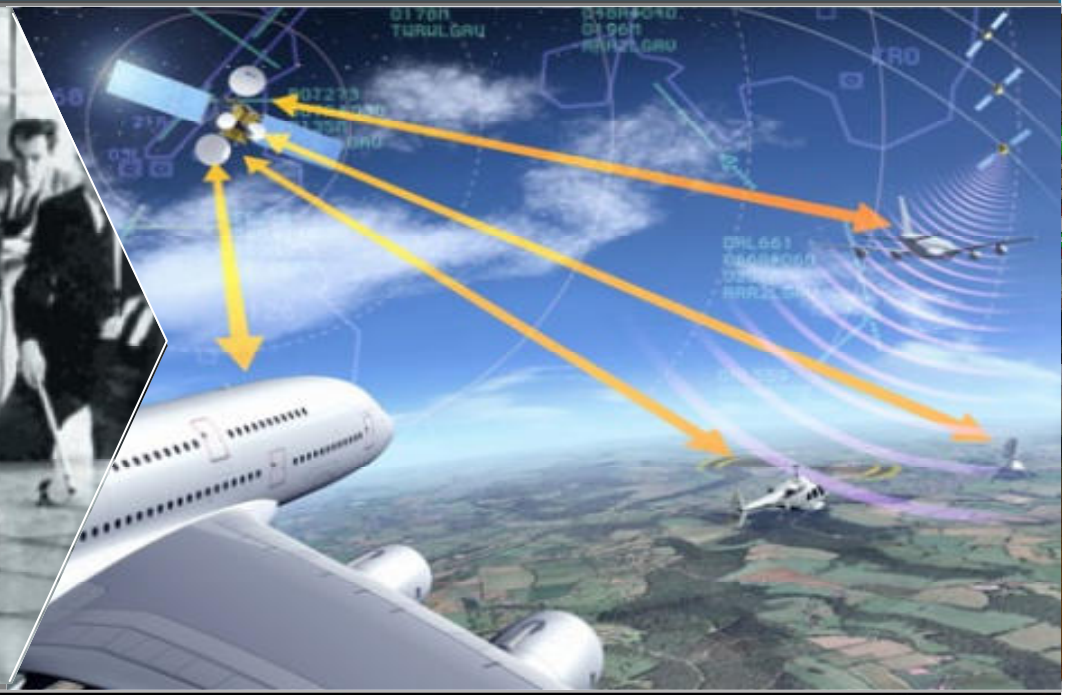

The Analytic Hierarchy Process (AHP) & The Aerospace Performance Factor (APF)

Tony Licu CND/ND
Gilles Le Galo SESI/CND

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The Analytic Hierarchy Process (AHP)

- 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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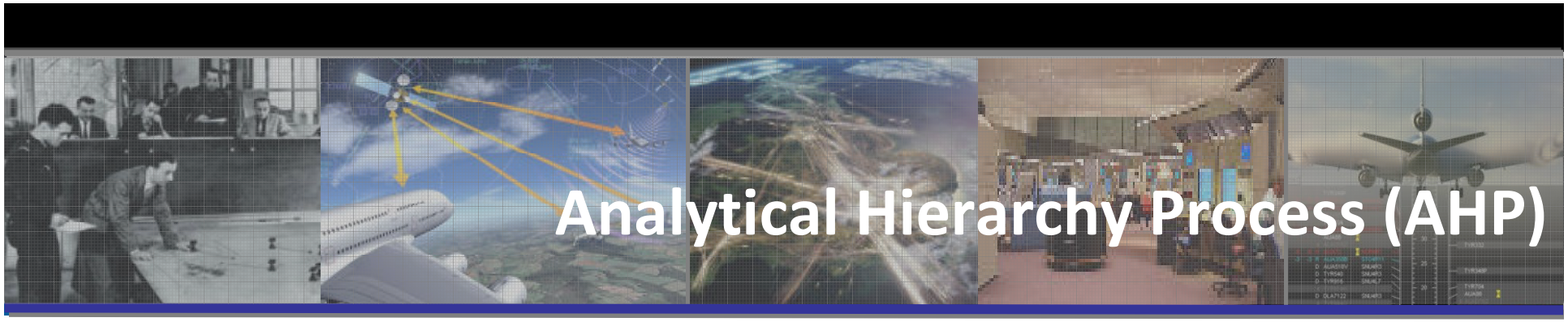

Analytical Hierarchy Process (AHP)

- Uses expert judgment to prioritise these criteria, i.e. give weights
- Example: rank a pool of cars based on a combination of criteria such as cost, safety, style, capacity
  - Each car evaluated separately
  - Importance of each criteria also weighed
  - Then each car evaluated based on those weights

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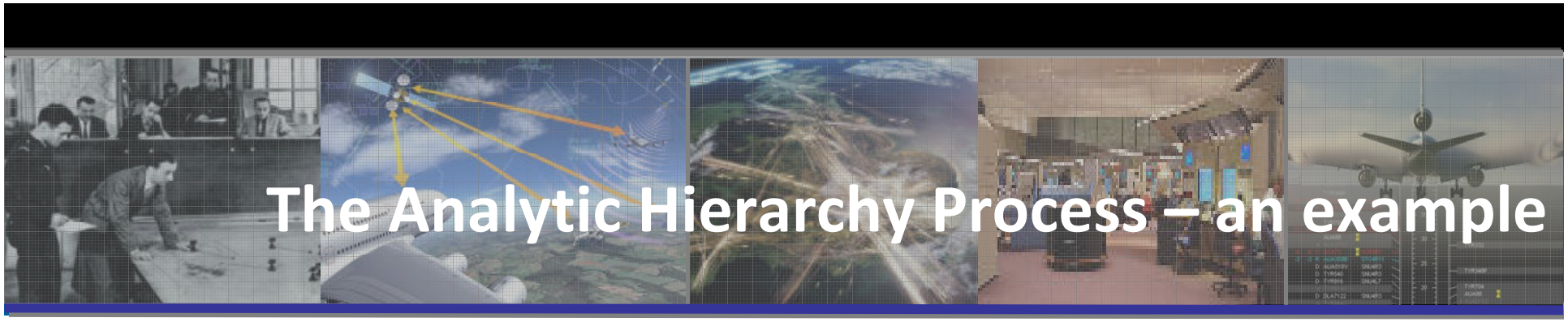

The Analytic Hierarchy Process – an example

GOAL

Choose the best car for the Jones family

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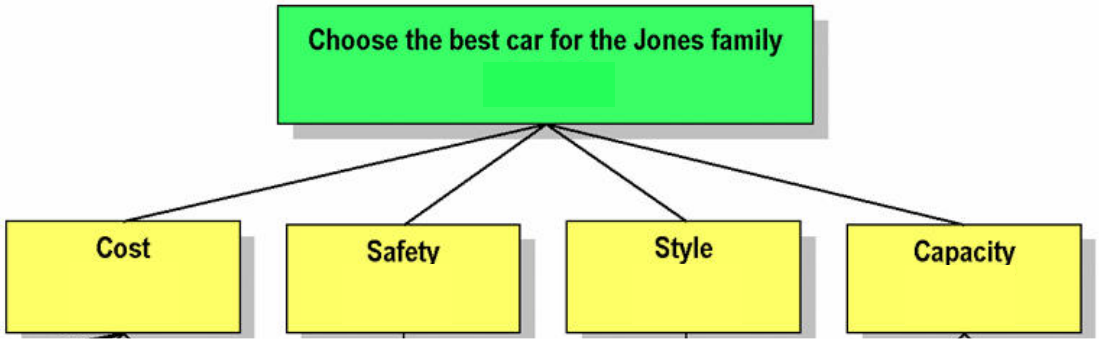
The Analytic Hierarchy Process – an example

GOAL

CRITERIA



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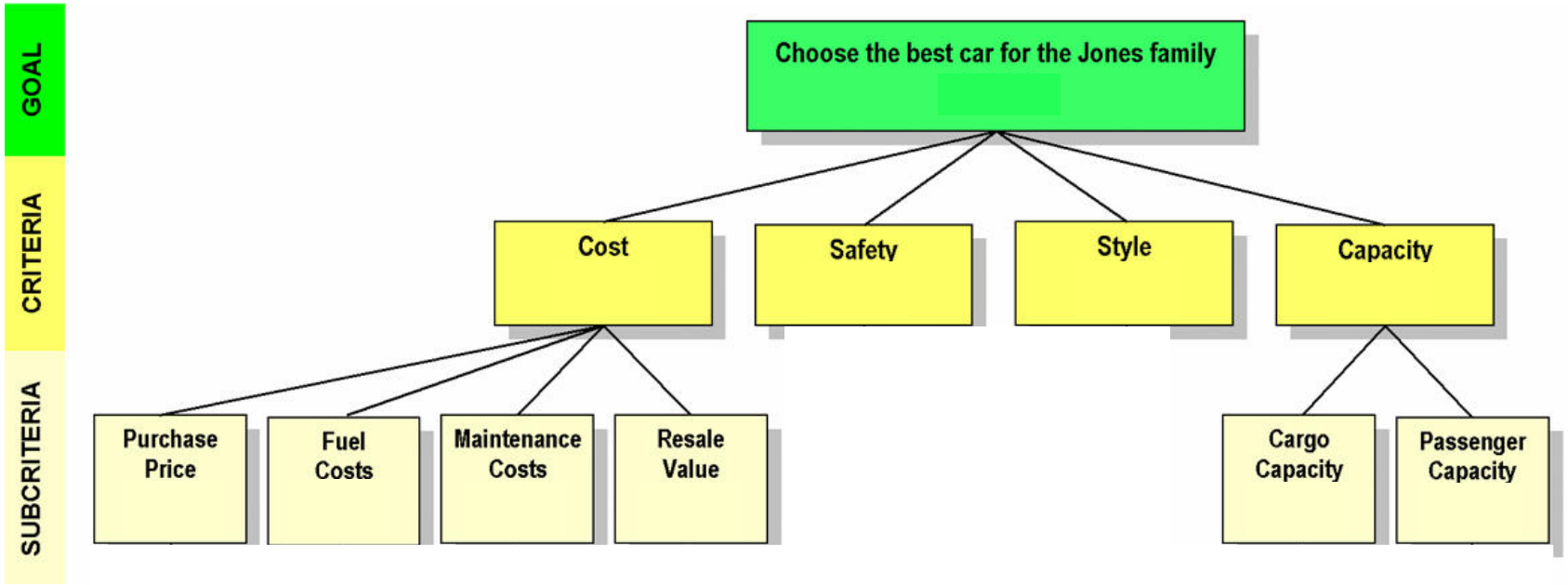
The Analytic Hierarchy Process – an example



