# 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.

How do we define "Performance"?

- 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 is size and scope.
  - Keep an organization "on track"
  - Will always "Follow the data"

# 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

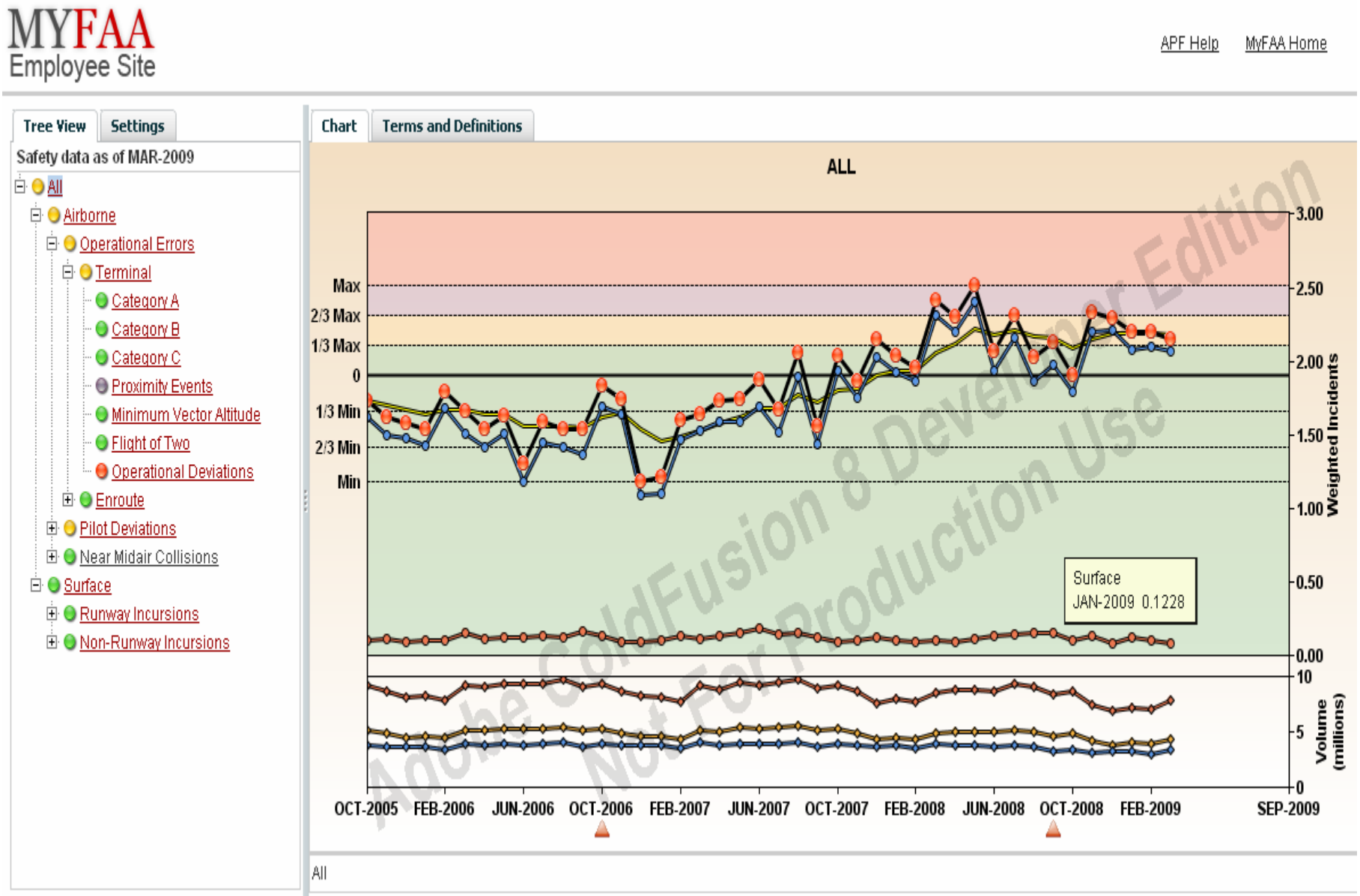
- All organizations maintain data elements to gauge themselves.
  - Databases are lagging indicators but can infer future trends.
  - Data elements, used individually, are poor representatives of overall performance.
  - Presenting multiple data graphs to Leadership creates, “Death By PowerPoint” and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

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

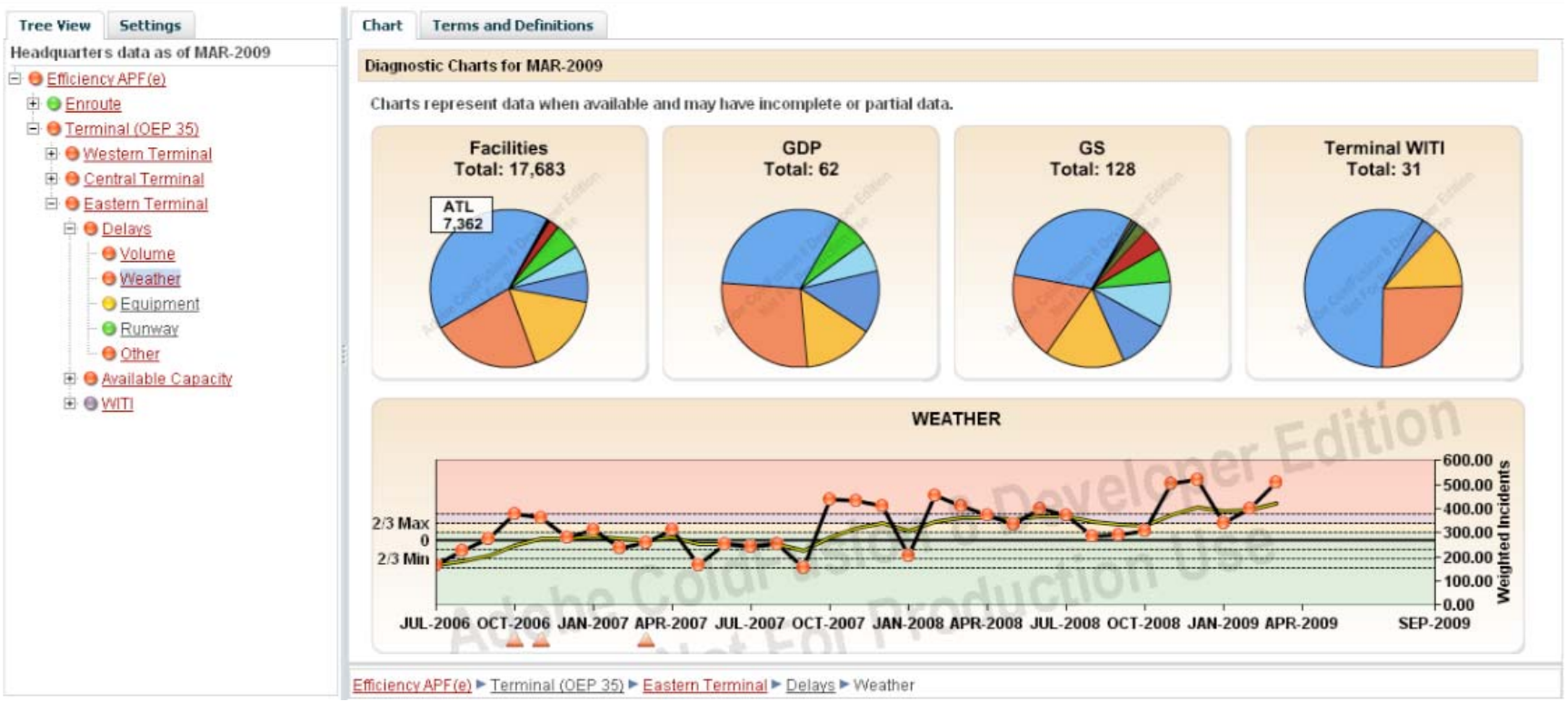
| | | 2000 | 2004 | Difference |
|---|---|---|---|---|
| **Aircraft Accidents** | | | | |
| | **Air Carrier** | 56 | 29 | -27 |
| | **Air Taxi/Commuter** | 92 | 73 | -19 |
| | **GA** | 1835 | 1614 | -221 |
| **NMAC** | | 237 | 145 | -92 |
| **PDs** | | 1919 | 2628 | 709 |
| **OE** | | 1139 | 1216 | 77 |
| **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



