



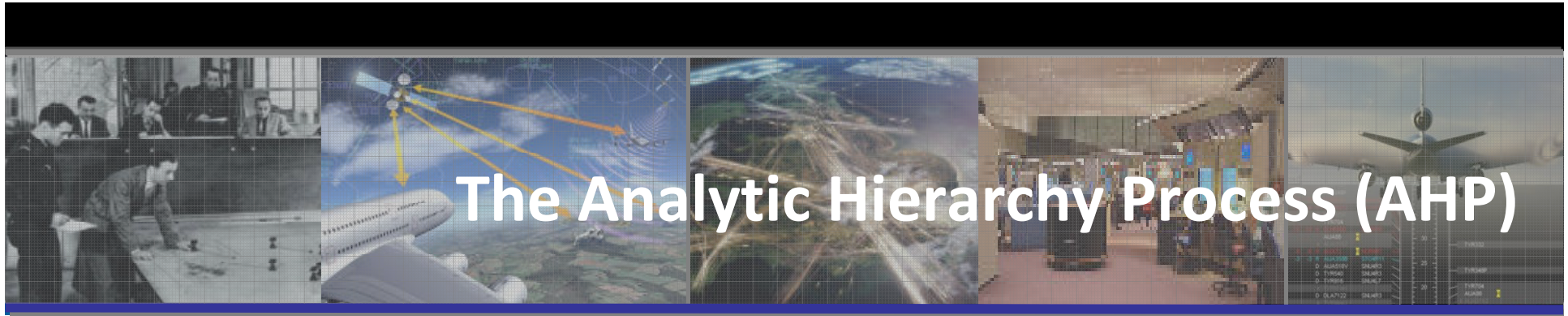
***The Analytic
Hierarchy Process
(AHP)***

&

***The Aerospace
Performance Factor
(APF)***

Tony Licu CND/ND
Gilles Le Galo SESI/CND





- AHP is a structured technique for making complex decisions, based upon psychological and mathematical principles
- Developed in the 1970s
- AHP decomposes decision problem into a hierarchy of more easily comprehended sub-problems (criteria)
- Criteria can relate to *any* aspect of the problem – tangible or intangible
- Once hierarchy is built options are systematically evaluated and combined to produce ‘local’ and ‘global’ ranking of elements
- Evaluation by pairwise comparison
 - e.g. option A vs option B, option A vs option C, etc ...

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The Analytic Hierarchy Process – an example

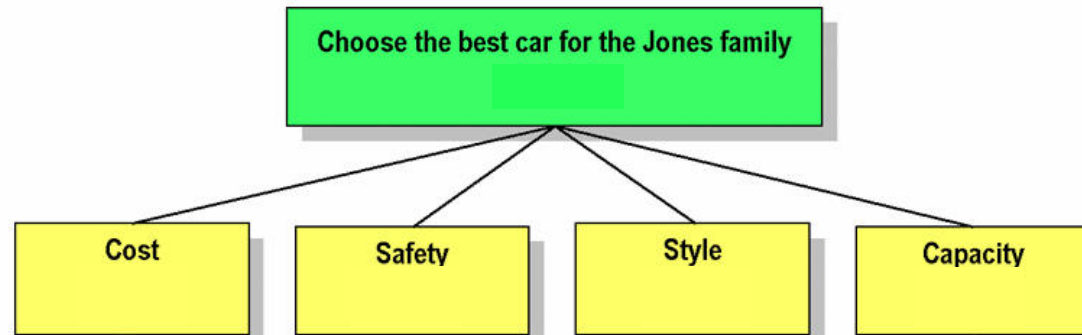
GOAL

Choose the best car for the Jones family

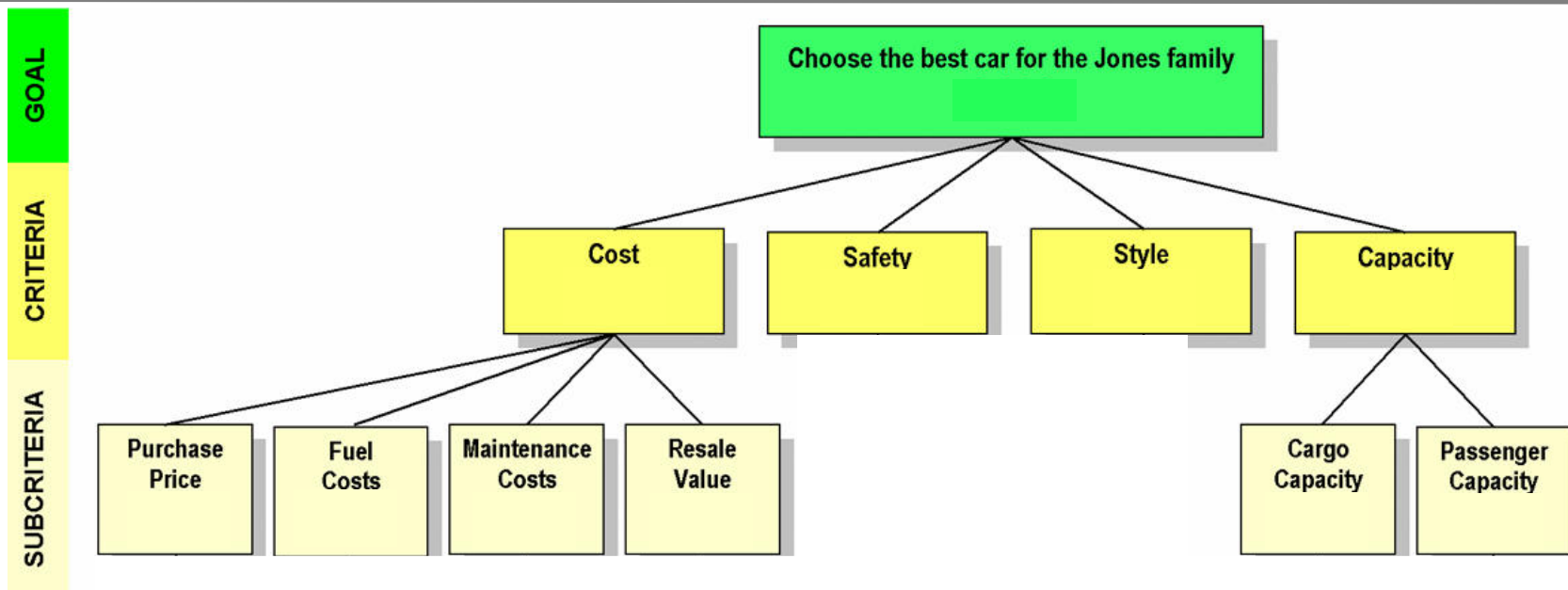
The Analytic Hierarchy Process – an example