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Weighting of criteria

- 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

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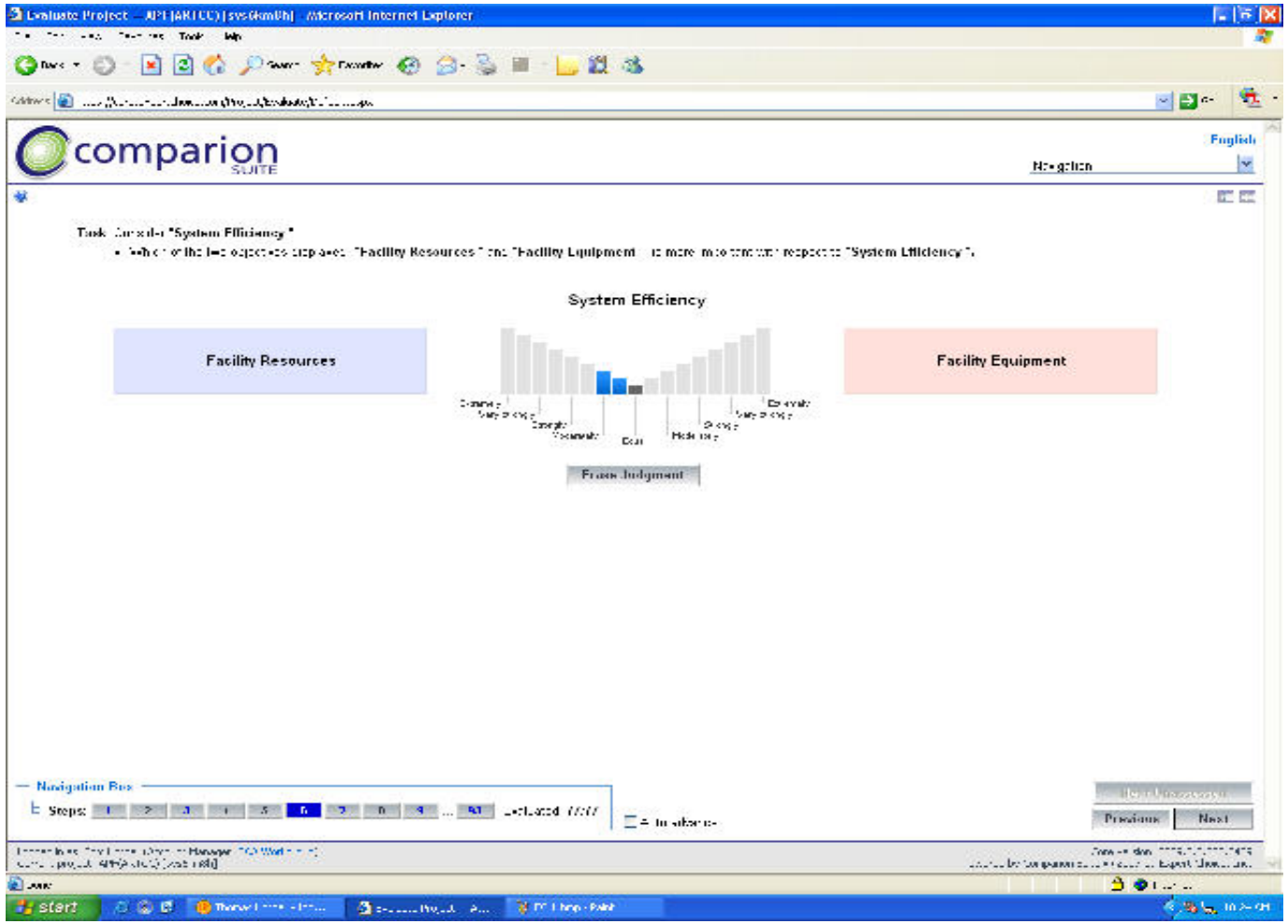
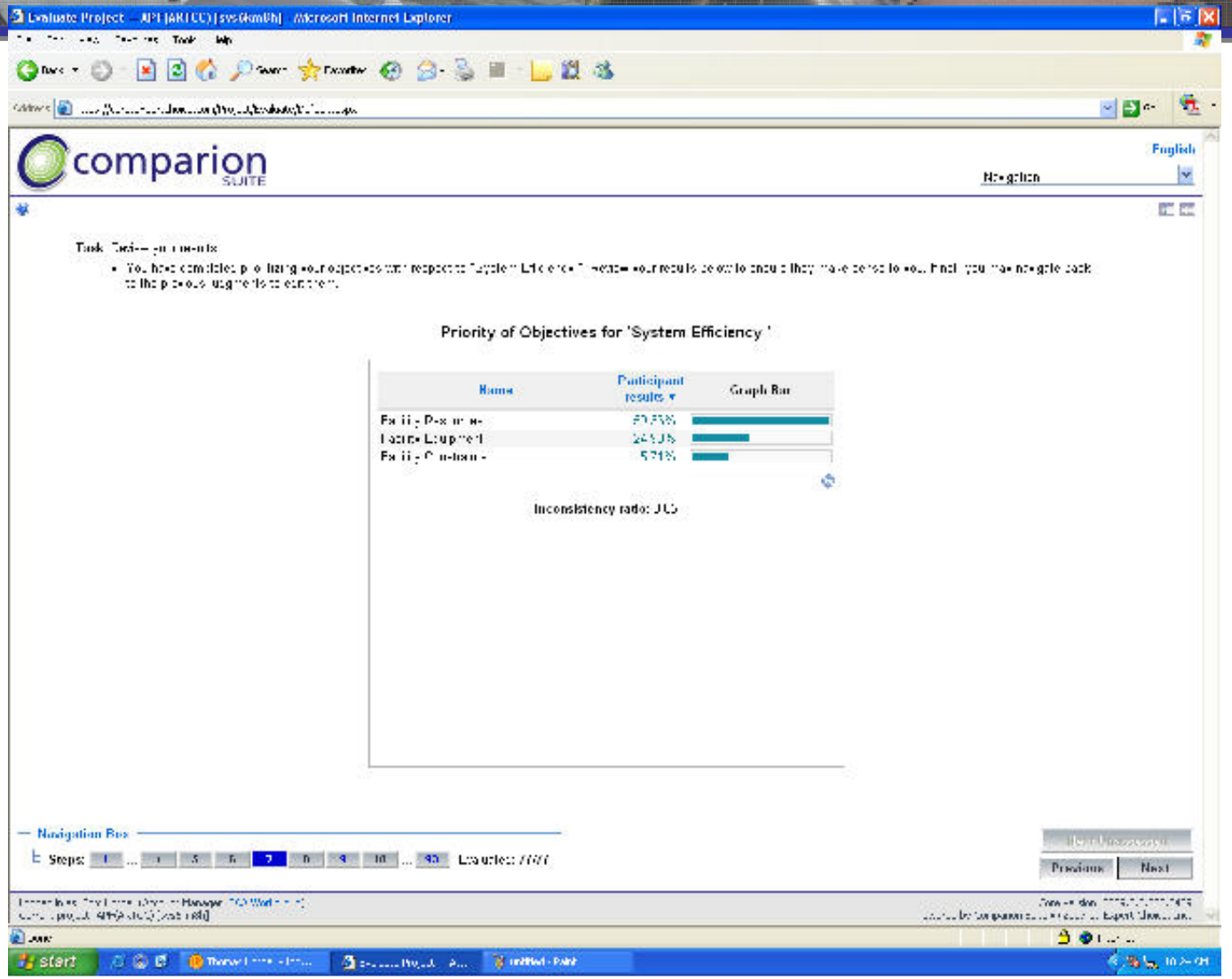
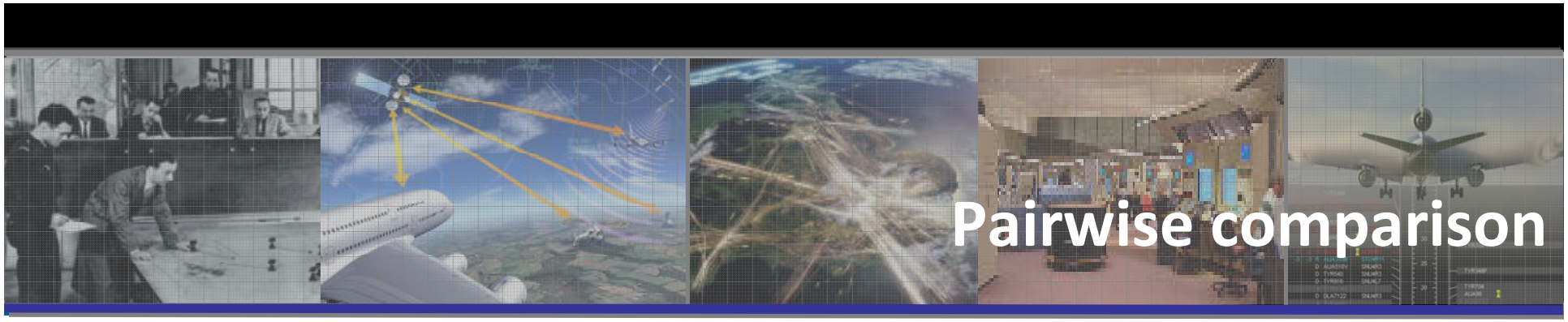
The Mechanics of How Experts (You) Use Pairwise Comparison



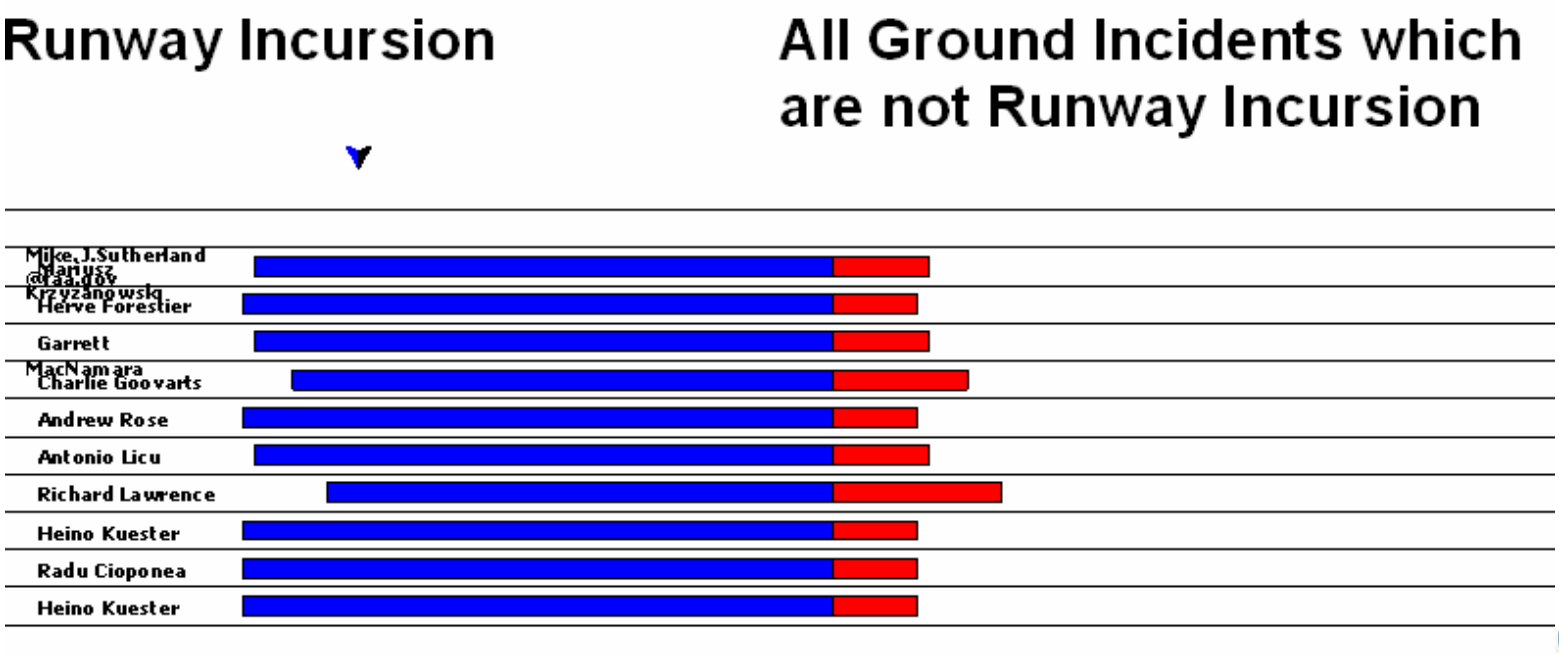
Obtaining Feedback As You Go





Pairwise comparison

- Very important: Subject Matter Experts
- Well prepared, good definitions, well explained
- Consistent weighting