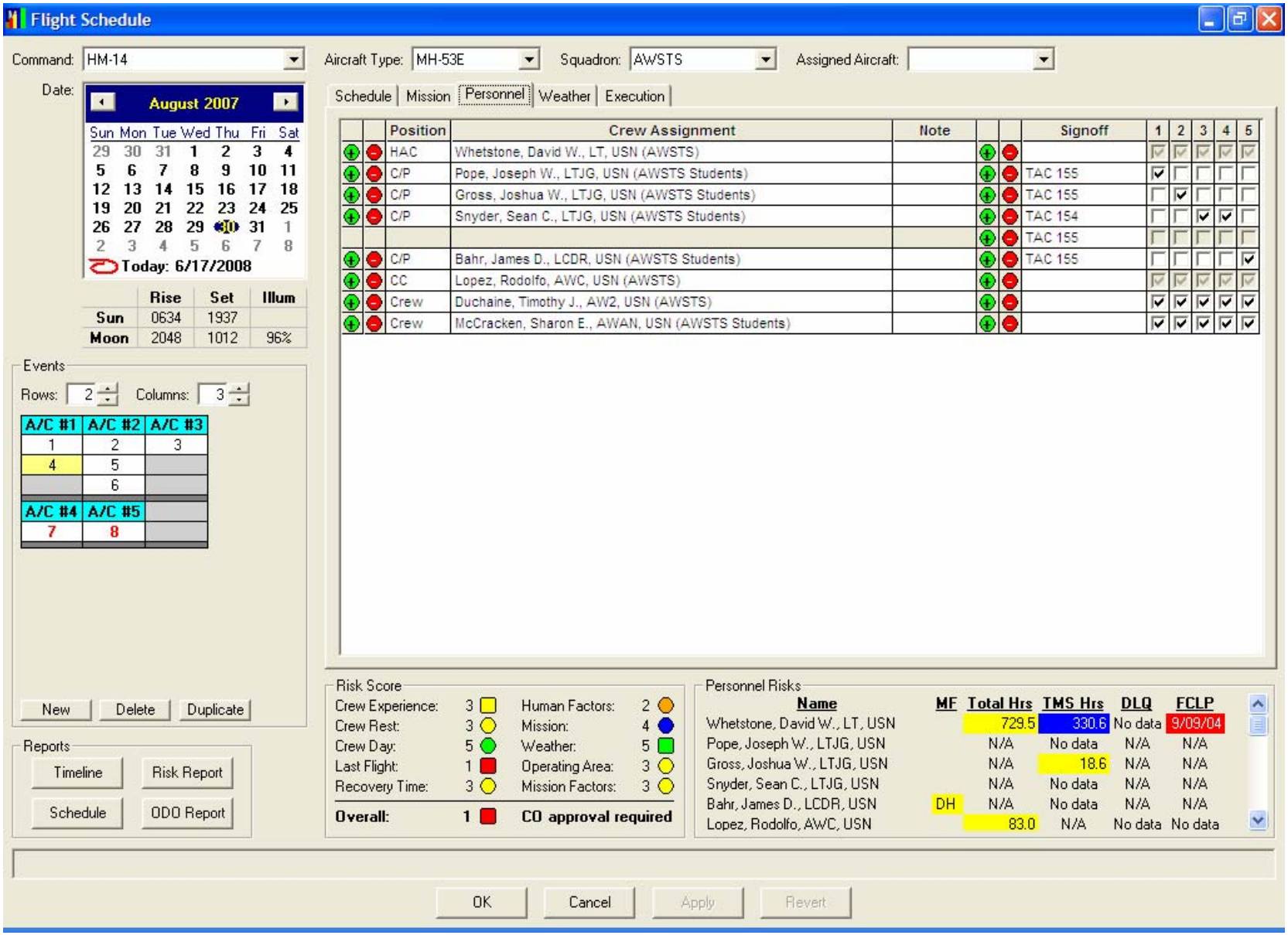
# From Trending to Diagnostics & Drill Down: How the APF Presents Selected Raw Data



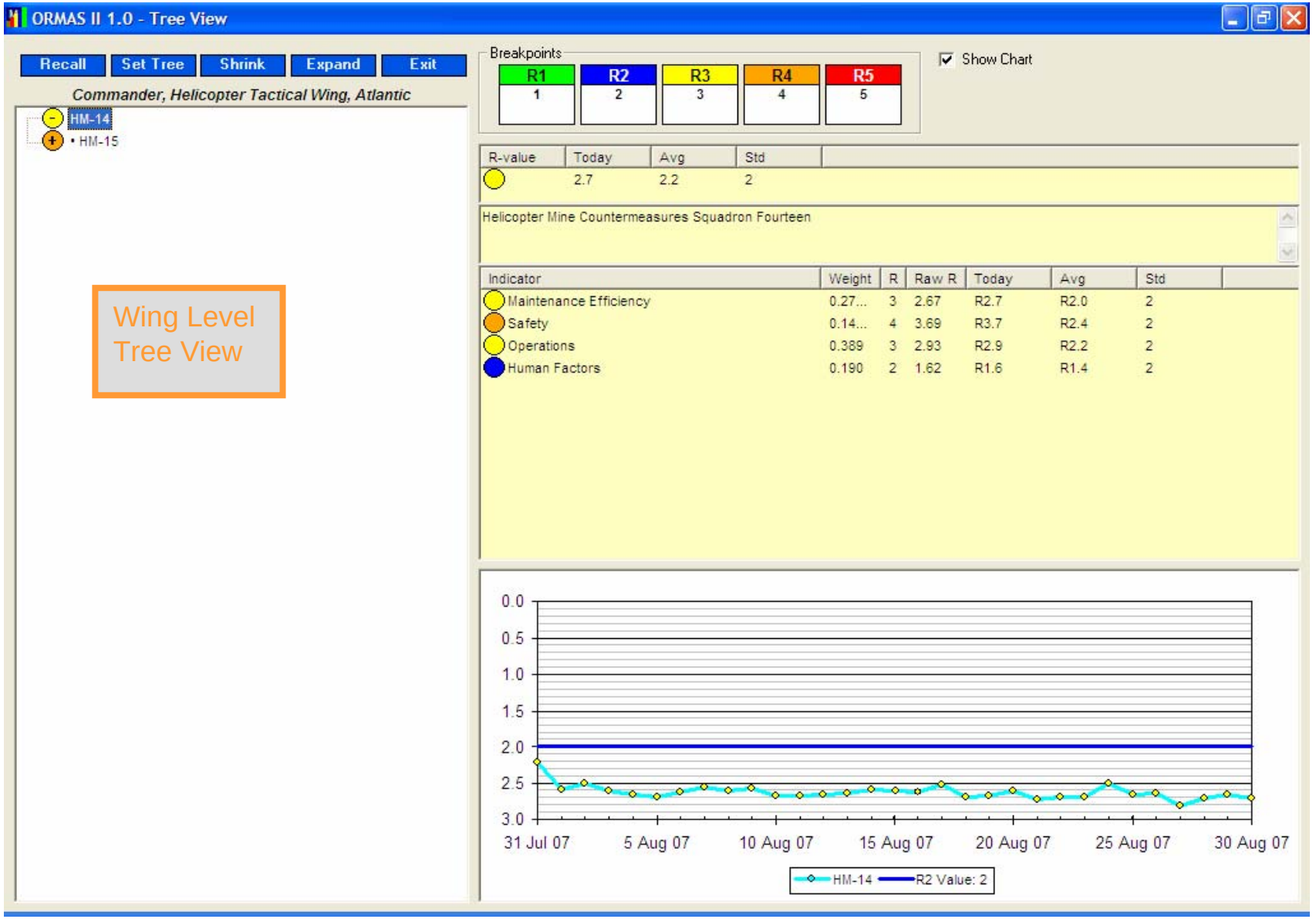
# The Role of Data:
# Manage What You Measure