GOAL

CRITERIA



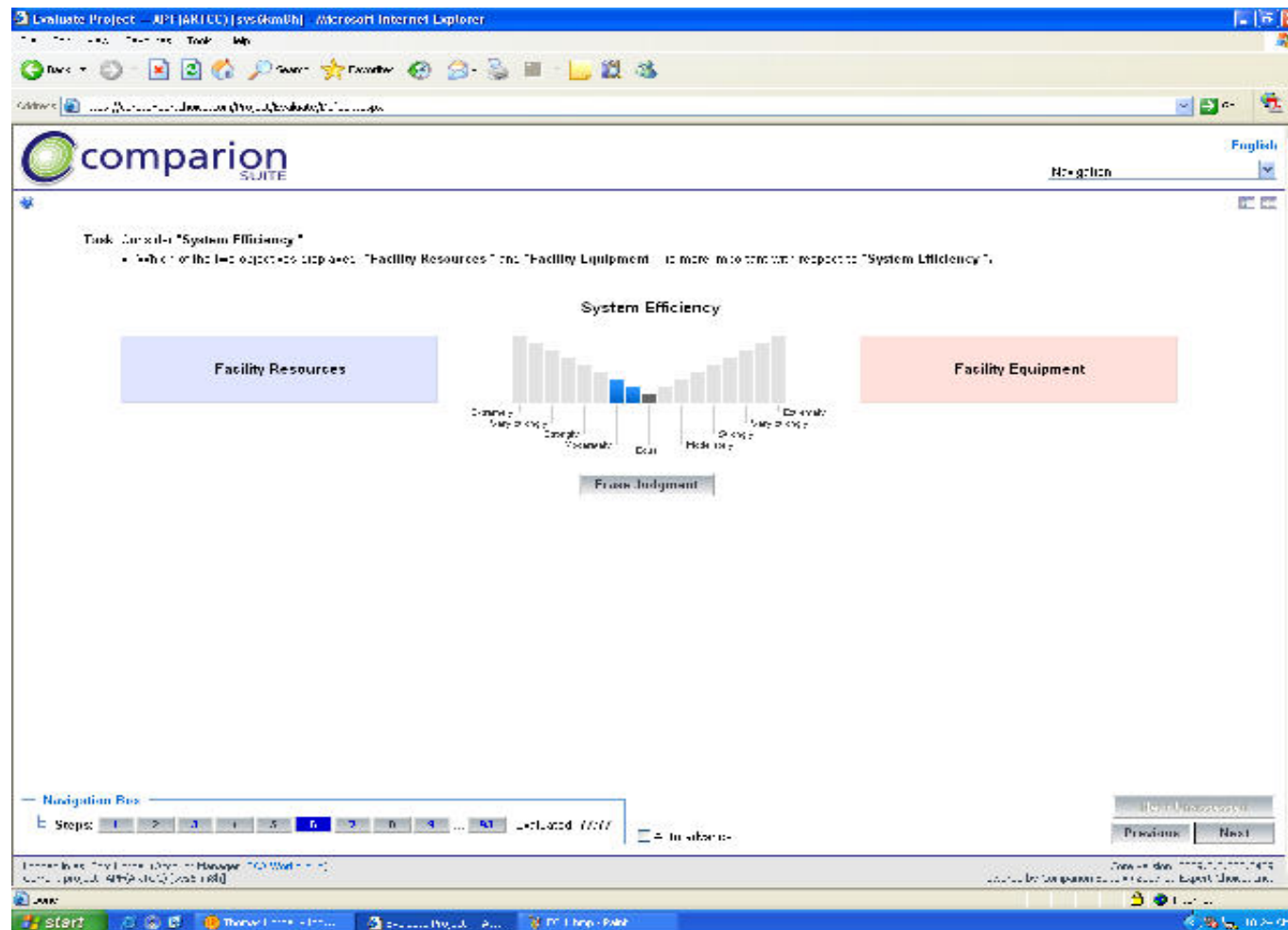
The Analytic Hierarchy Process – an example





- All criteria are equal, but some are more equal than others
- Therefore, criteria must be allocated weights
- Easiest way to do it: pairwise comparison
 - Between criterion A and criterion B, which one is more important?
 - By how much?
- The result: each criterion gets a weight between 0 and 1
- All weights add up to 1

The Mechanics of How Experts (You) Use Pairwise Comparison



Obtaining Feedback As You Go



comparion SUITE

Task: Test your team's

- You have completed prioritizing your objectives and responses to "System Life cycle". Hence your results are available and they have been shared with you. And you may navigate back to the previous segments to enhance.

Priority of Objectives for 'System Efficiency'

Name	Participant results	Graph Bar
Facility Performance	70.55%	<div></div>
Facility Equipment	24.13%	<div></div>
Facility Construction	5.71%	<div></div>

Inconsistency ratio: 0.05

Navigation Bar

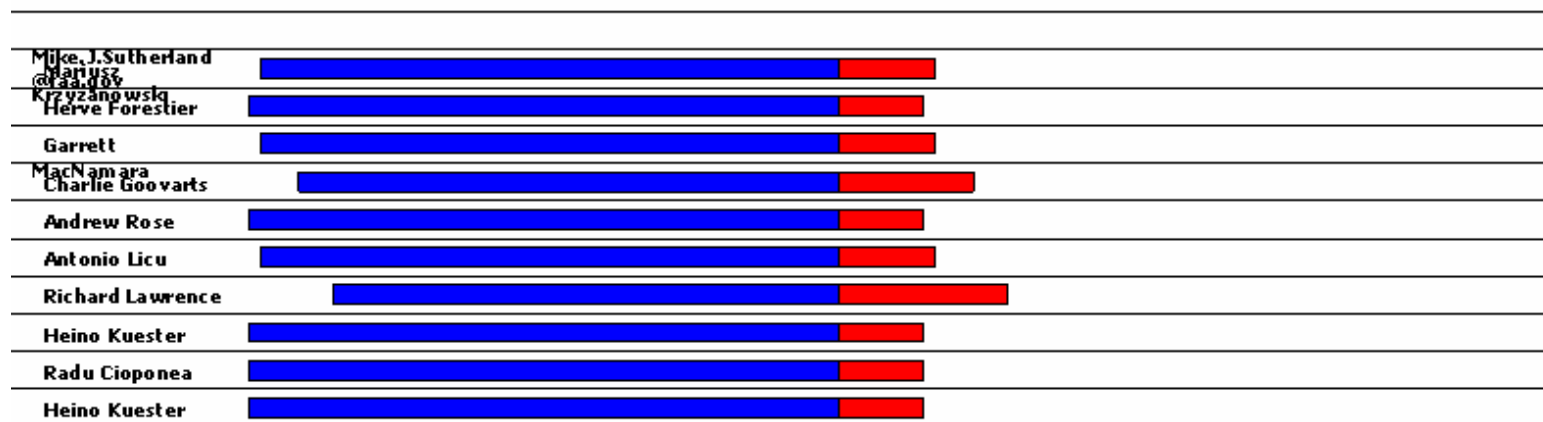
Steps: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 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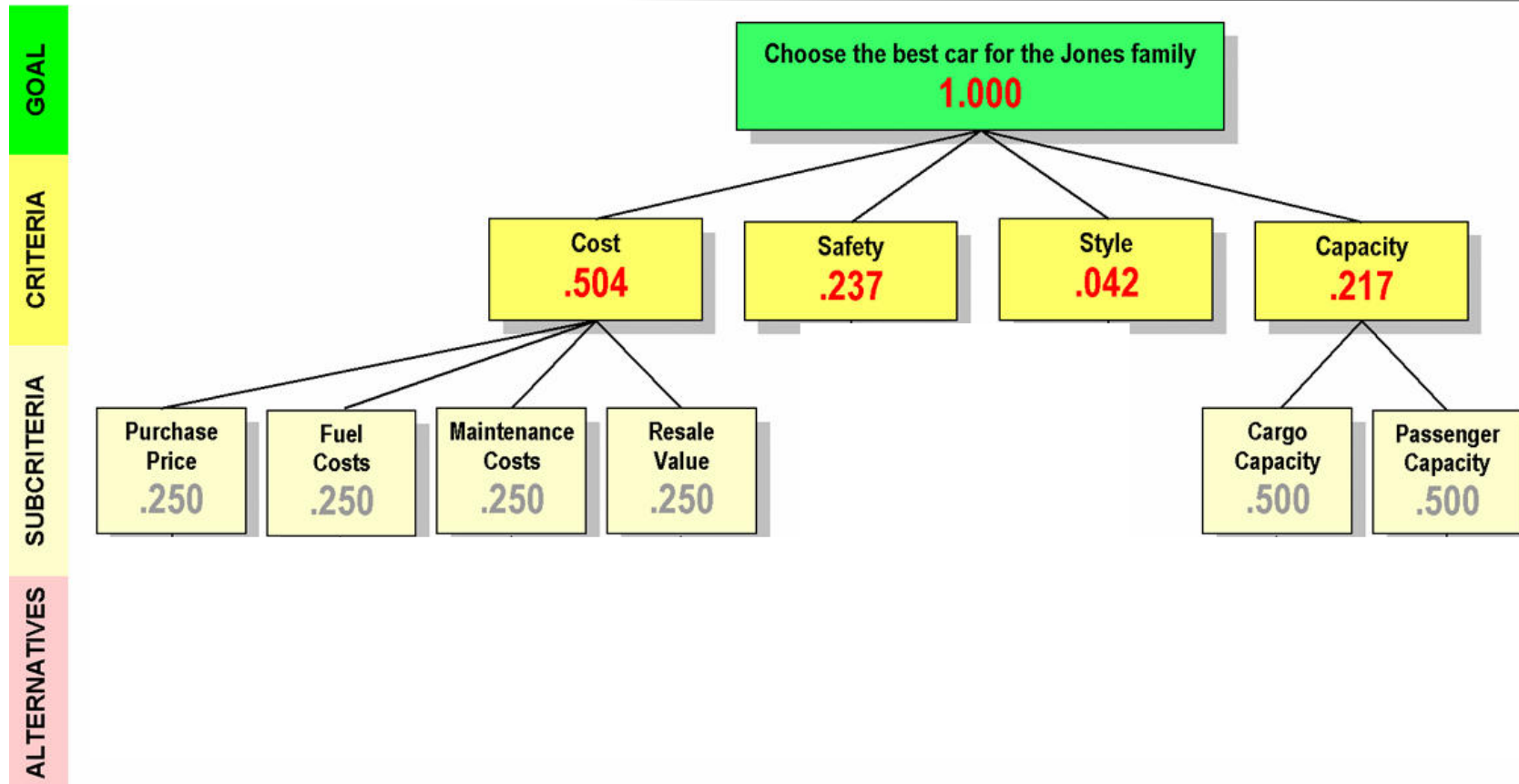
- Very important: Subject Matter Experts
- Well prepared, good definitions, well explained
- Consistent weighting