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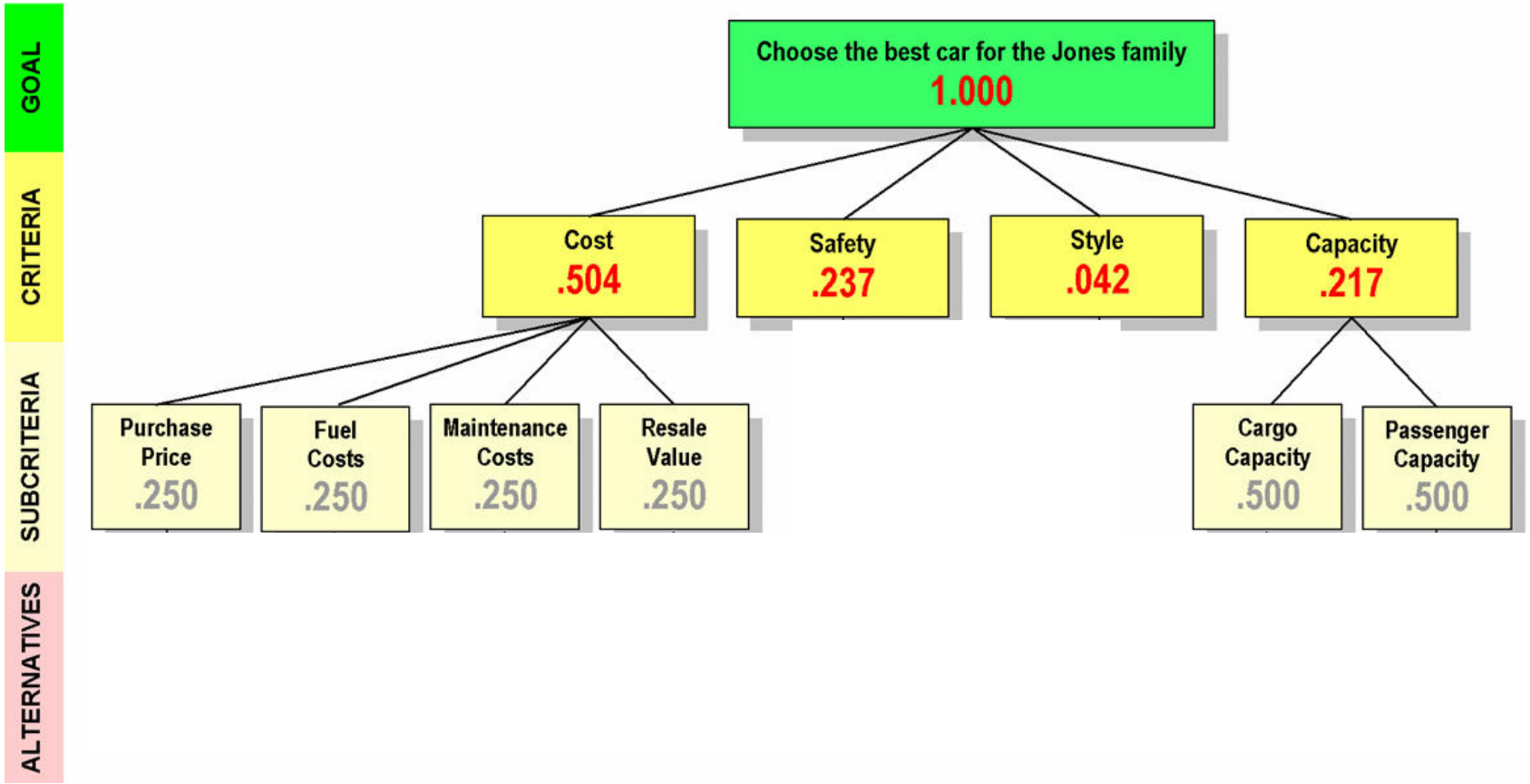
The Analytic Hierarchy Process – an example



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The Analytic Hierarchy Process – an example

GOAL

CRITERIA

SUBCRITERIA

ALTERNATIVES

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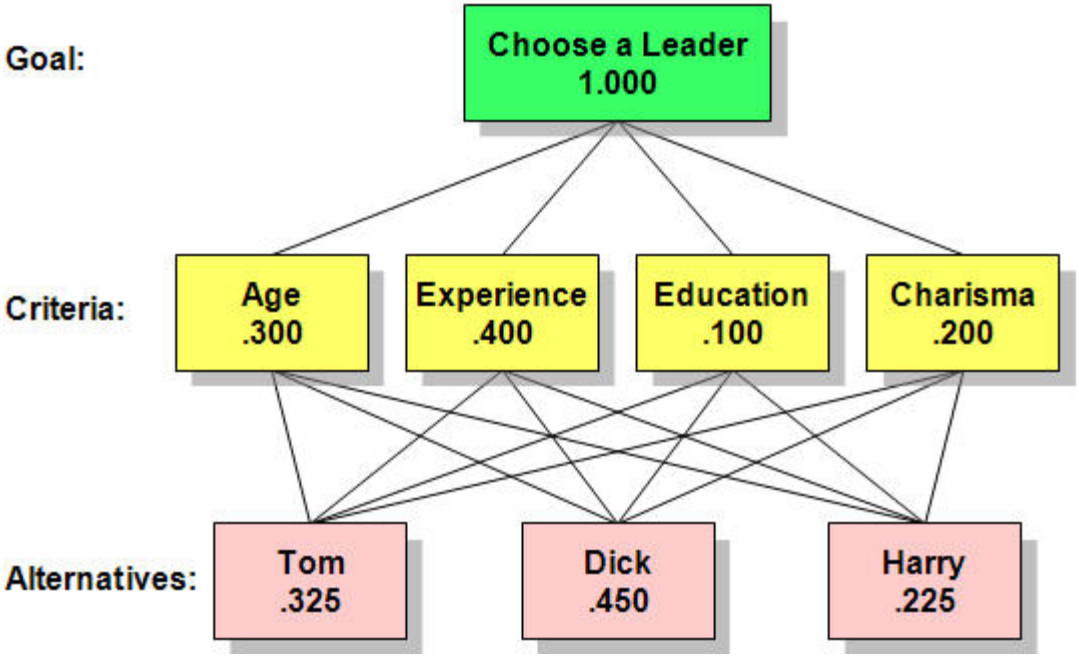
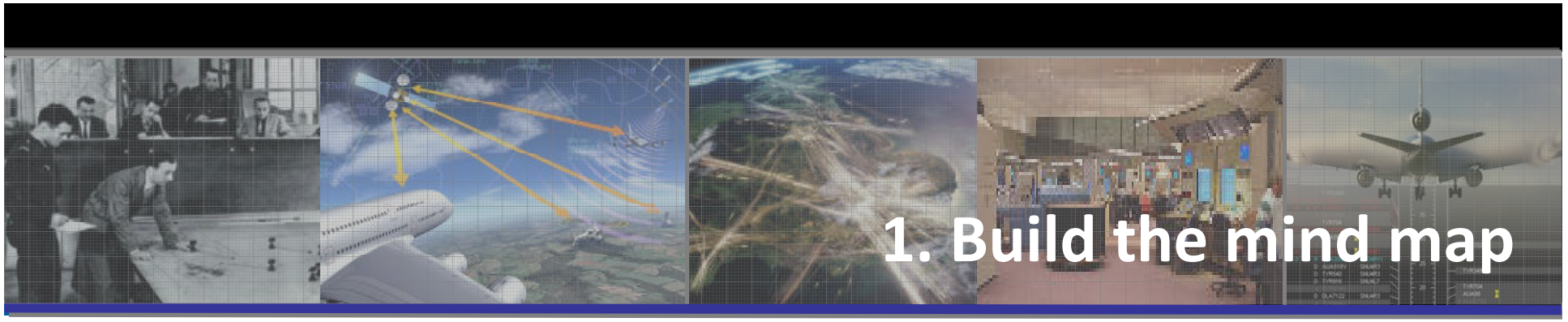
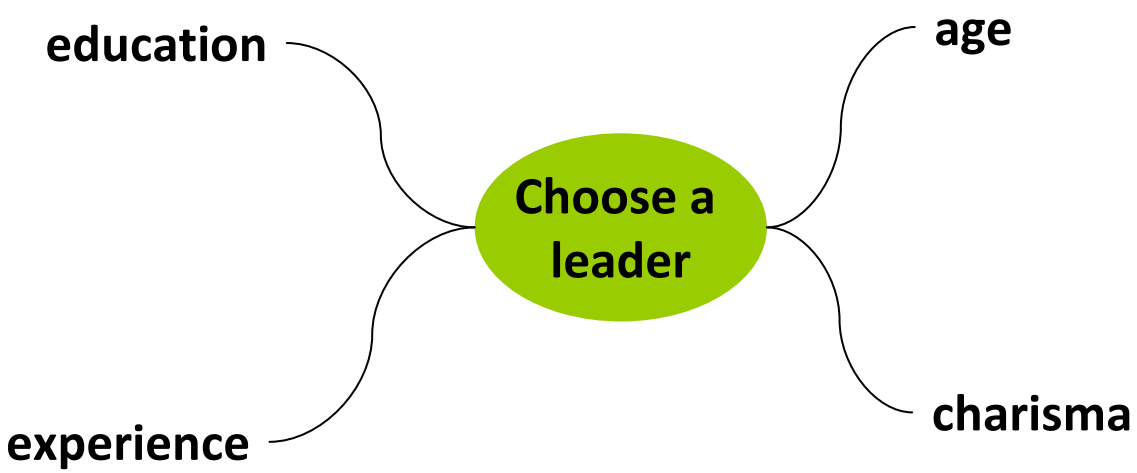
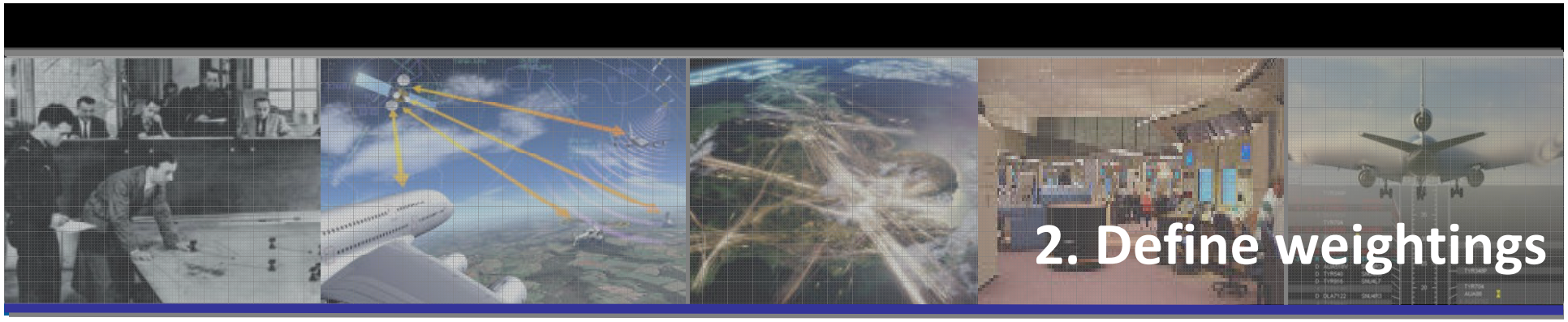
The Analytic Hierarchy Process – Another Example





