lost” in the pair-wise combinations.
- Go with your instinct!!! Shoot from the hip!!!
 - Don’t think and debate with yourself! Depend on your experience!
- Understand “Inconsistency”
 - We’ll discuss..it’s important but don’t drive yourself crazy
- Enjoy the post-exercise discussion!
- Agree on results!

Overview Of AHP Process



- Important Aspects For A Car (Goal)
- Body Type (Element)
 - 2-Door (sub criteria)
 - 4-Door (sub criteria)
- Engine Type
 - Gasoline
 - Diesel
- Transmission Type
 - Manual Transmission
 - Automatic Transmission
- Manufacturer Type
 - European Manufacture
 - Asian Manufacture