- 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.

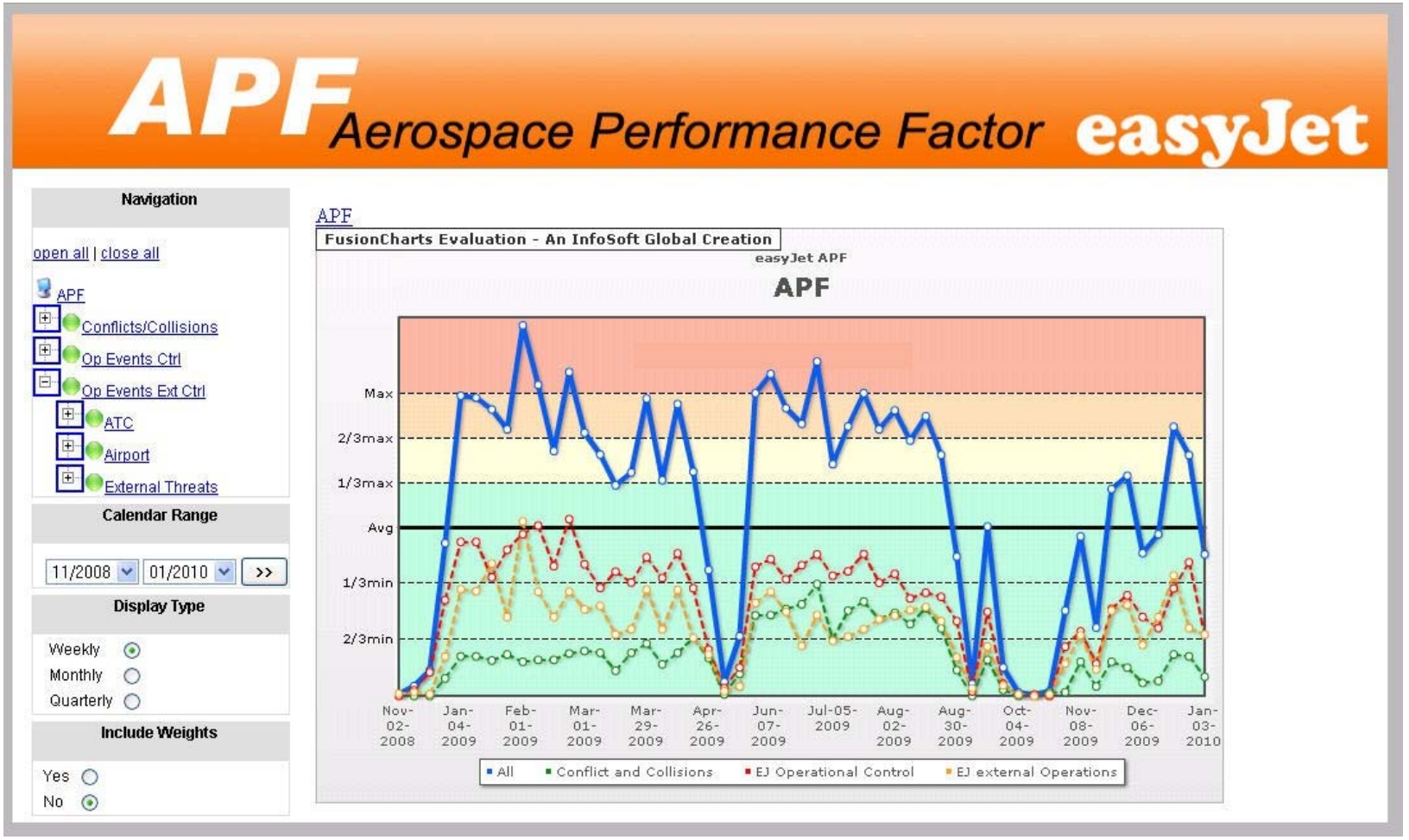
# US Navy ORMAS Risk Tool: Based on APF Concepts