Runway Incursion

All Ground Incidents which are not Runway Incursion



The Analytic Hierarchy Process – an example



The Analytic Hierarchy Process – an example

GOAL

CRITERIA

SUBCRITERIA

ALTERNATIVES



The Analytic Hierarchy Process – Another Example



Tom



Dick



Harry

Goal:

Choose a Leader
1.000

Criteria:

Age
.300

Experience
.400

Education
.100

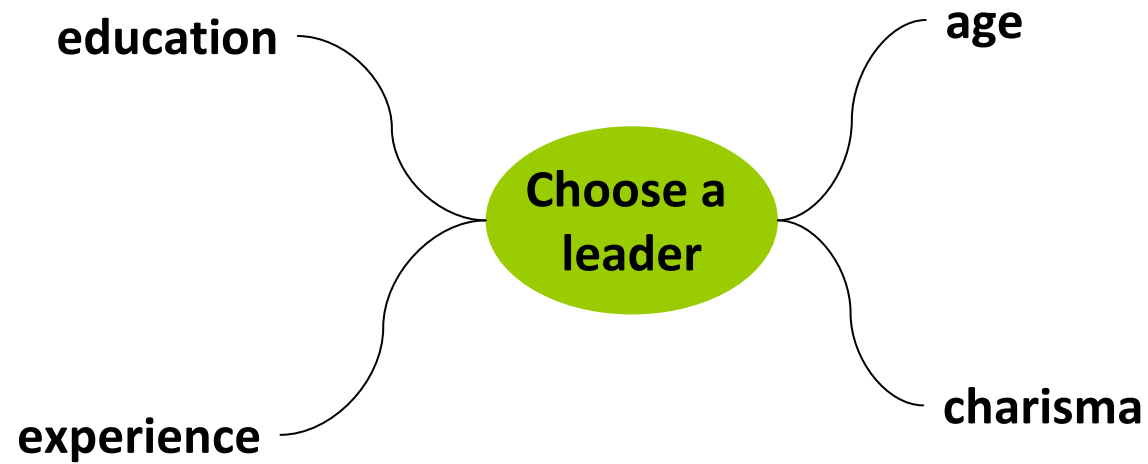
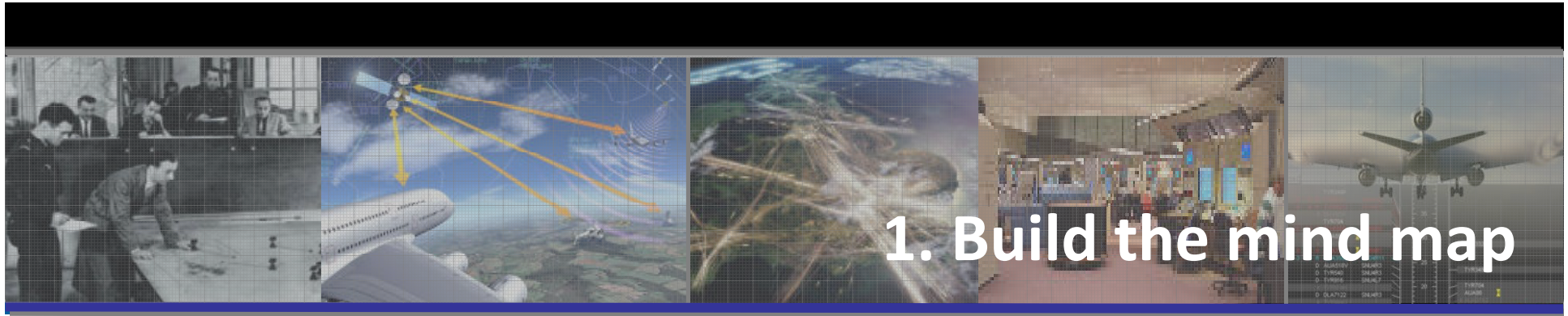
Charisma
.200