1. Build the mind map





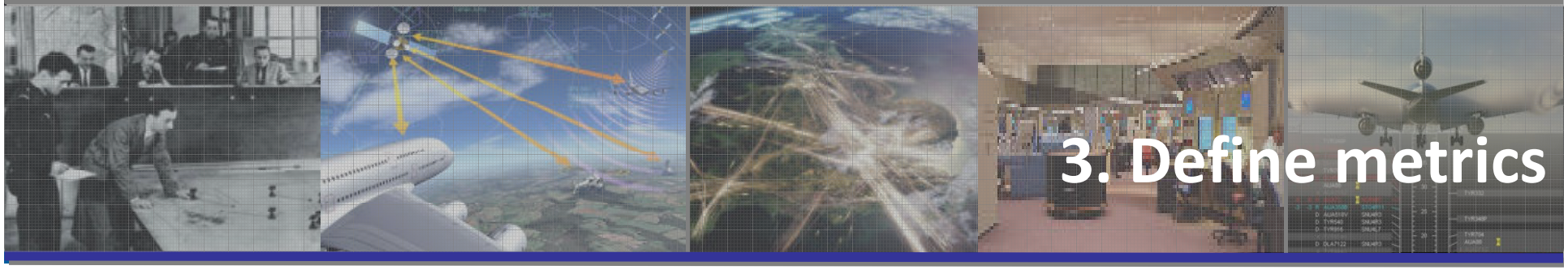
education

age

Choose a leader

experience

charisma



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	

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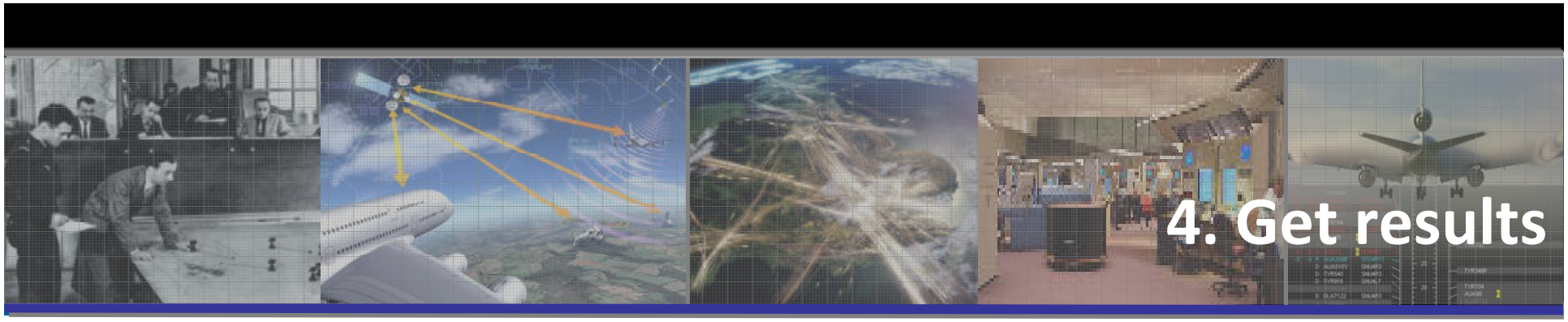

TOM (?)

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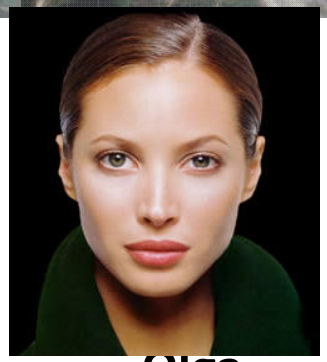
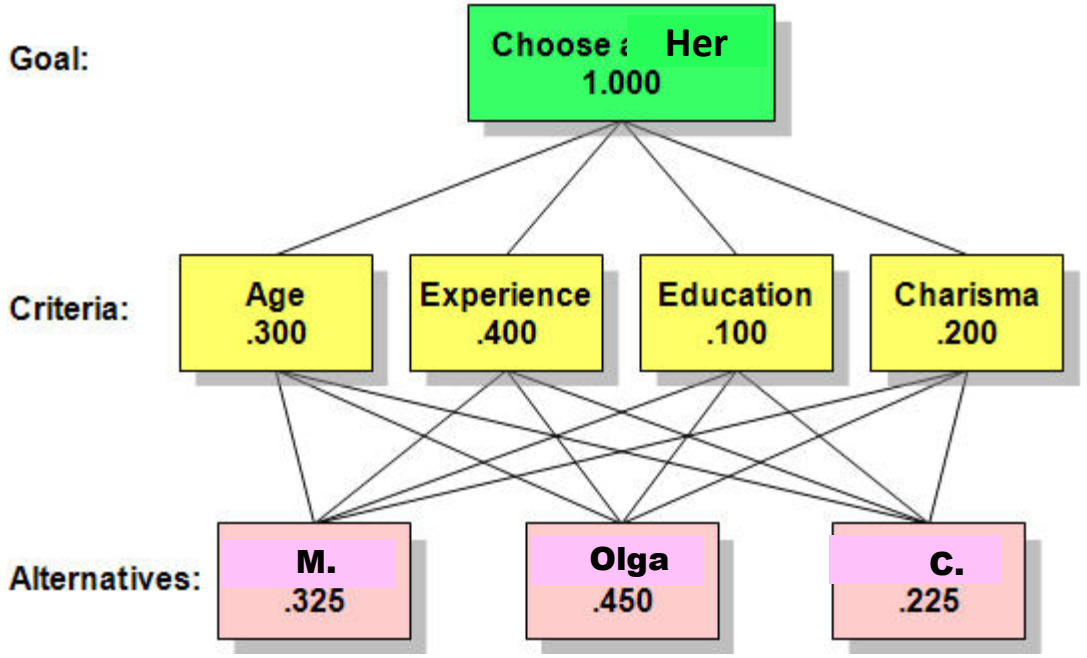
The Analytic Hierarchy Process – Another Example

M.



Olga

C.



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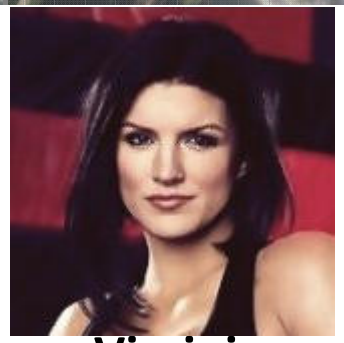
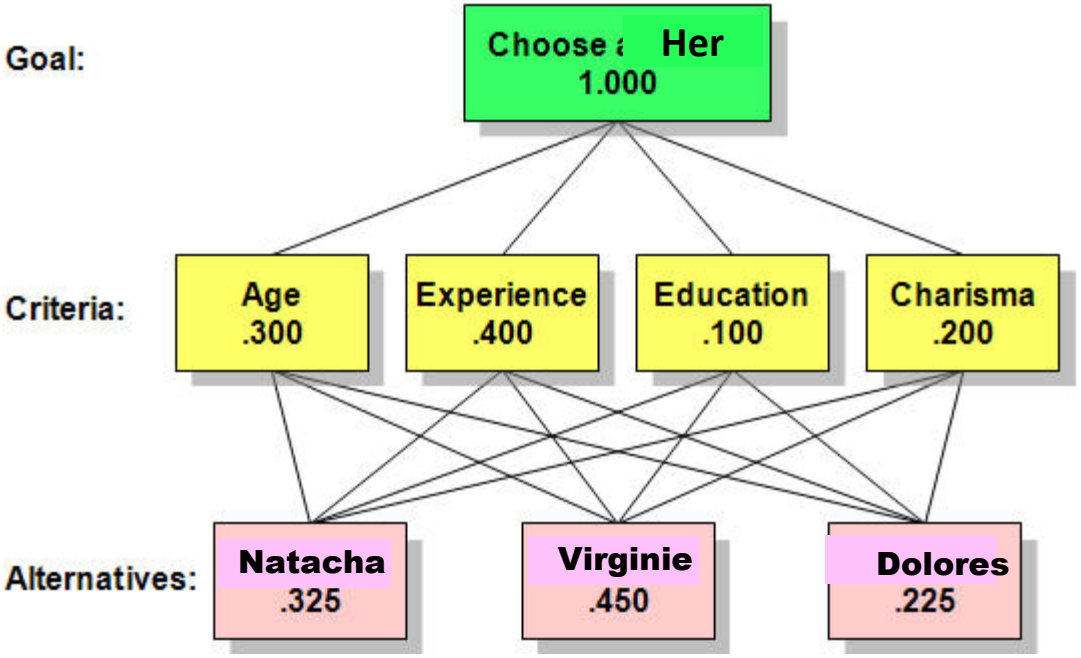
The Analytic Hierarchy Process – Another Example

Natacha



Virginie

Dolores



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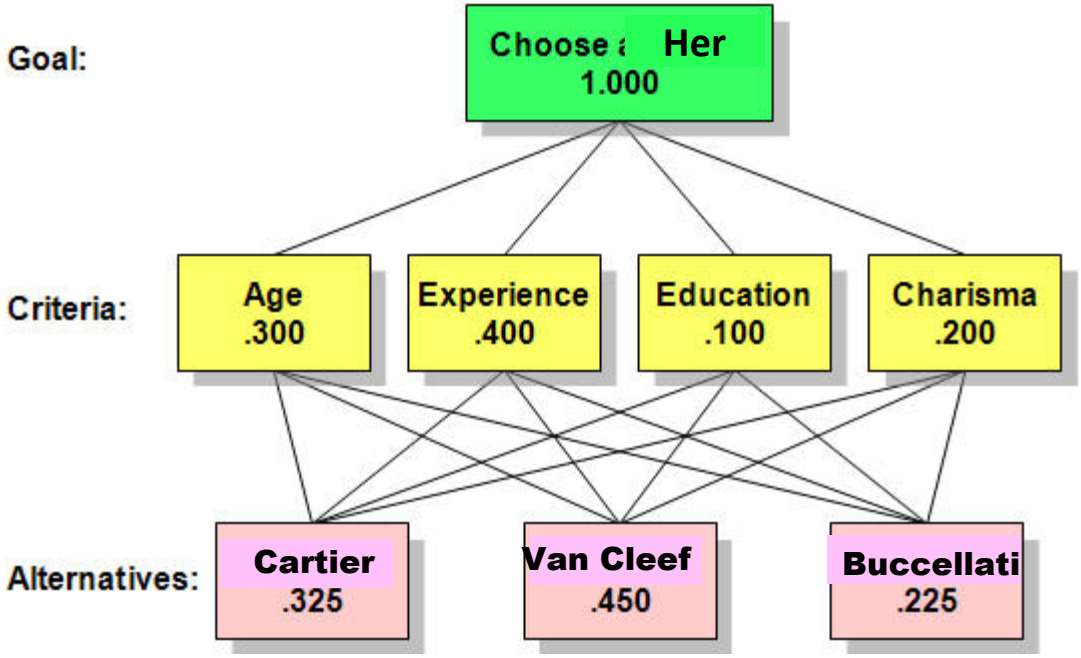
The Analytic Hierarchy Process – Another Example

Cartier

Van Cleef

Buccellati



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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?”