# 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.

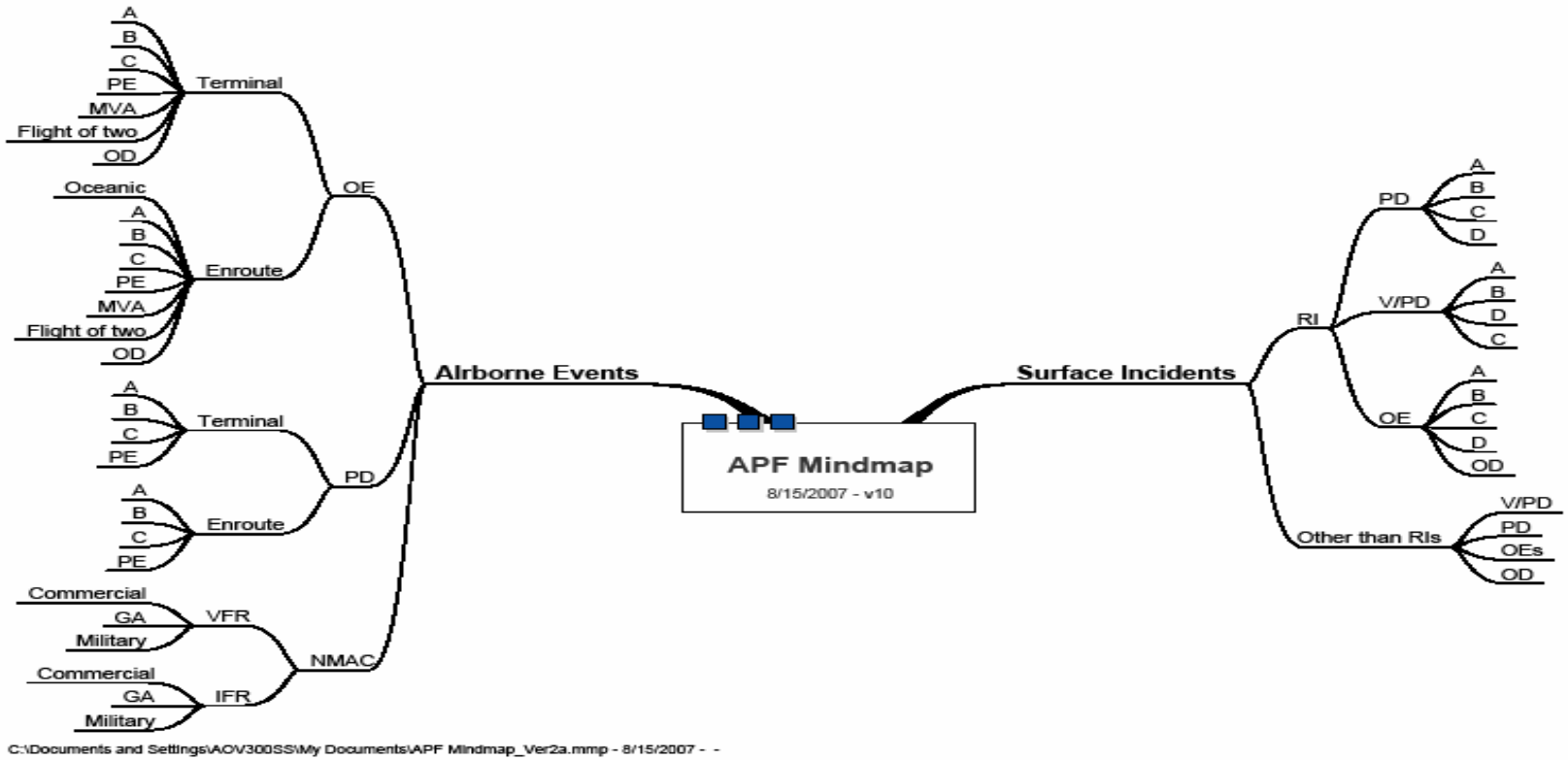
# Listing Elements: “The Clean Sheet of Paper”
# Later: Determining Weighting Values

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 Ski
Runway Conditions
Miltary and Other
APU
Pushback Clearance
Limited or No Communication
Other Animal Strike

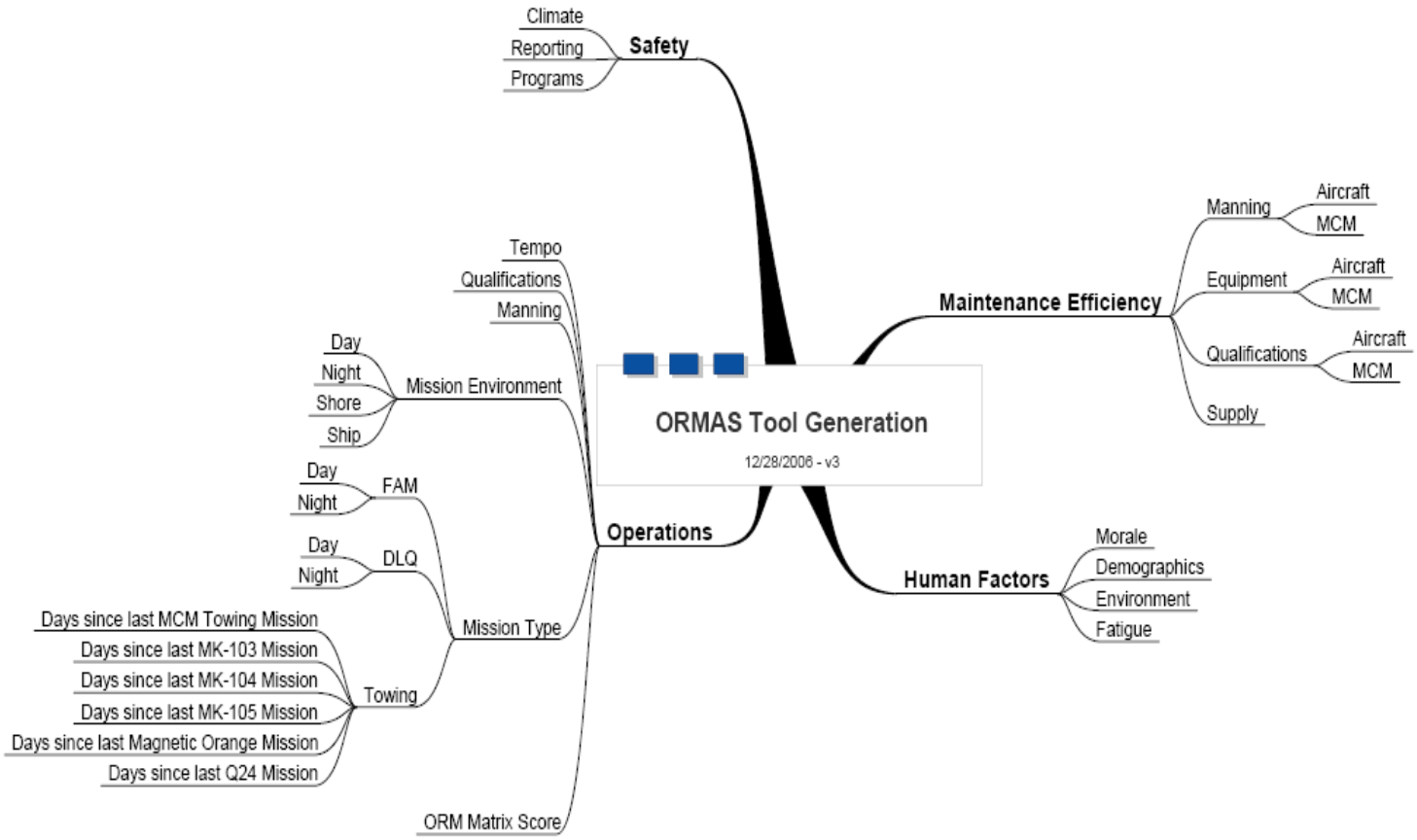
# Mindmaps: The Magic Part

- 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?