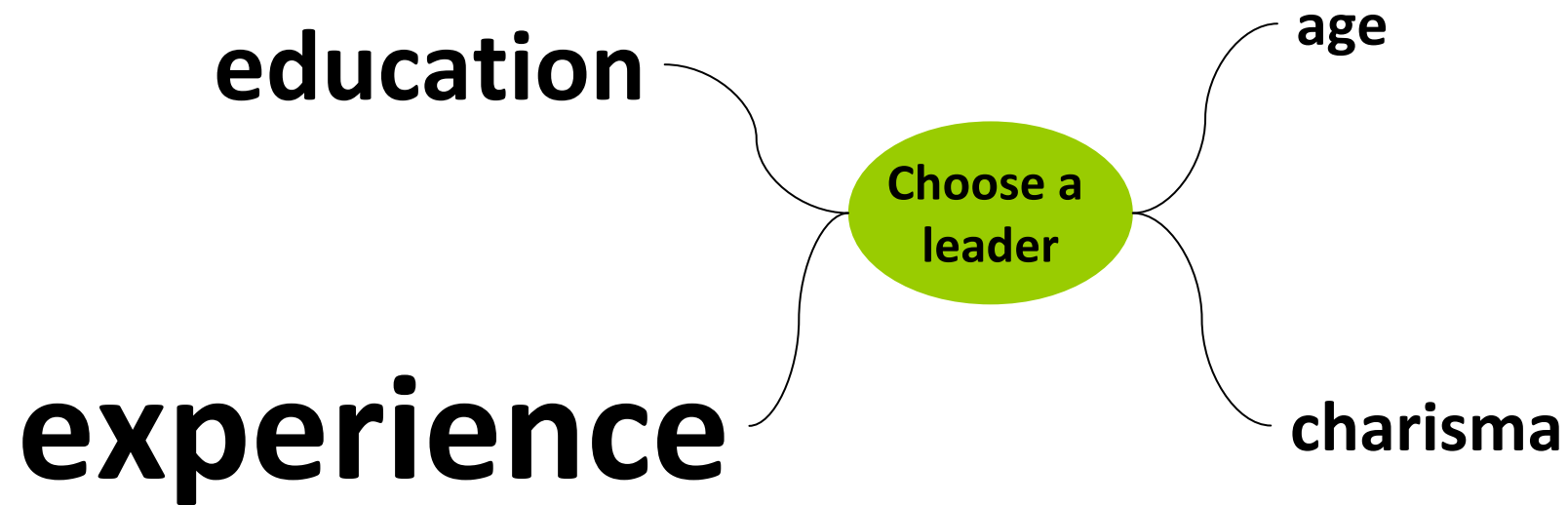
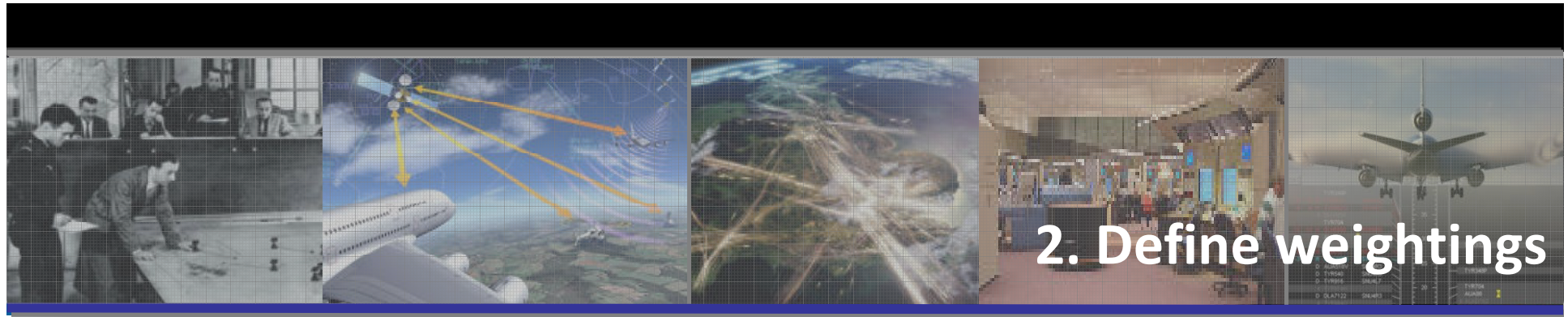
Alternatives:

Tom
.325

Dick
.450

Harry
.225





3. Define metrics

		(age ranges: >20-<35=value 1, 35-<45=value 2, 45-<55=value 3, 55 and >=value 4)	
Age	enter value		
TOM	3	54	
DICK	4	57	
HARRY	2	36	
Experience	enter value	(number of years in field 1 (X2)+ number of years in field 2 (X3)):100	
TOM	7,4	22x2=44, 10x3=30	
DICK	7,5	30x2=60, 5x3=15	
HARRY	3,6	12x2=24, 7x3=21	
Education	enter value	(secondary education diploma (1) + university degree (2)+ PhD (5))	
TOM	3	Secondary plus university degree	
DICK	1	Secondary	
HARRY	5	secondary plus university degree plus Phd	
Charisma	enter value	(subjective mark allocated during interview-range 1 to 5)	
TOM	4		
DICK	2		
HARRY	4		



TOM (?)

The Analytic Hierarchy Process – Another Example



M.



Olga



C.

Goal:

Choose : Her
1.000

Criteria:

Age
.300

Experience
.400

Education
.100

Charisma
.200

Alternatives:

M.
.325

Olga
.450

C.
.225

The Analytic Hierarchy Process – Another Example



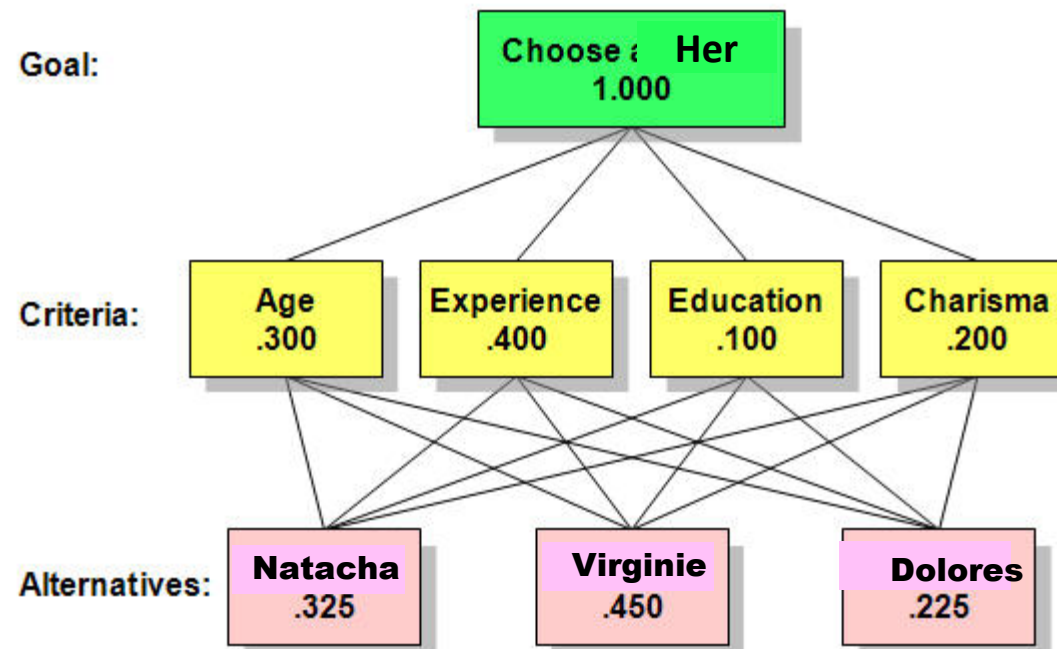
Natacha



Virginie



Dolores



The Analytic Hierarchy Process – Another Example



Cartier



Van Cleef



Buccellati

Goal:

**Choose : Her
1.000**

Criteria:

**Age
.300**

**Experience
.400**

**Education
.100**

**Charisma
.200**

Alternatives:

**Cartier
.325**

**Van Cleef
.450**

**Buccellati
.225**



AHP applications

Described applications below

- use a “hybrid” or “simplified” version of AHP techniques to gather expert opinions for weighting.
- Are not used as a multi criterion decision tool but pair-wise comparison process determines the weights
- Can finally merge “apples’ and “oranges”
- “Between these two elements, which one has more influence on the organizations goal?”



AHP application

Aerospace Performance Factor (APF)

- The APF presents a graphical view of performance.
 - based on *historical indicators (lagging) from multiple databases.*
- Allows organization to have a *macro-system-wide view of performance.*
 - then “drill down” into data to search for causal factors.
- Tracks organizational performance over time.
 - using safety, operational, and/or equipment metrics.
- Does not focus on a single metric to measure performance.
- Incorporates organizational judgment and experience of factors.
 - Measures intangibles
- Allows for analysis and search for precursors.
- Can function as a model for decision making & is expandable in size and scope.