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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 is size and scope.

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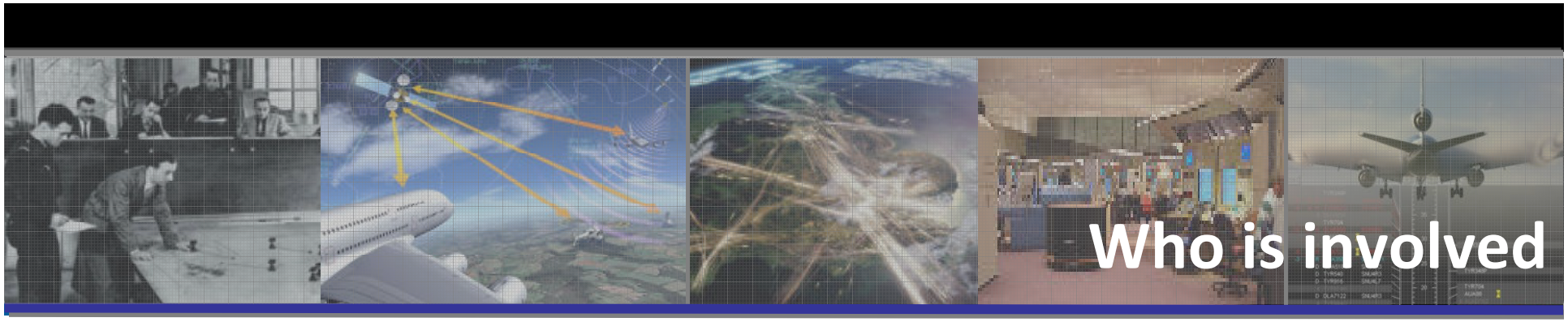

Who is involved

- FAA
  - Imperial College, London
  - easyJet Airlines
  - U. S. Navy's Aviation Safety Center
  - Albuquerque New Mexico and Denver Colorado Air Route Traffic Control Centers (ACCs)
  - Southwest Airlines
- EUROCONTROL &
  - Ireland (IAA)
  - UK (NATS)
  - Germany (DFS)
  - France (DSNA)
  - Poland (PANSA)
  - Netherlands (LVNL)
  - Hungary
  - ENAV
  - ROMATSA
  - NAV
  - FABs (BLUEMED)
  - …

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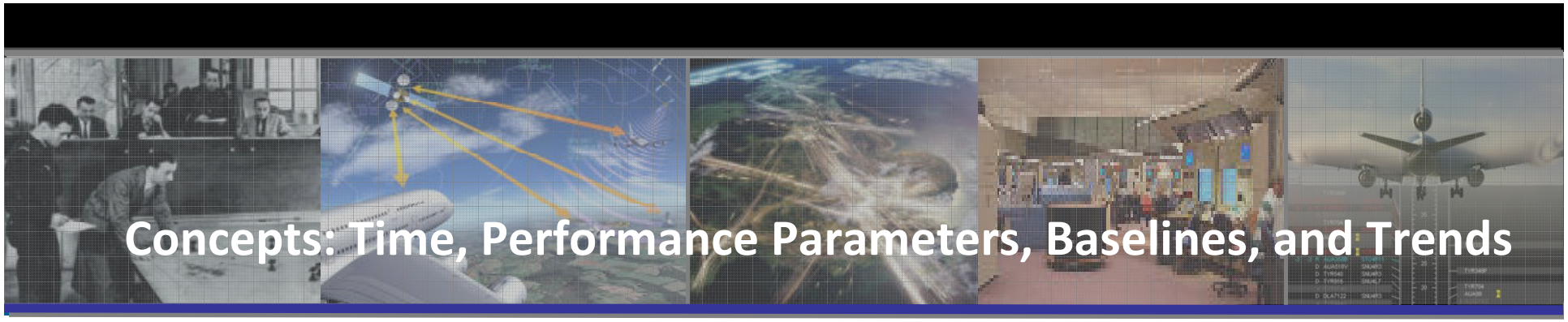
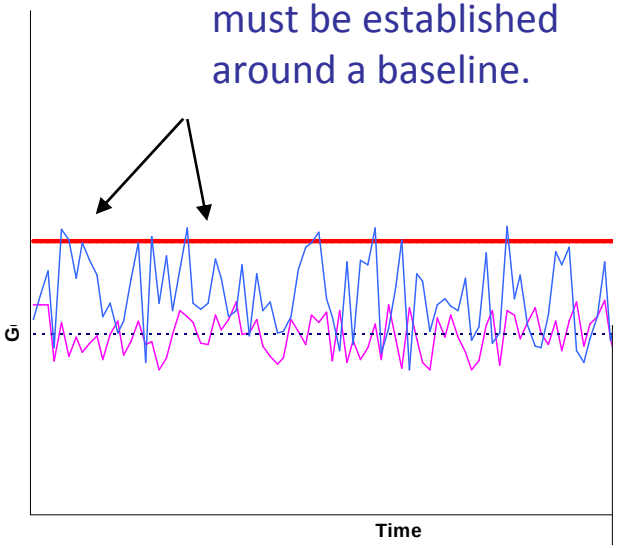
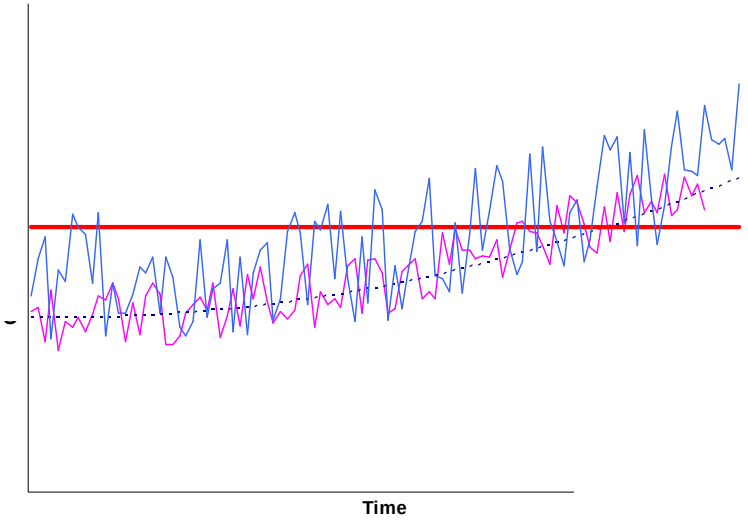