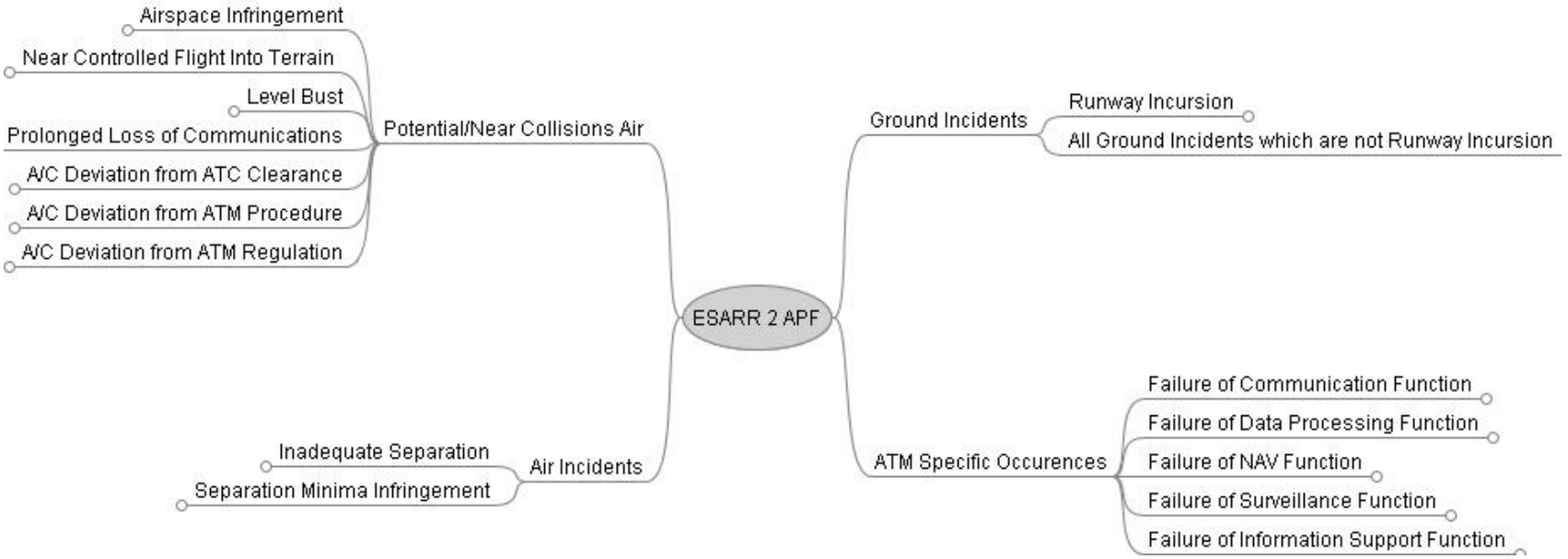
# First ANSP (FAA) Mindmap; Development Of A Simple Version



# First US Navy Mindmap: More Complex



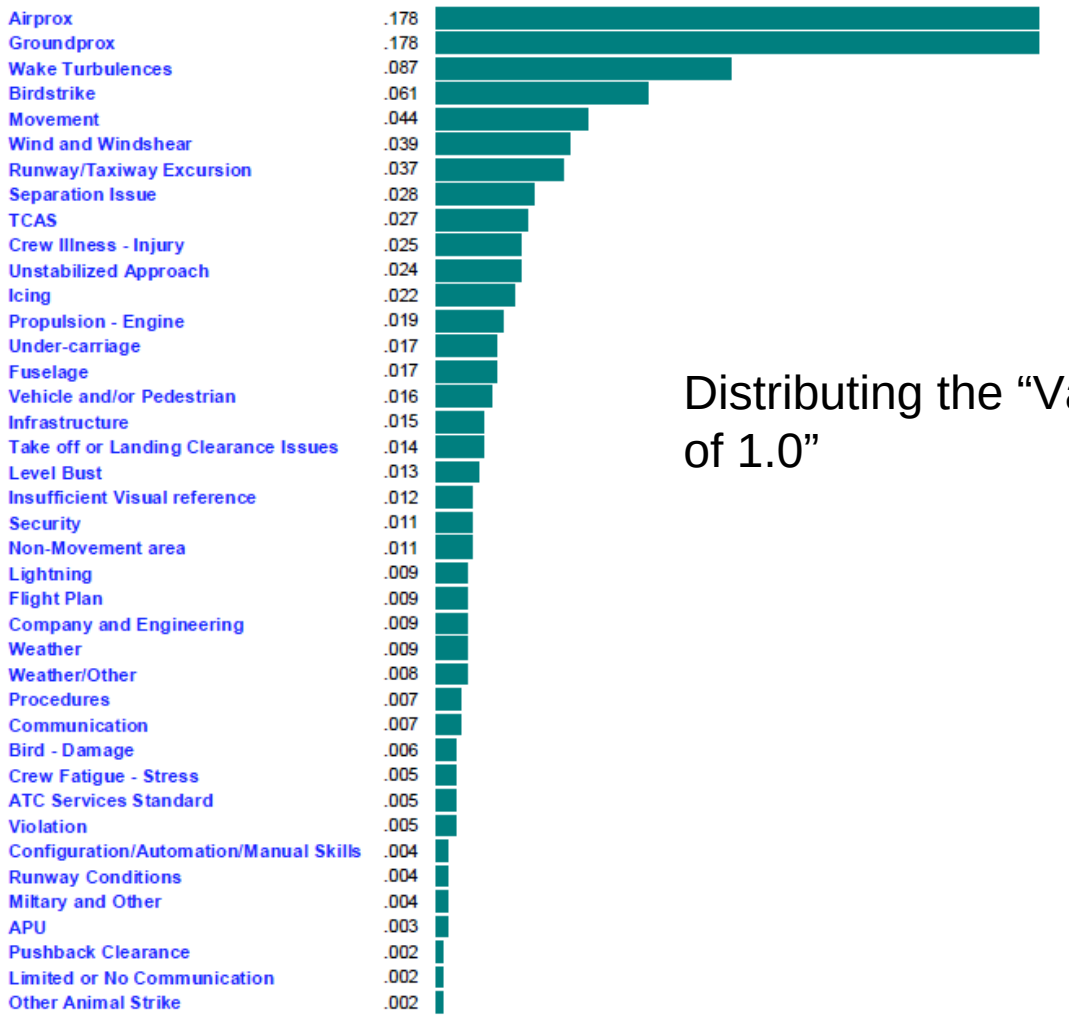
# Current EUROCONTROL Mindmap
# Best Design To Date
# Note The  Symmetrical Shape:



# 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)

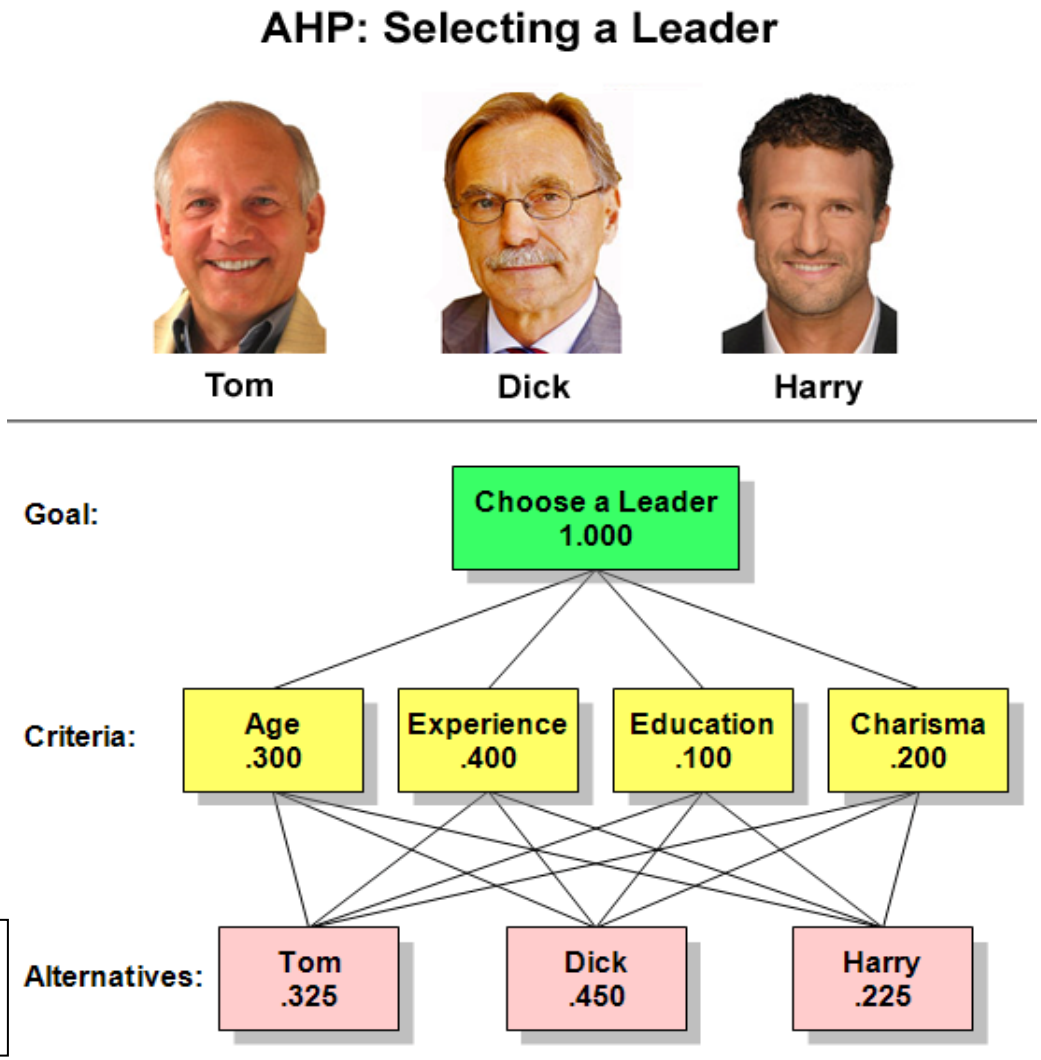
- AHP- Originally designed as a decision making process using input from many people.
- Developed by Dr. Thomas Saaty to use multiple factors involved in complex decisions.
- A “blend” of mathematics and the psychology of measuring intangibles.
- Uses a hierarchy (same as a mindmap) and pair-wise comparisons.
- 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:

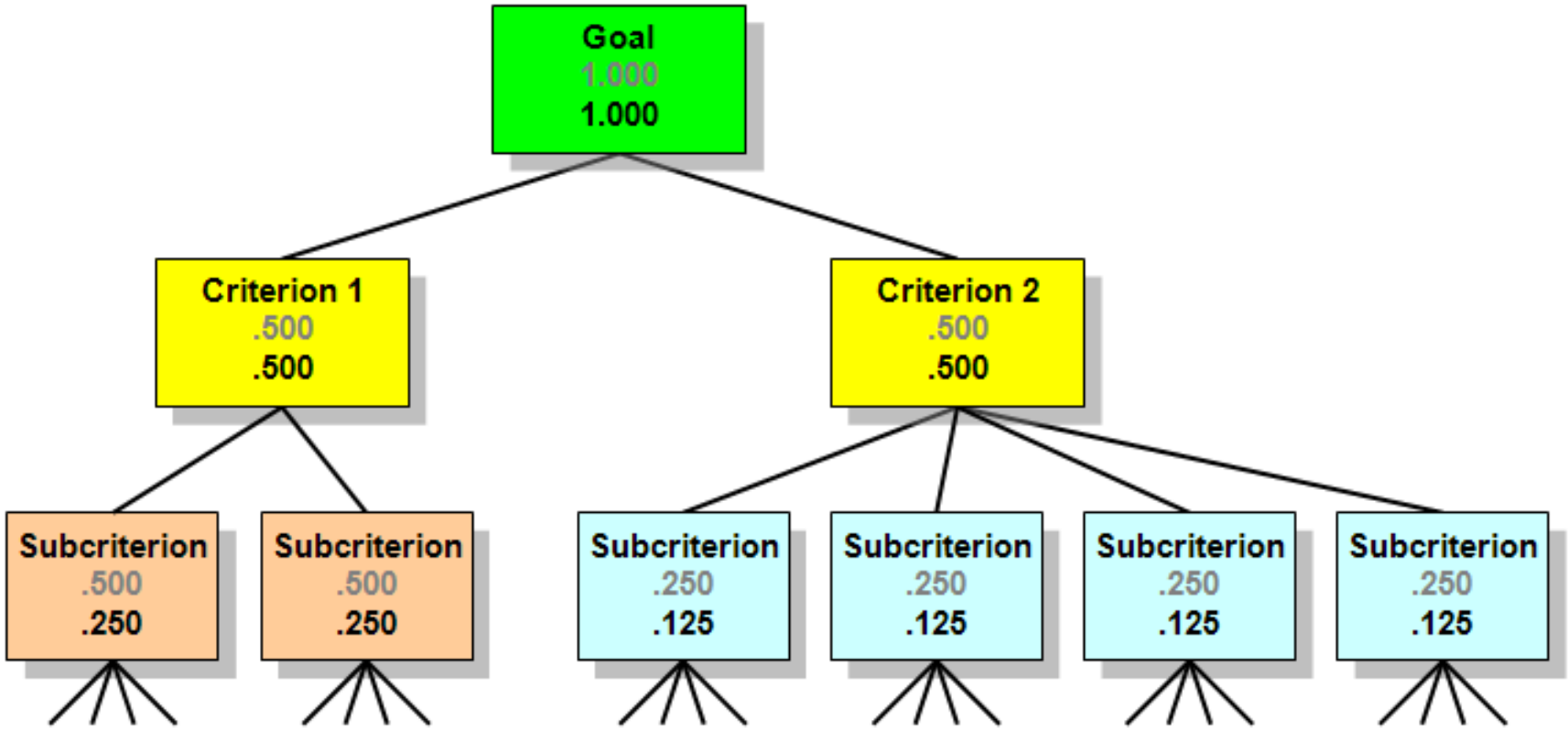
# Example 1: Classic AHP




Alternatives not used by APF!