Who is involved

- **FAA**

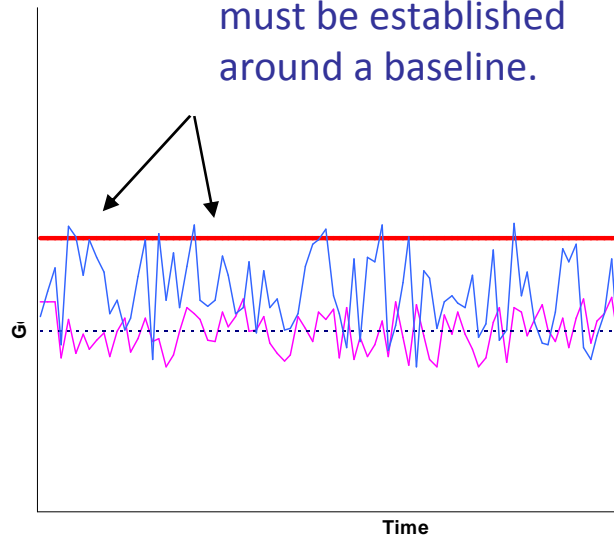
- Imperial College, London
- easyJet Airlines
- U. S. Navy's Aviation Safety Center
- Albuquerque New Mexico and Denver Colorado Air Route Traffic Control Centers (ATISs)
- Southwest Airlines

- **EUROCONTROL &**

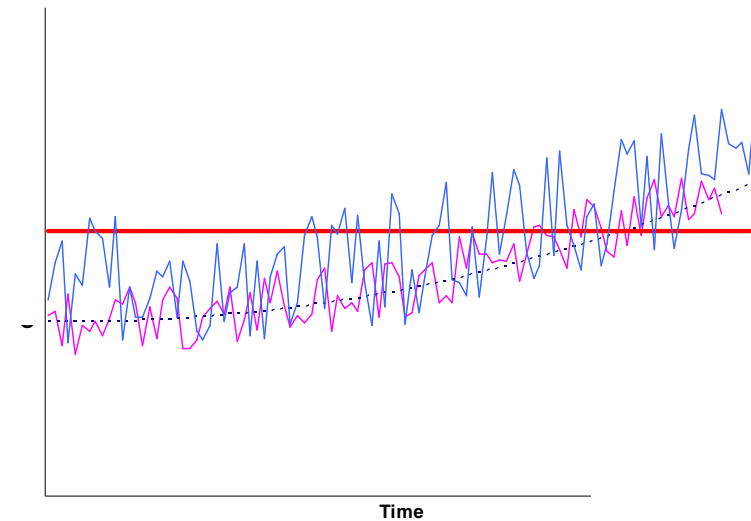
- Ireland (IAA)
- UK (NATS)
- Germany (DFS)
- France (DSNA)
- Poland (PANSO)
- Netherlands (LVNL)
- Hungary
- ENAV
- ROMATSA
- NAV
- FABs (BLUEMED)
- ...

Concepts: Time, Performance Parameters, Baselines, and Trends

Organizations can fluctuate. An acceptable parameter must be established around a baseline.

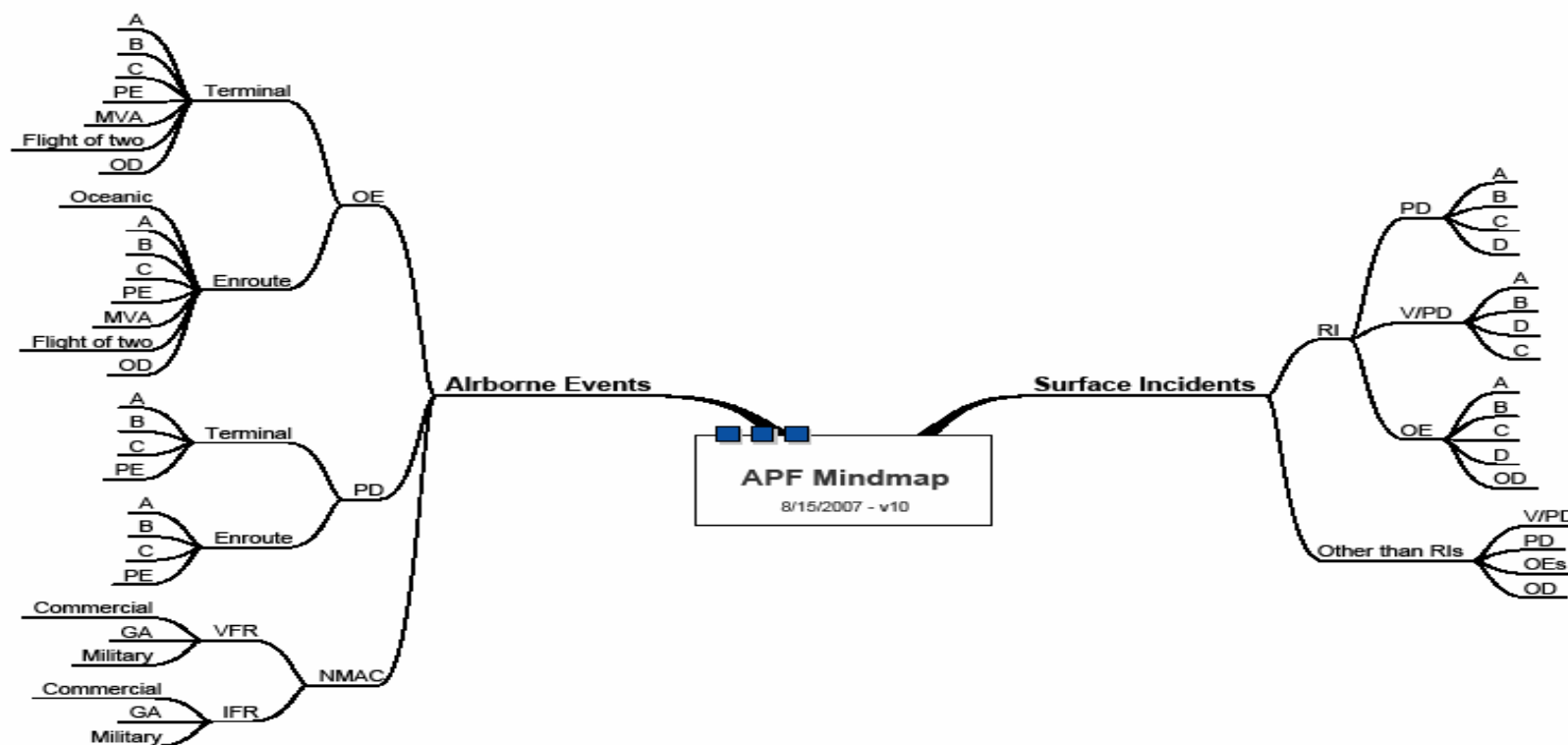


Trends assist in seeing gradual changes. Drill down into the trend data focuses on specific problem areas.