Concepts: Time, Performance Parameters, Baselines, and Trends

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

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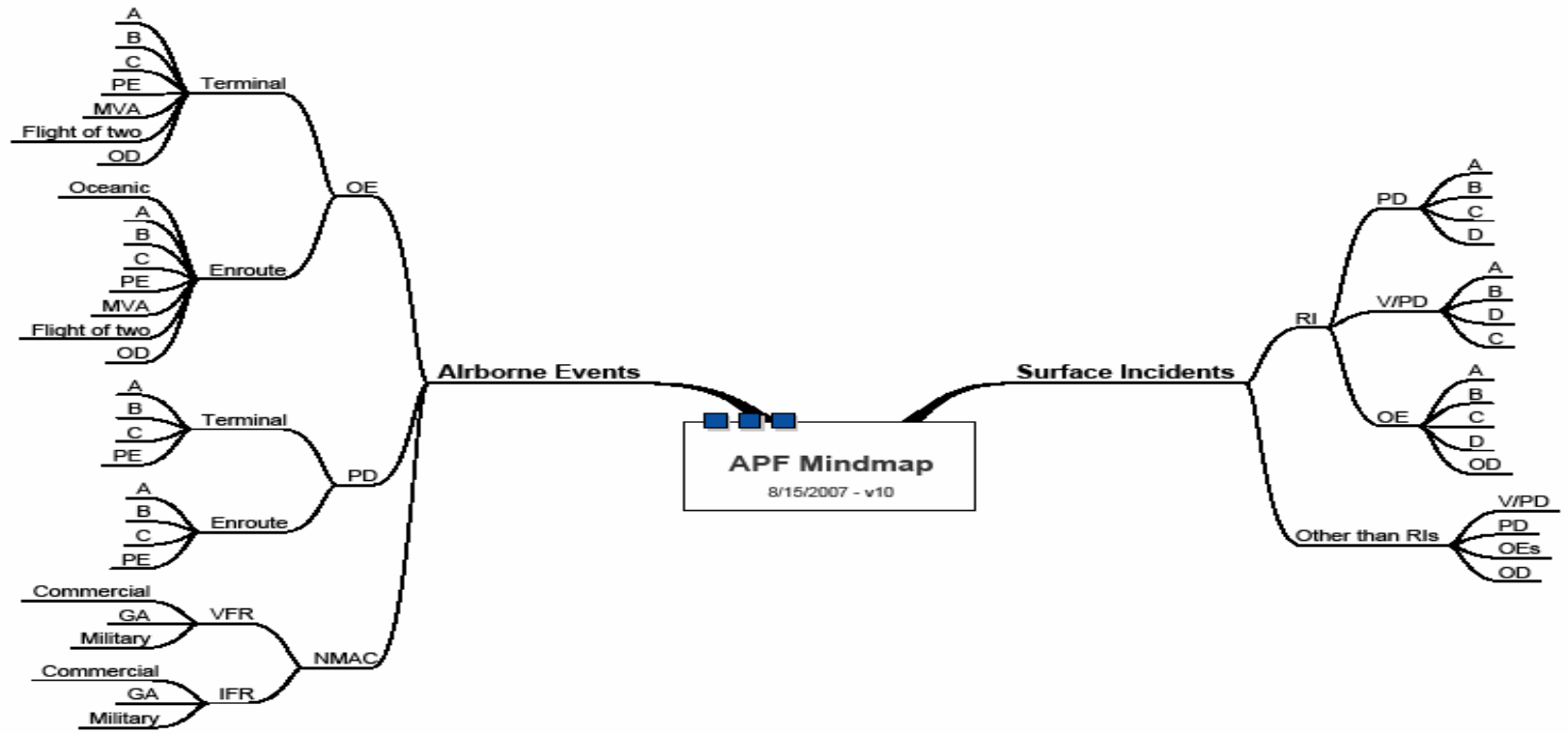
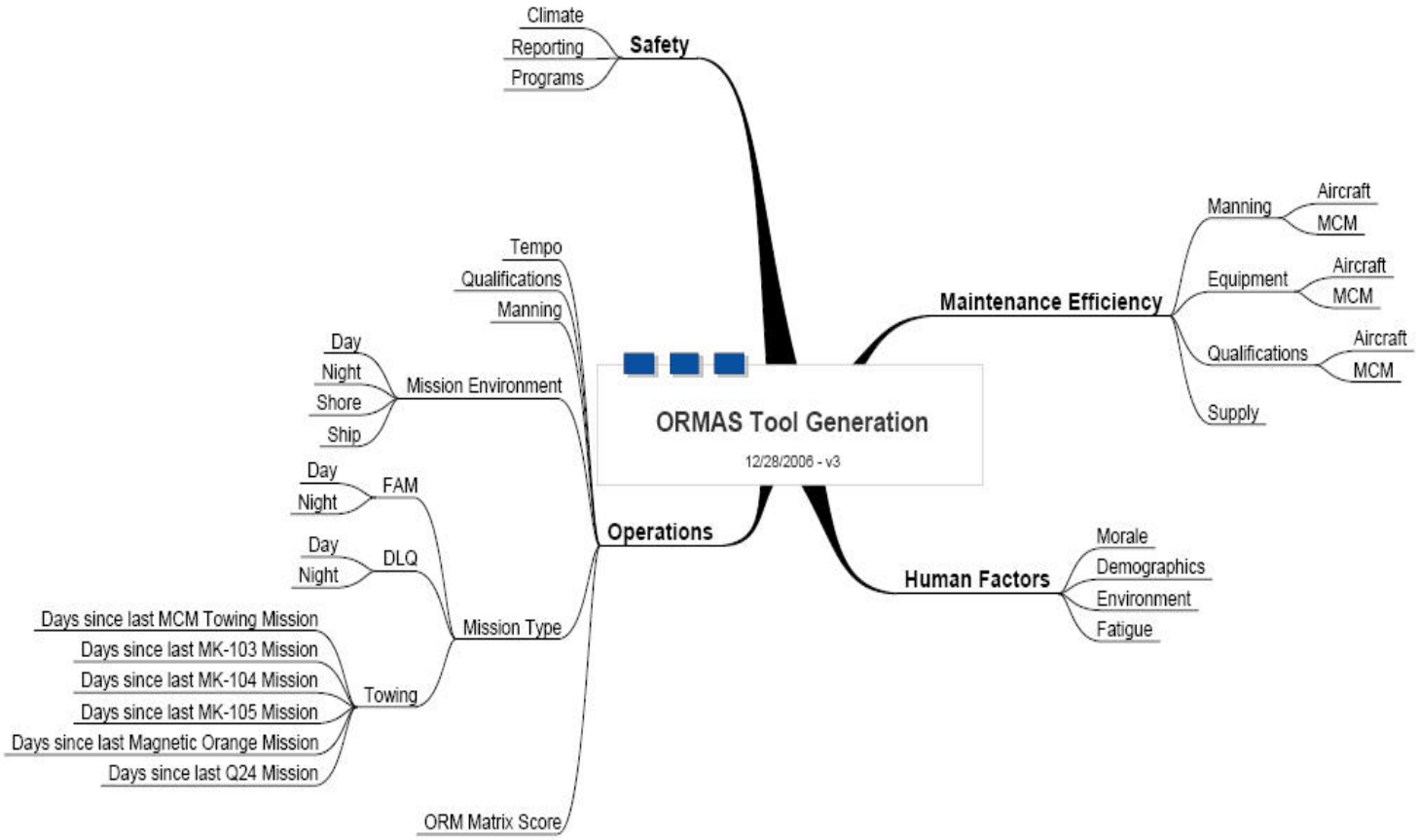
First ANSP (FAA) Mindmap; Development Of A Simple Version



First US Navy Mindmap: More Complex



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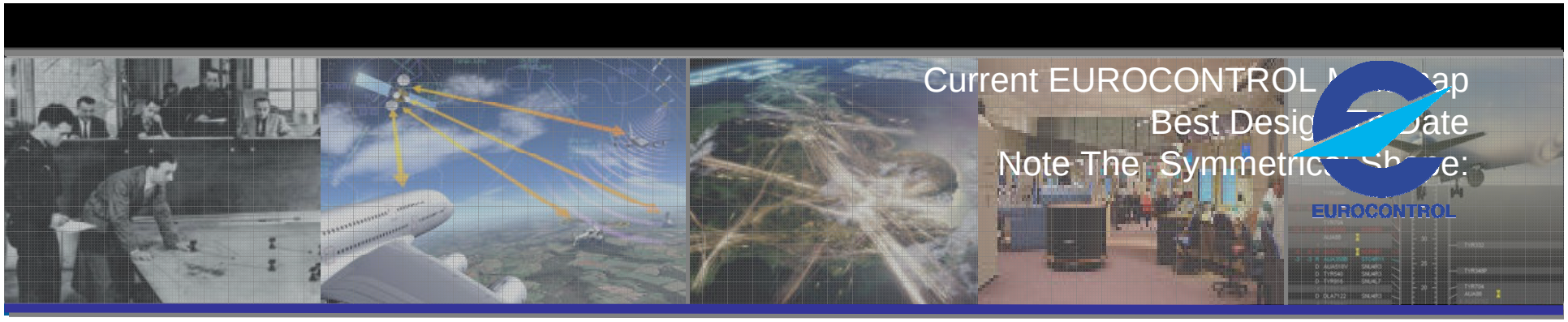

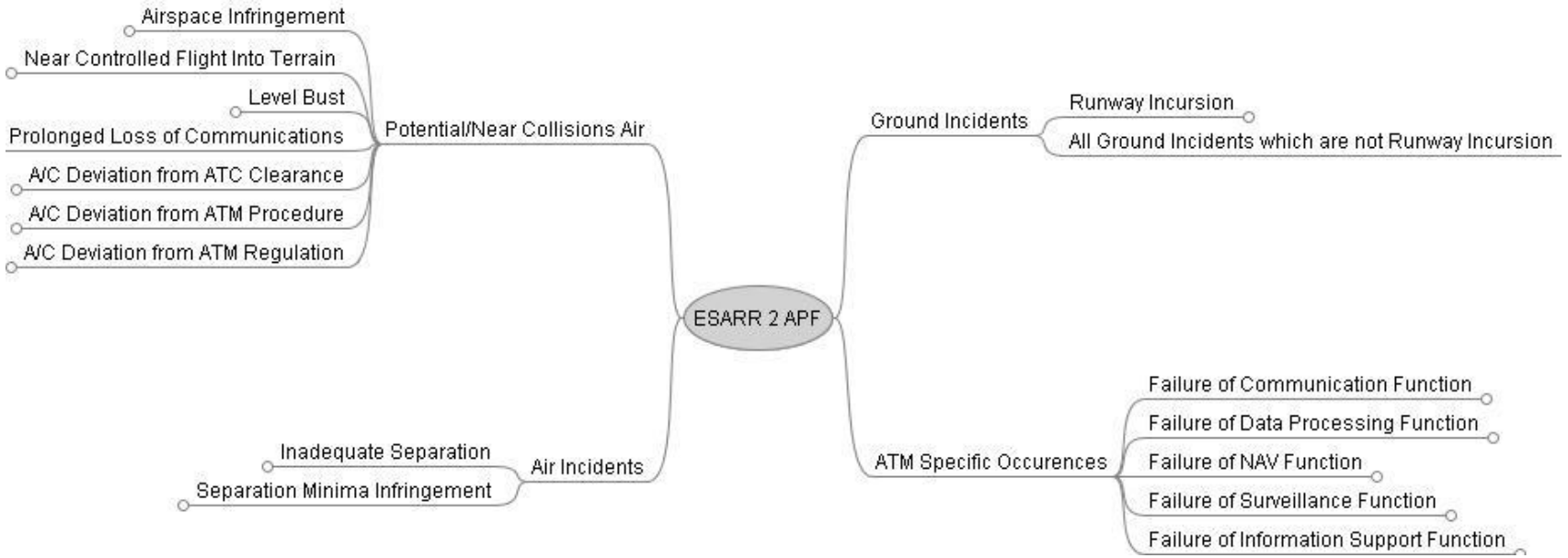

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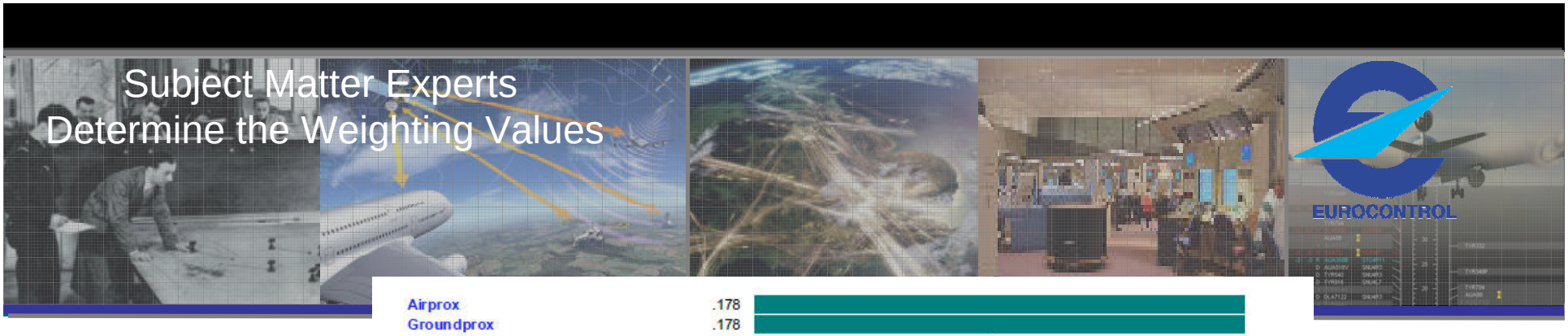
Subject Matter Experts Determine the Weighting Values