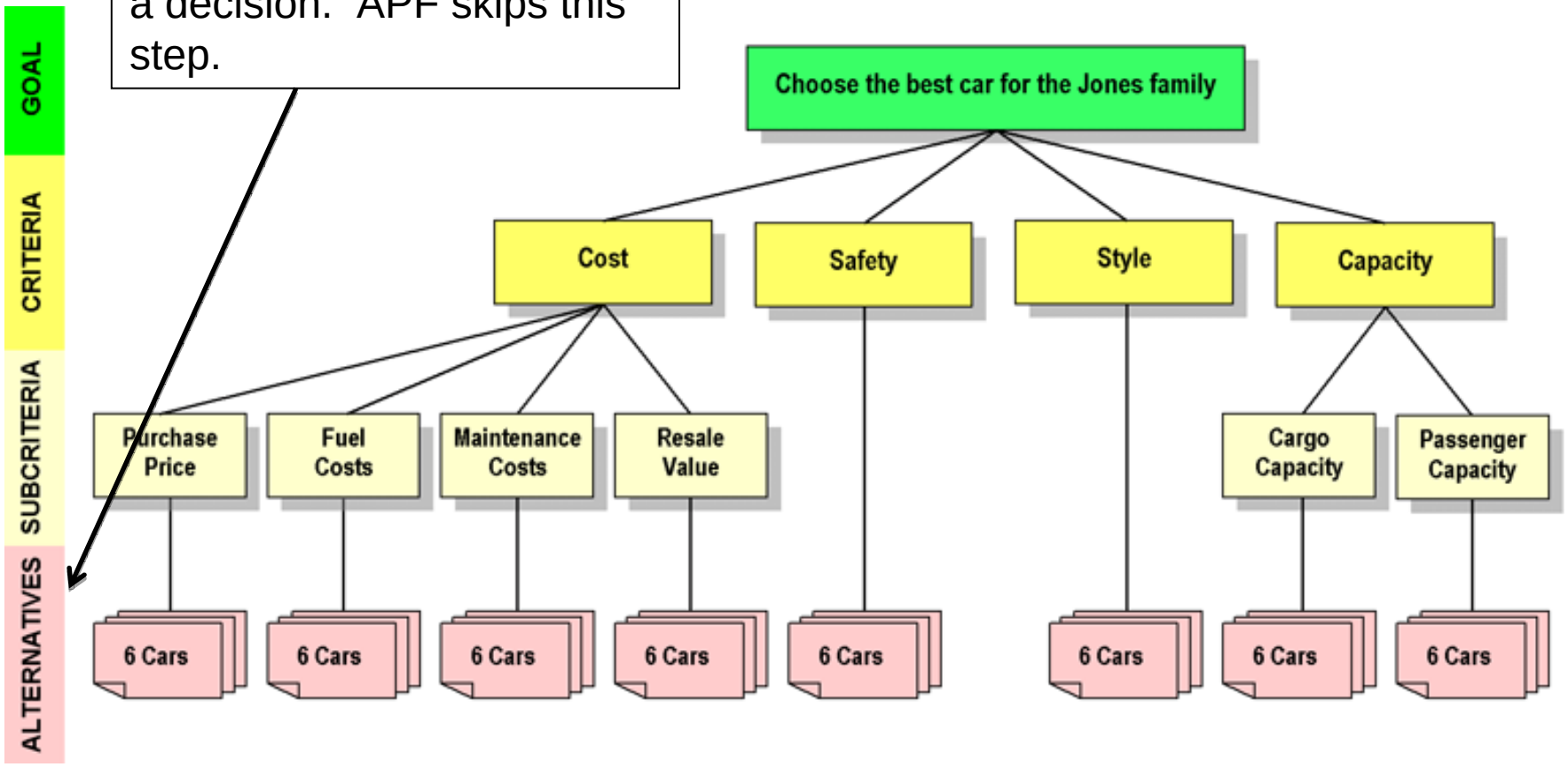
# Example 2: More Complex Mindmap

Local Weights & Global Weights



# The Classic Car Example

Remember, Alternatives are only used if you are making a decision. APF skips this step.



# 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”

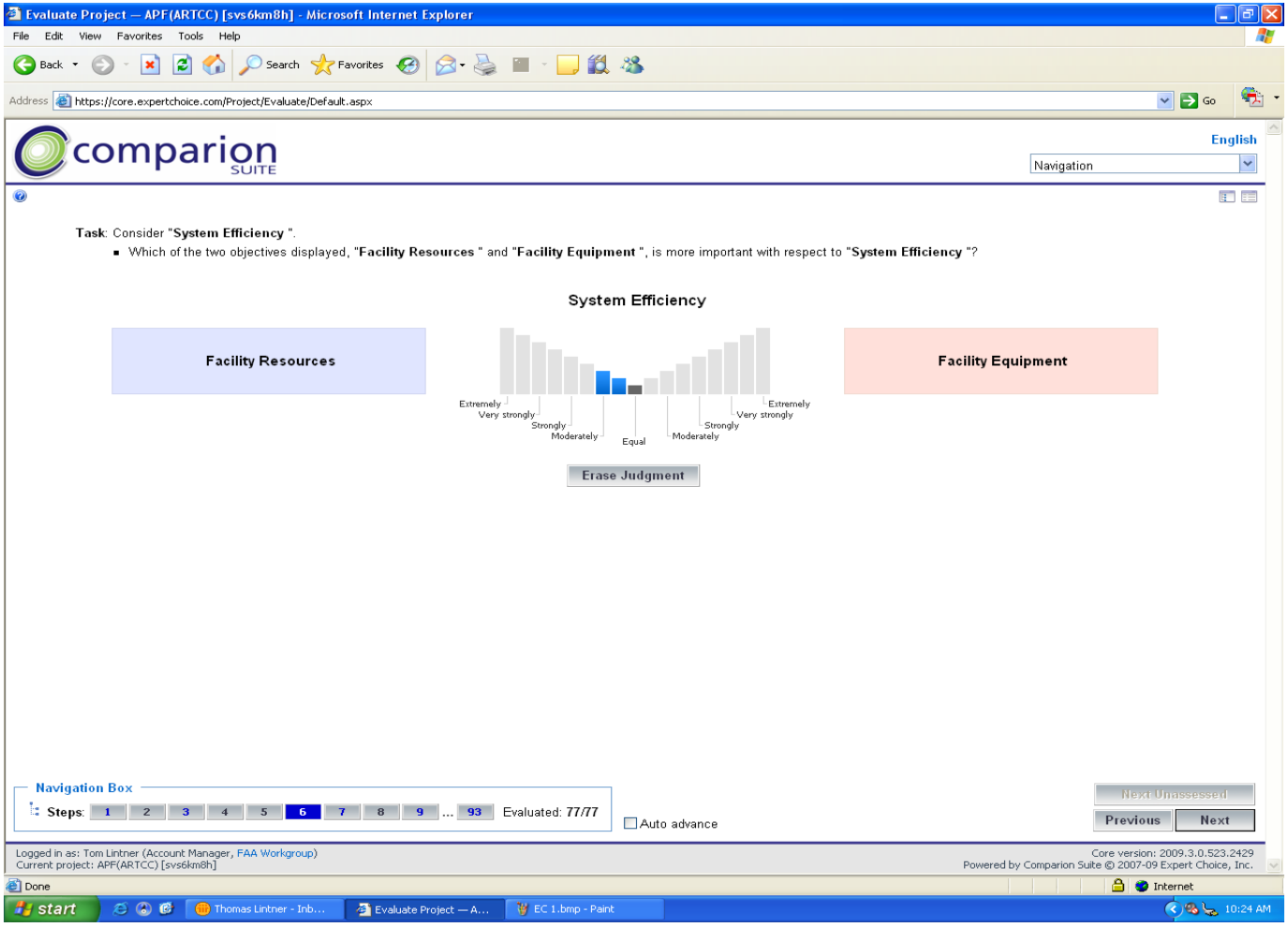
- Consistency simply means your answers are following the same relative pattern:

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

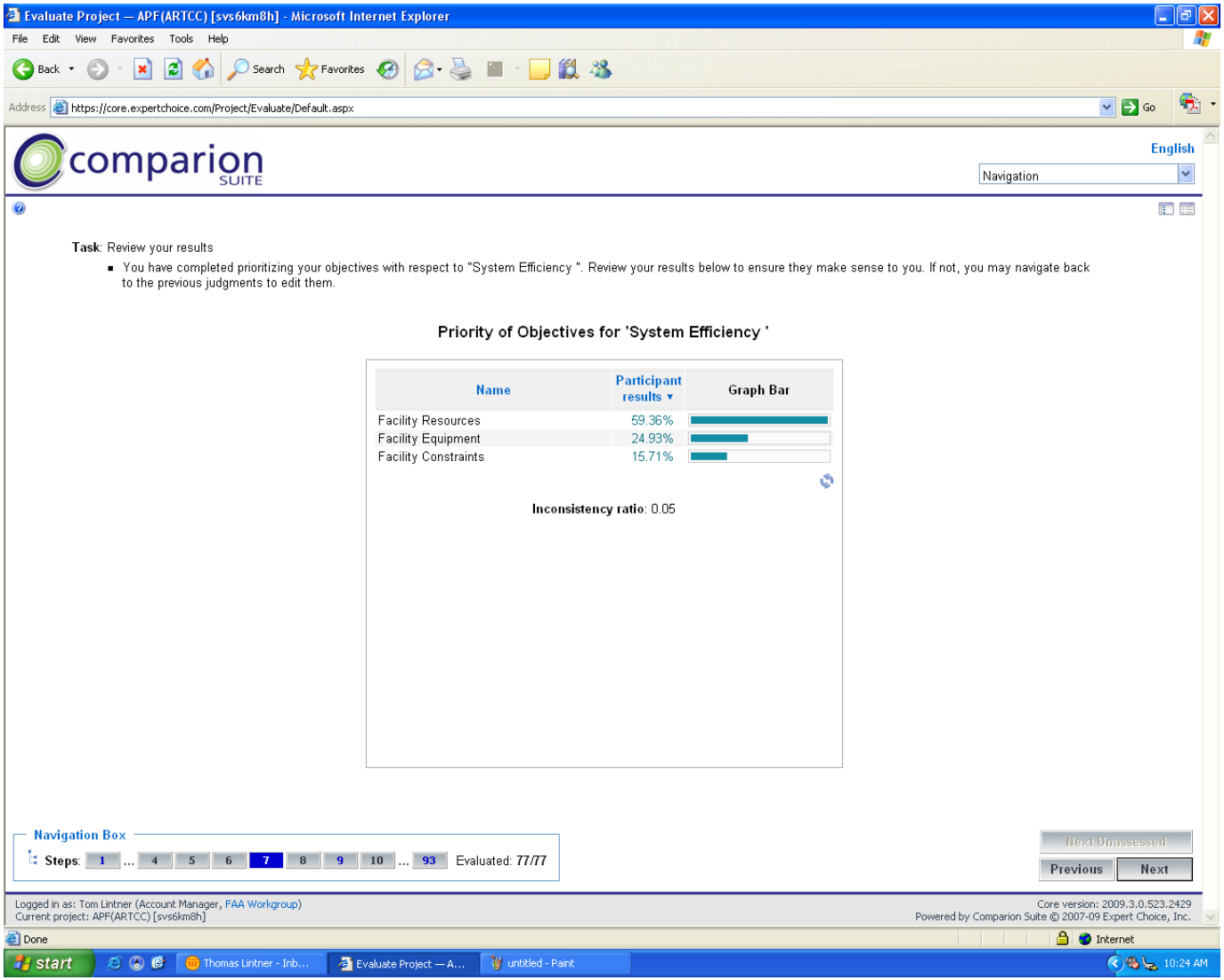
  Inconsistency = If A>B and B>C, you answer C>A

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

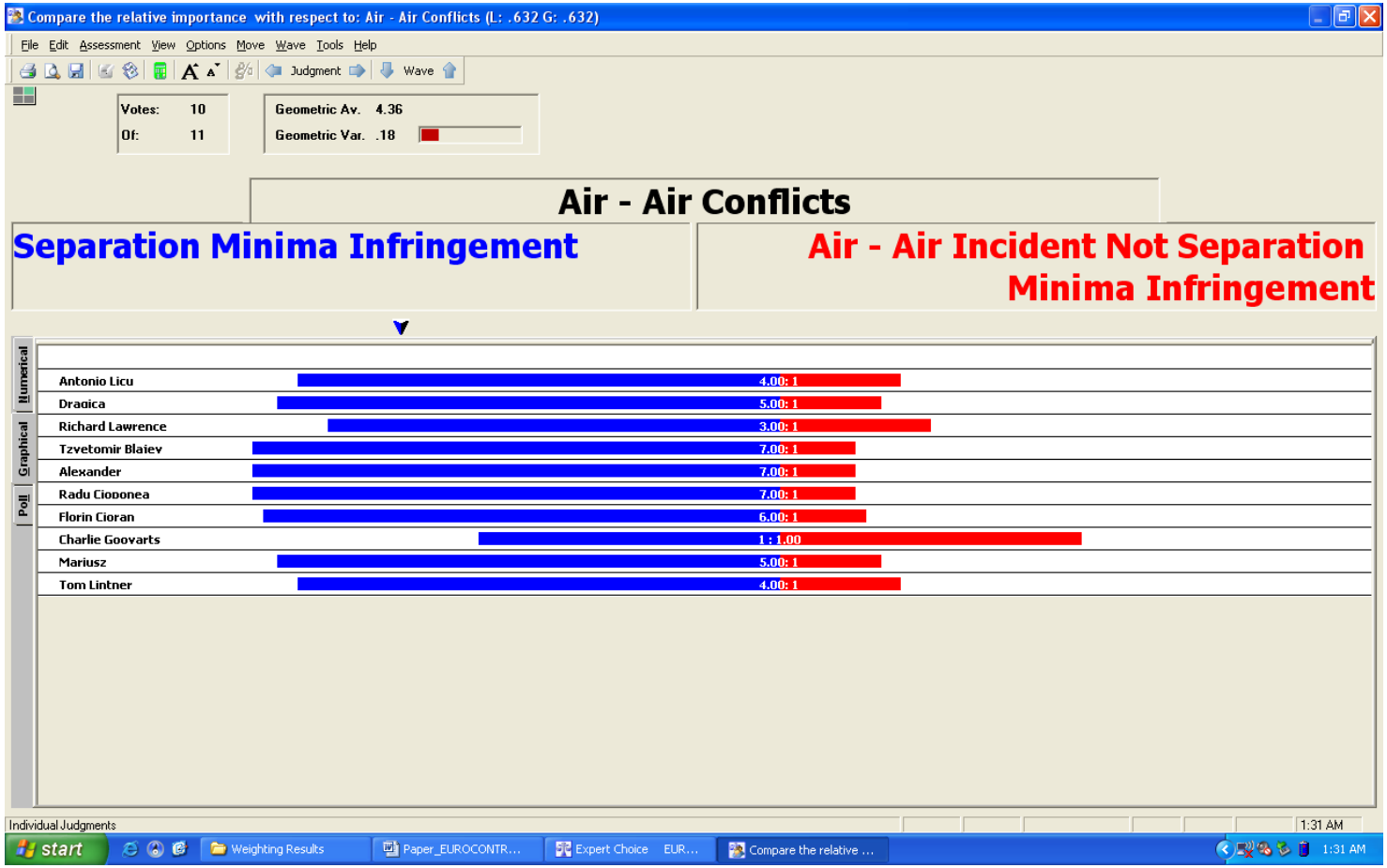
# The Mechanics of How Experts (You) Use Pairwise Comparison



# Obtaining Feedback As You Go



# 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