Avoids the “Boil the Frog” Syndrome

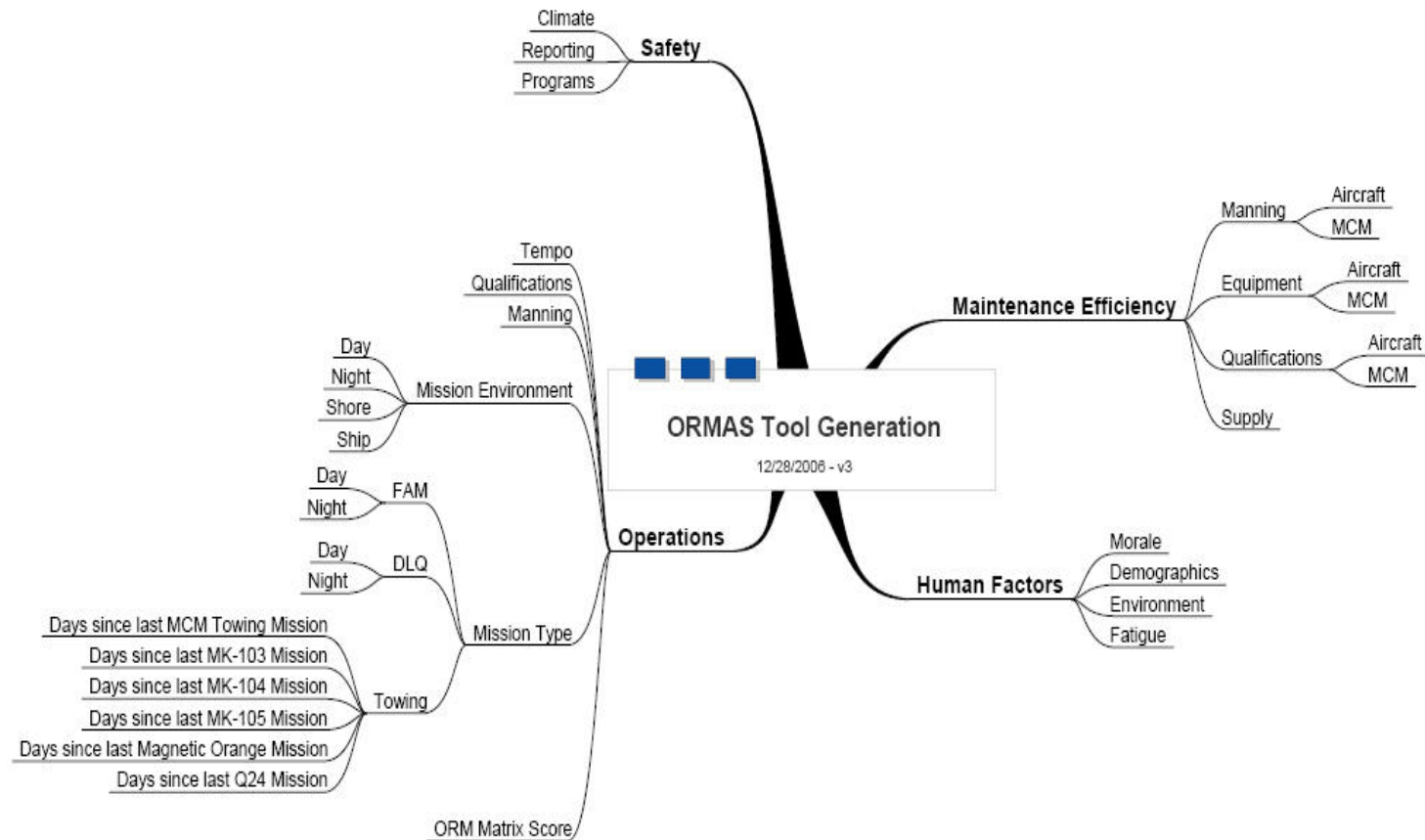
First ANSP (FAA) Mindmap; Development Of A Simple Version



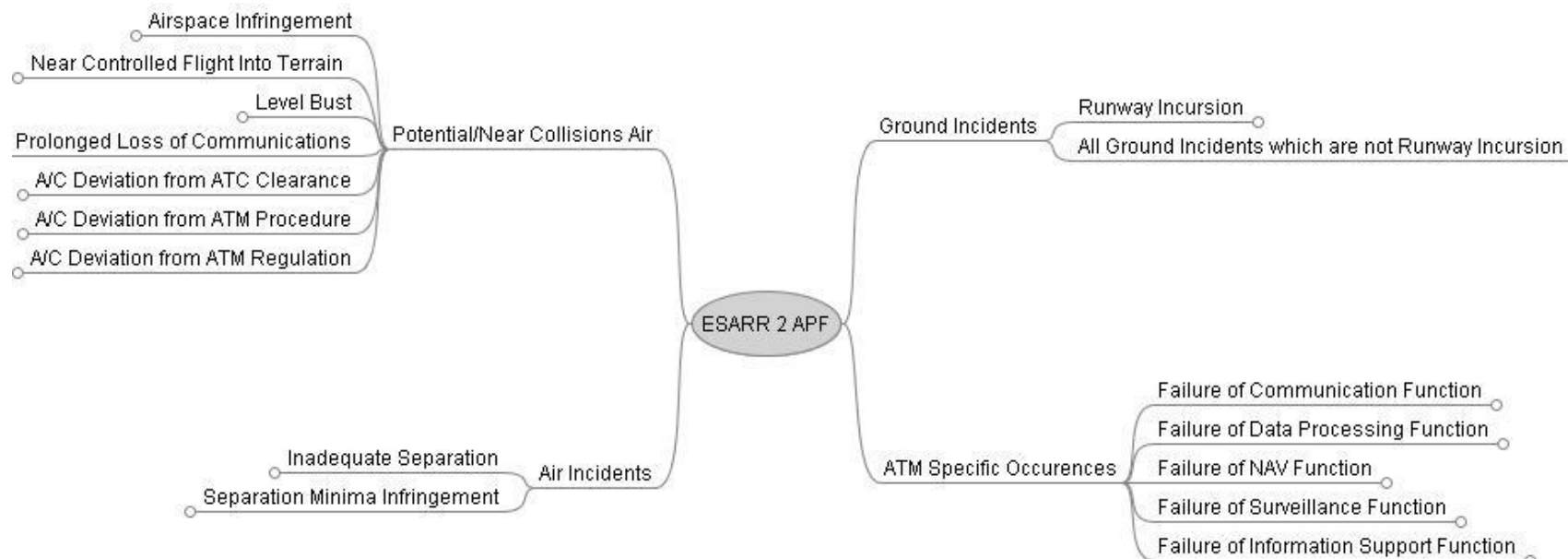
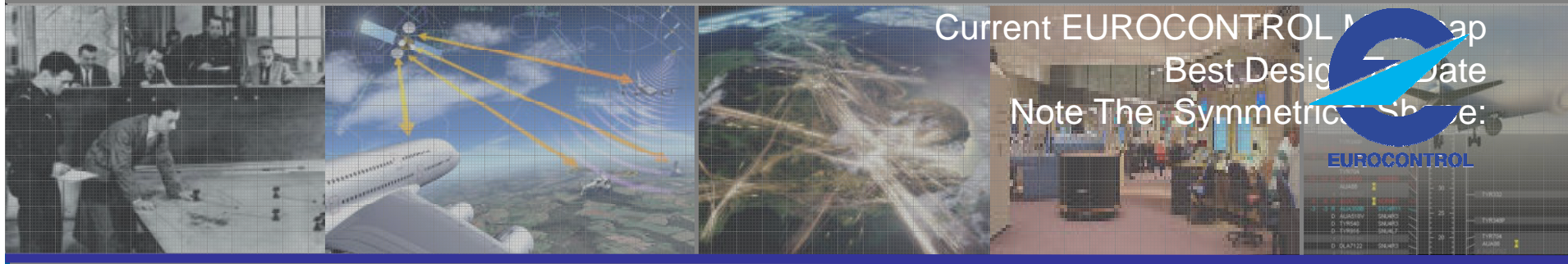
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First US Navy Mindmap: More Complex