Airprox	.178
Groundprox	.178
Wake Turbulences	.087
Birdstrike	.061
Movement	.044
Wind and Windshear	.039
Runway/Taxiway Excursion	.037
Separation Issue	.028
TCAS	.027
Crew Illness - Injury	.025
Unstabilized Approach	.024
Icing	.022
Propulsion - Engine	.019
Under-carriage	.017
Fuselage	.017
Vehicle and/or Pedestrian	.016
Infrastructure	.015
Take off or Landing Clearance Issues	.014
Level Bust	.013
Insufficient Visual reference	.012
Security	.011
Non-Movement area	.011
Lightning	.009
Flight Plan	.009
Company and Engineering	.009
Weather	.009
Weather/Other	.008
Procedures	.007
Communication	.007
Bird - Damage	.006
Crew Fatigue - Stress	.005
ATC Services Standard	.005
Violation	.005
Configuration/Automation/Manual Skills	.004
Runway Conditions	.004
Miltary and Other	.004
APU	.003
Pushback Clearance	.002
Limited or No Communication	.002
Other Animal Strike	.002

Distributing the “Value of 1.0”

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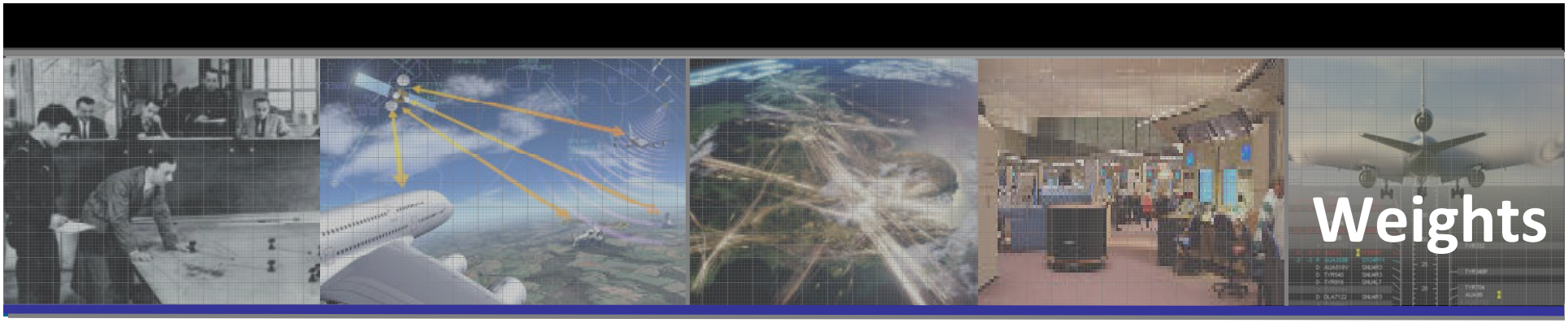

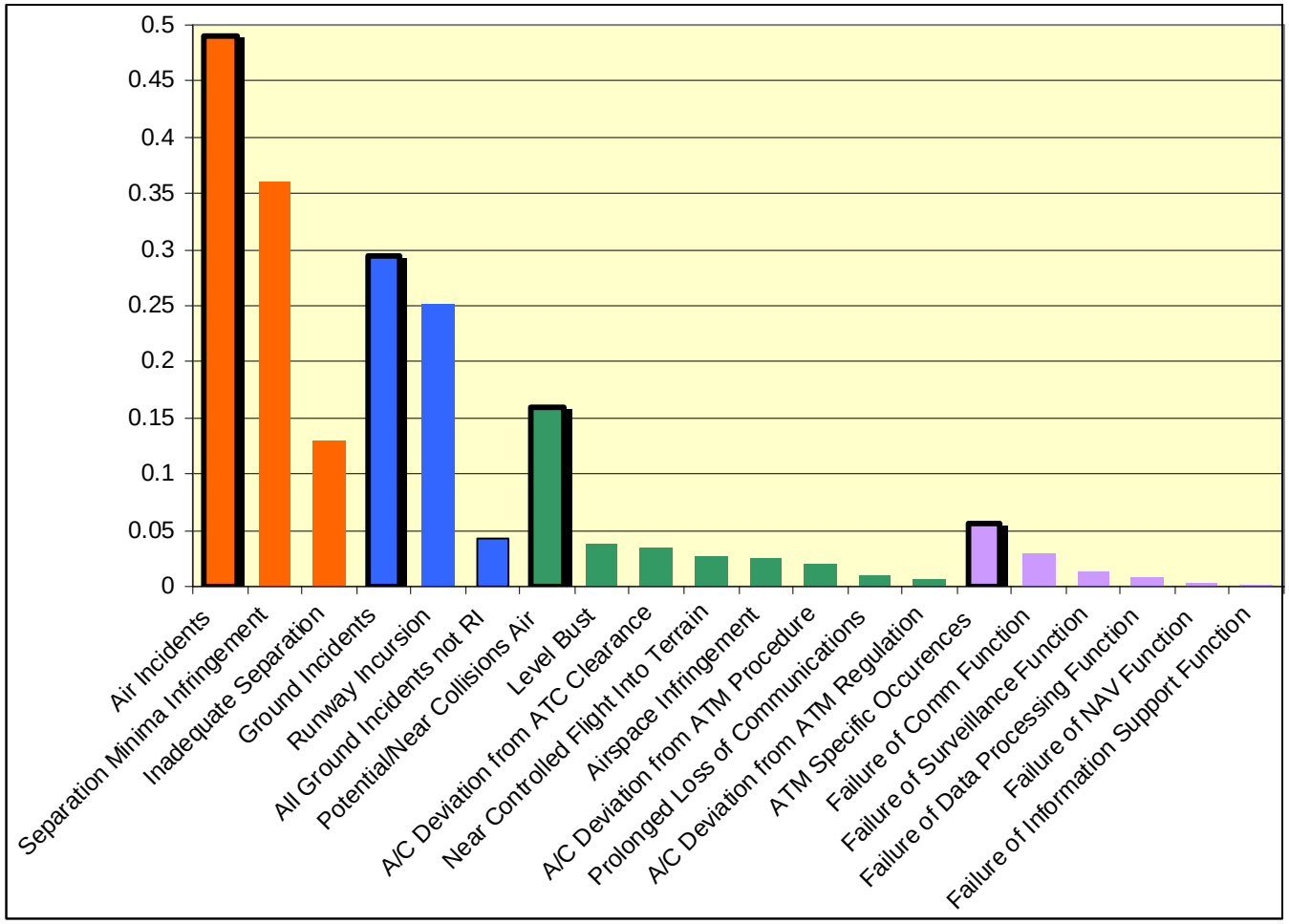

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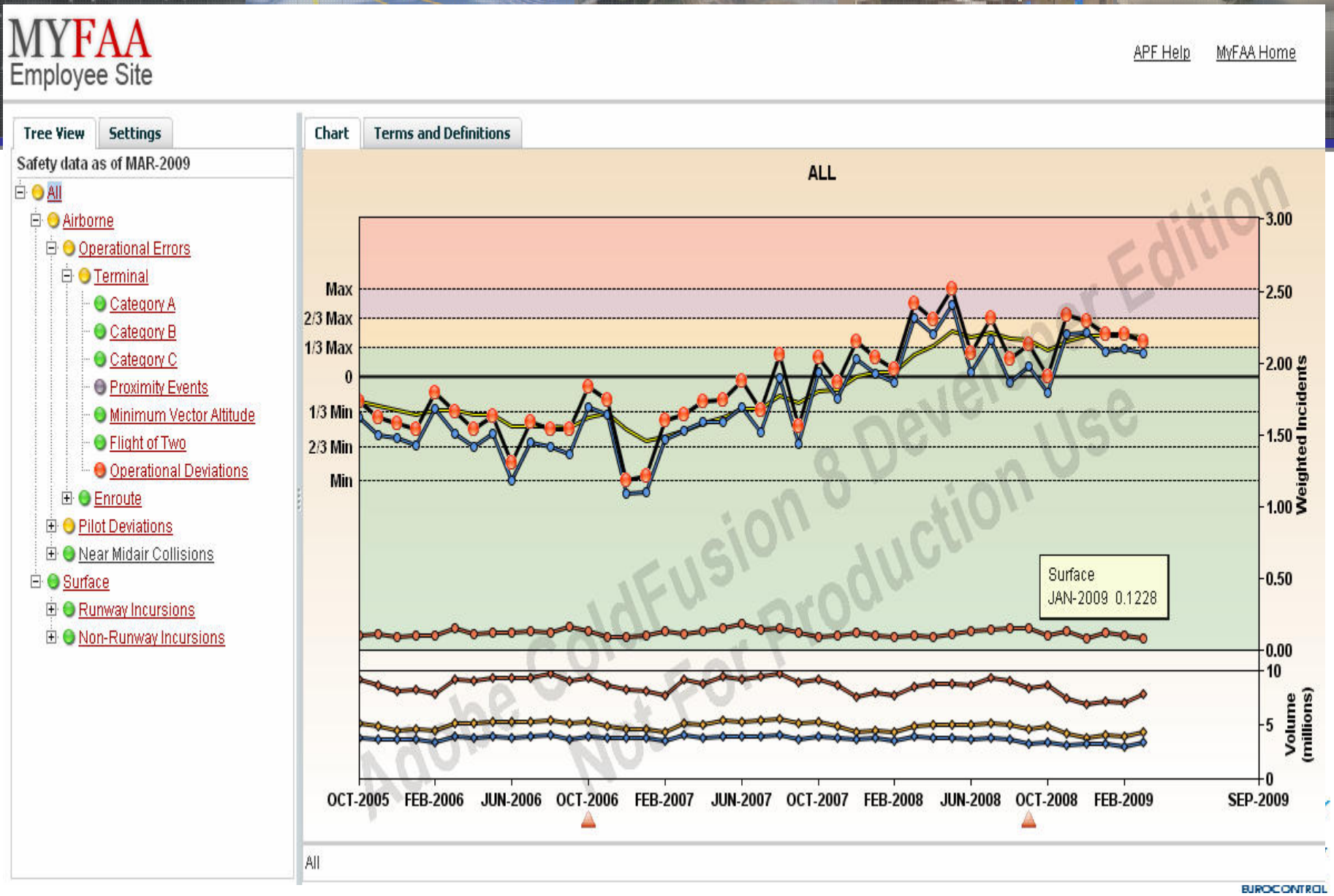
An Example Of The "New" Data Display Methodology Development