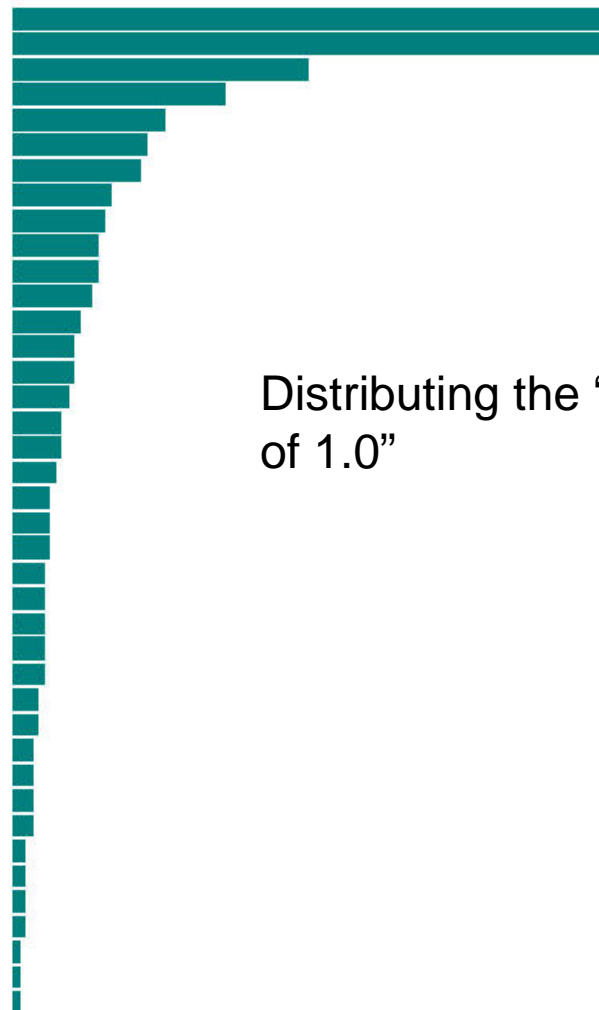
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Subject Matter Experts Determine the Weighting Values

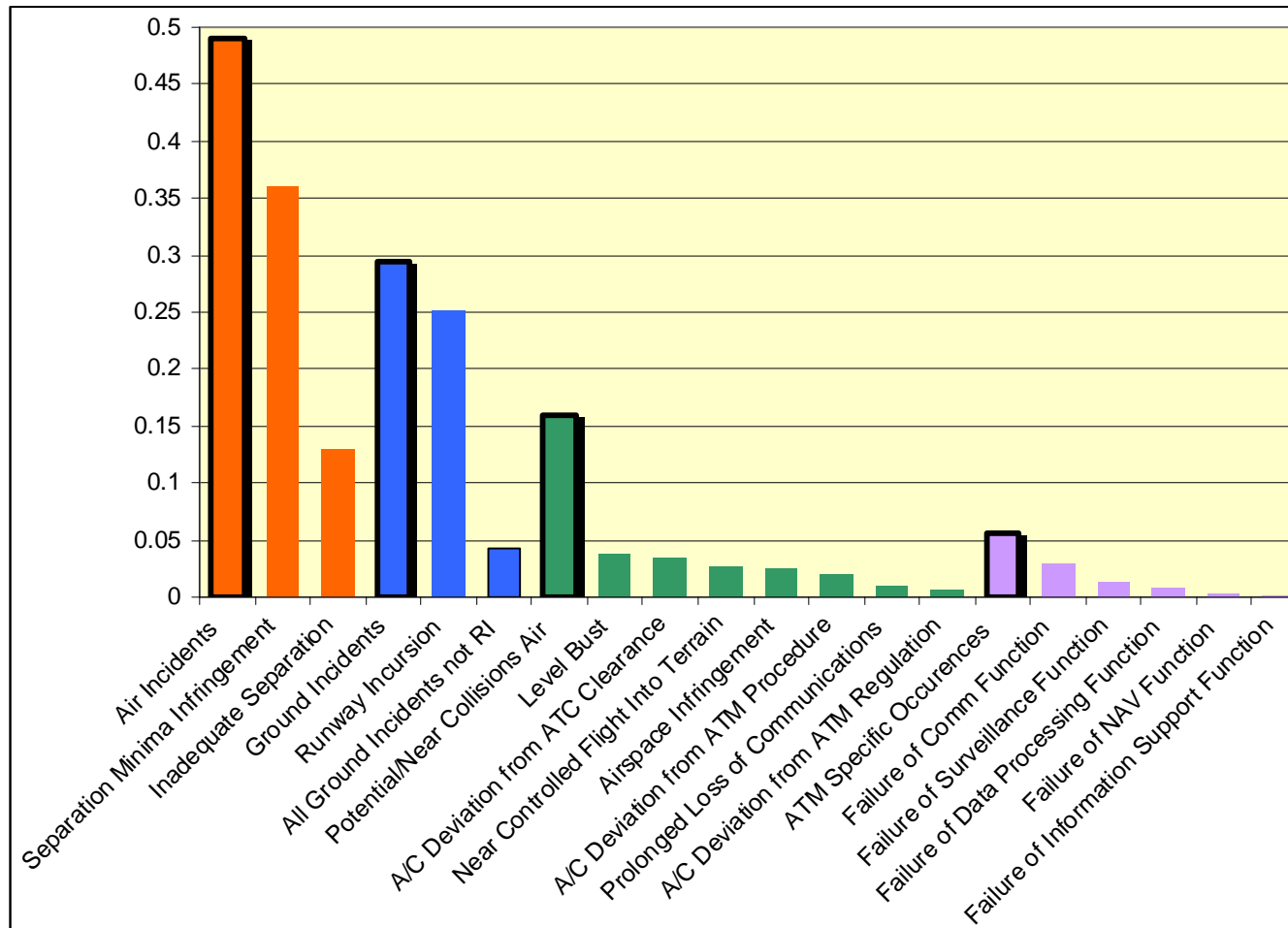
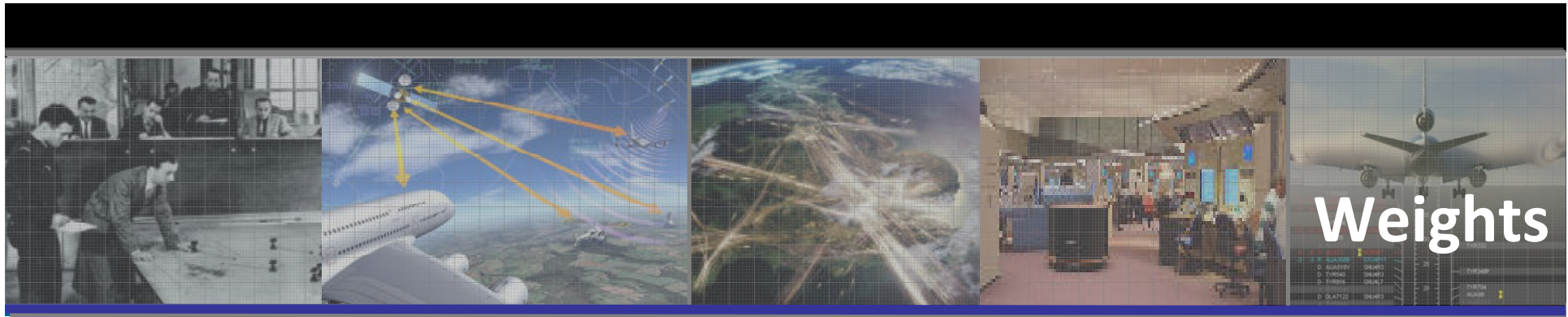
Airprox
Groundprox
Wake Turbulences
Birdstrike
Movement
Wind and Windshear
Runway/Taxiway Excursion
Separation Issue
TCAS
Crew Illness - Injury
Unstabilized Approach
Icing
Propulsion - Engine
Under-carriage
Fuselage
Vehicle and/or Pedestrian
Infrastructure
Take off or Landing Clearance Issues
Level Bust
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 Skills
Runway Conditions
Military and Other
APU
Pushback Clearance
Limited or No Communication
Other Animal Strike

.178
.178
.087
.061
.044
.039
.037
.028
.027
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Distributing the “Value
of 1.0”





An Example Of The “New” Data Display Methodology Development

MYFAA
Employee Site

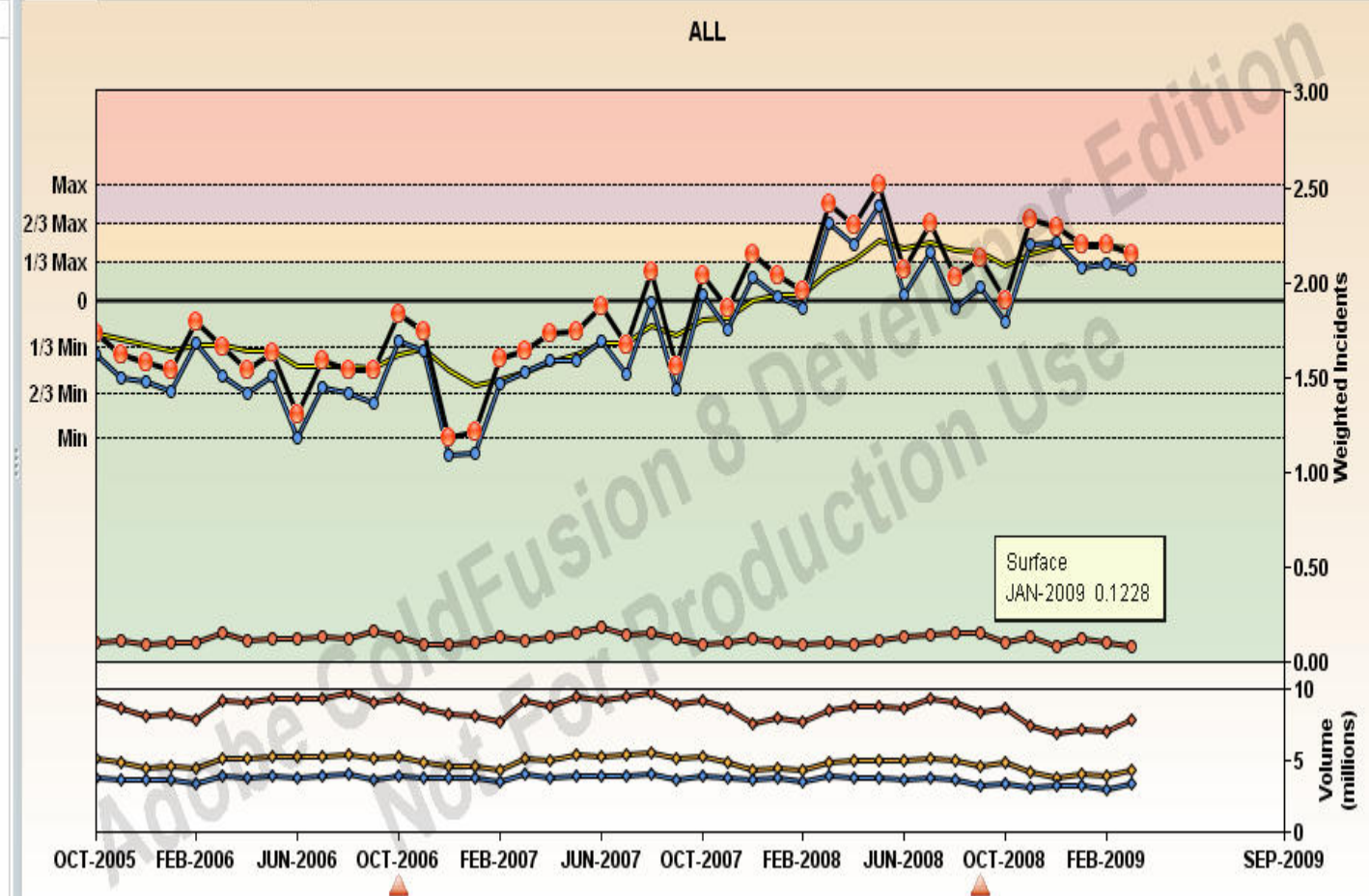
[APF Help](#) [MyFAA Home](#)

Tree View Settings

Safety data as of MAR-2009

- ☒ All
 - ☒ Airborne
 - ☒ Operational Errors
 - ☒ Terminal
 - ☒ Category A
 - ☒ Category B
 - ☒ Category C
 - ☒ Proximity Events
 - ☒ Minimum Vector Altitude
 - ☒ Flight of Two
 - ☒ Operational Deviations
 - ☒ Enroute
 - ☒ Pilot Deviations
 - ☒ Near Midair Collisions
 - ☒ Surface
 - ☒ Runway Incursions
 - ☒ Non-Runway Incursions

Chart Terms and Definitions



All

EUROCONTROL

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



Tree View Settings

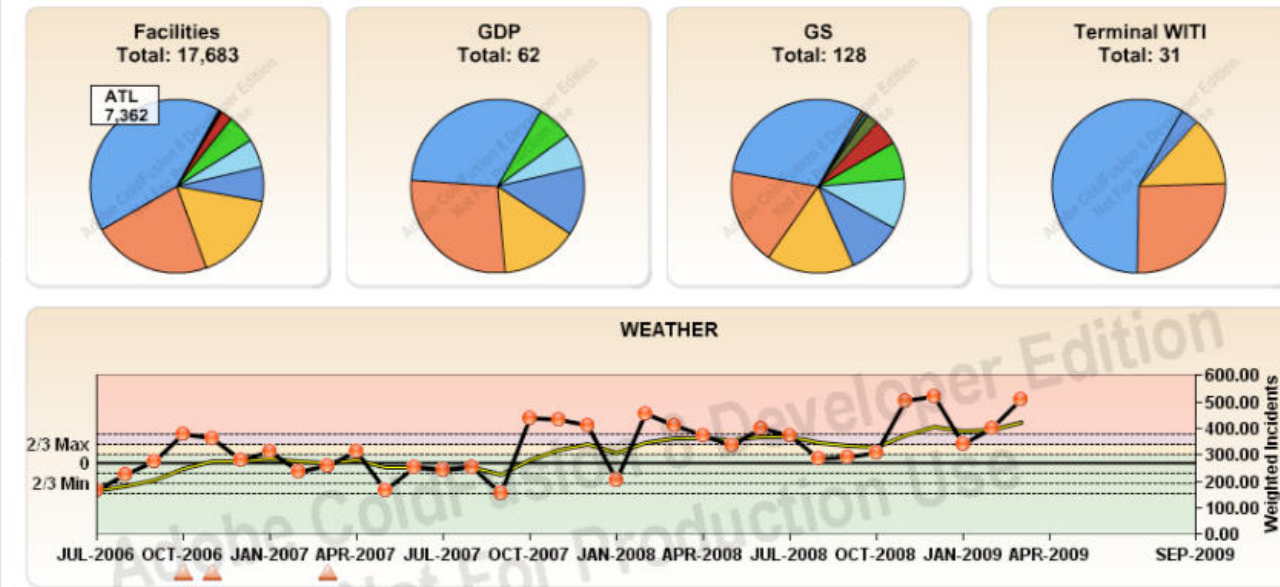
Headquarters data as of MAR-2009

- Efficiency APF(e)
- Enroute
- Terminal (OEP 35)
 - Western Terminal
 - Central Terminal
 - Eastern Terminal
- Delays
 - Volume
 - Weather
 - Equipment
 - Runway
 - Other
- Available Capacity
- WITI

Chart Terms and Definitions

Diagnostic Charts for MAR-2009

Charts represent data when available and may have incomplete or partial data.



Efficiency APF(e) ▶ Terminal (OEP 35) ▶ Eastern Terminal ▶ Delays ▶ Weather





Conclusions & Caveats

- The APF is not a stand alone tool
 - Current measurements must be maintained.
- The APF identifies “what” is happening, “where”, and “when” thru both trending and diagnostics:
 - 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.
- The APF can be used to measure efficiency & effectiveness depending on what measures are used.

Lisboa TWR Unit Safety Case

- EXERCISE