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

Tree View | Settings

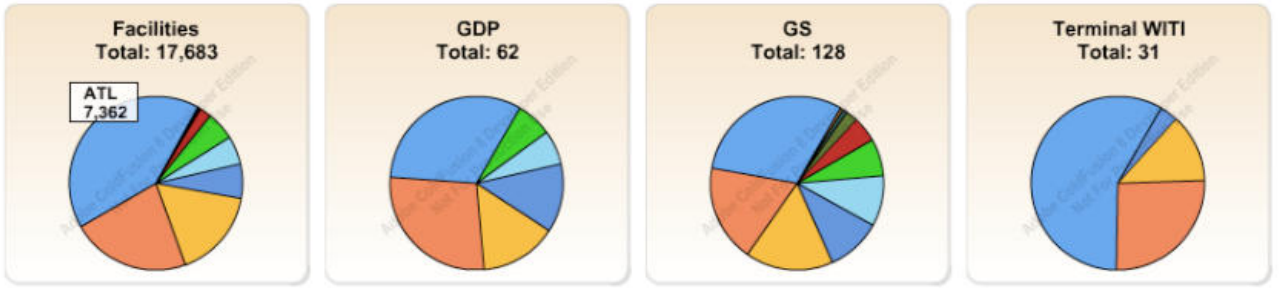
Headquarters data as of MAR-2009

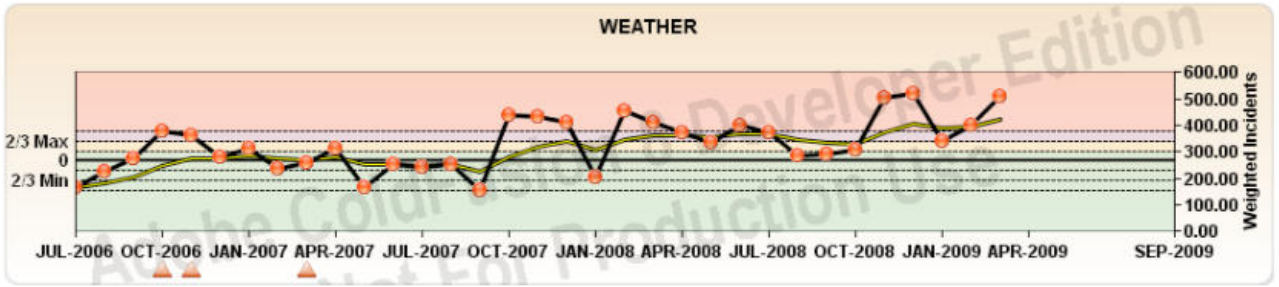
- Efficiency APF(e)
  - Enroute
  - Terminal (OEP 35)
    - Western Terminal
    - Central Terminal
    - Eastern Terminal
      - Delays
        - Volume
        - Weather
        - Equipment
        - Runway
        - Other
      - Available Capacity
      - WITI

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

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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.

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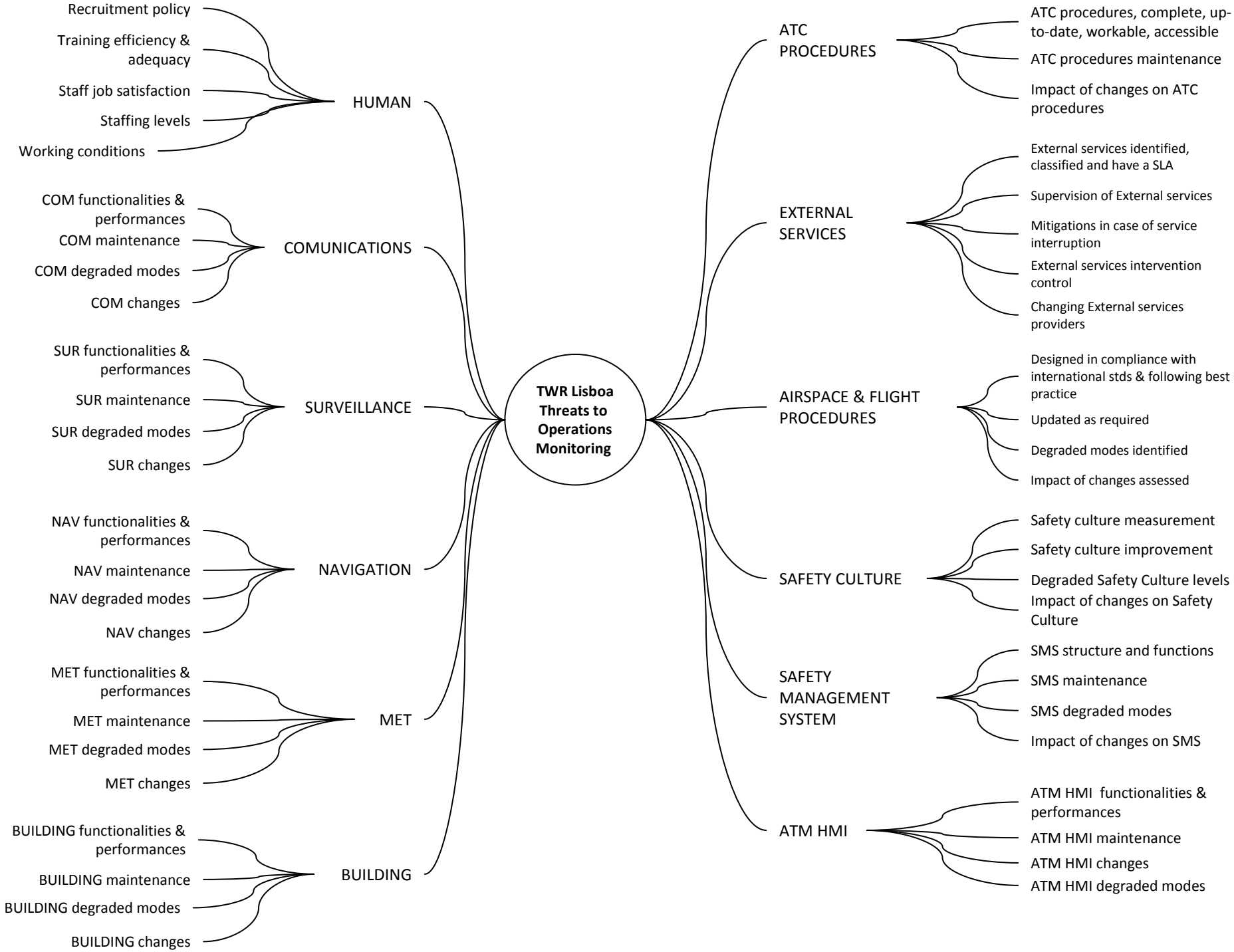
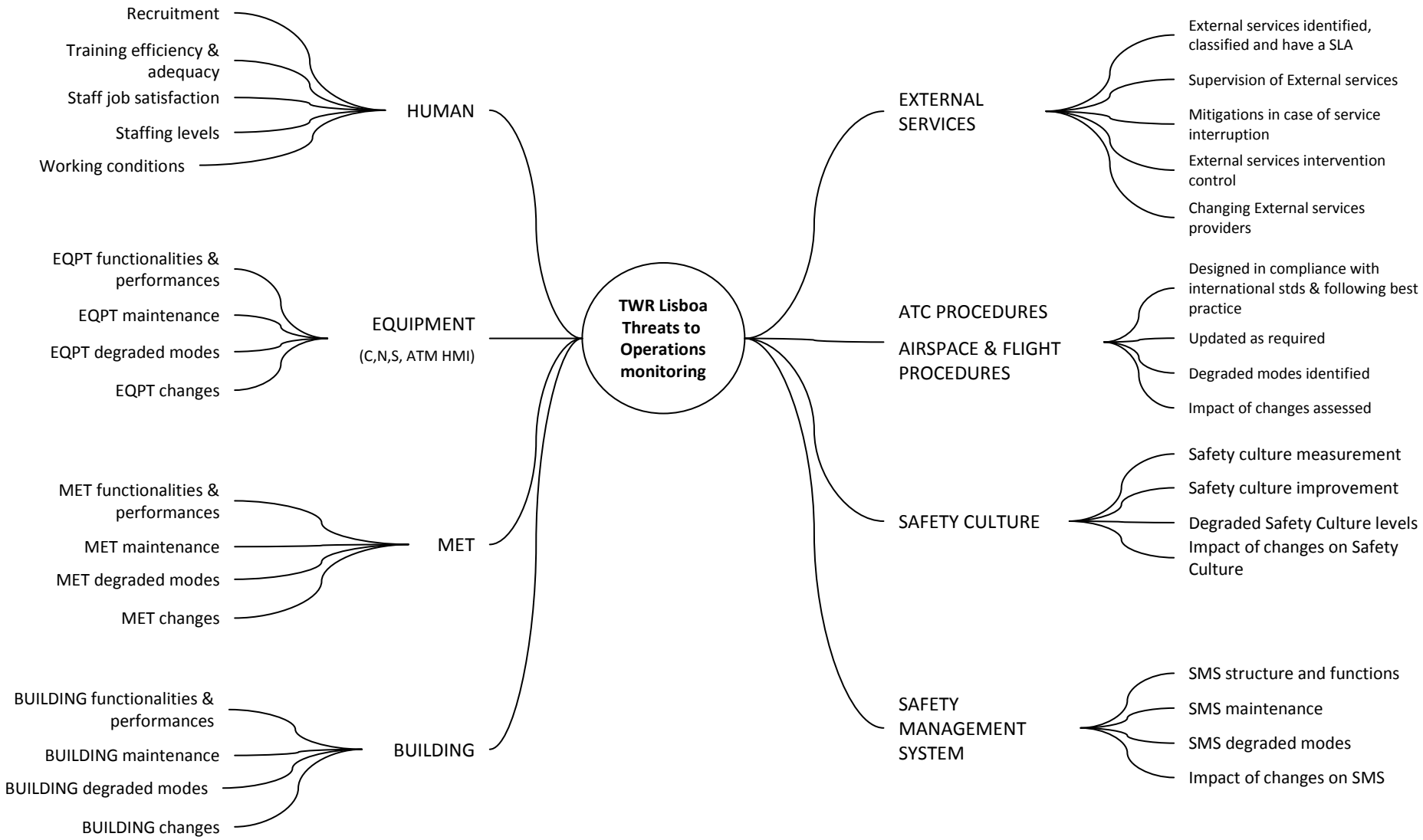
- EXERCISE


TWR Lisboa Threats to Operations Monitoring
HUMAN
Recruitment policy
Training efficiency & adequacy
Staff job satisfaction
Staffing levels
Working conditions
COMUNICATIONS
COM functionalities & performances
COM maintenance
COM degraded modes
COM changes
SURVEILLANCE
SUR functionalities & performances
SUR maintenance
SUR degraded modes
SUR changes
NAVIGATION
NAV functionalities & performances
NAV maintenance
NAV degraded modes
NAV changes
MET
MET functionalities & performances
MET maintenance
MET degraded modes
MET changes
BUILDING
BUILDING functionalities & performances
BUILDING maintenance
BUILDING degraded modes
BUILDING changes
ATC PROCEDURES
ATC procedures, complete, up-to-date, workable, accessible
ATC procedures maintenance
Impact of changes on ATC procedures
EXTERNAL SERVICES
External services identified, classified and have a SLA
Supervision of External services
Mitigations in case of service interruption
External services intervention control
Changing External services providers
AIRSPACE & FLIGHT PROCEDURES
Designed in compliance with international stds & following best practice
Updated as required
Degraded modes identified
Impact of changes assessed
SAFETY CULTURE
Safety culture measurement
Safety culture improvement
Degraded Safety Culture levels
Impact of changes on Safety Culture
SAFETY MANAGEMENT SYSTEM
SMS structure and functions
SMS maintenance
SMS degraded modes
Impact of changes on SMS
ATM HMI
ATM HMI functionalities & performances
ATM HMI maintenance
ATM HMI changes
ATM HMI degraded modes


TWR Lisboa Threats to Operations monitoring
HUMAN
Recruitment
Training efficiency & adequacy
Staff job satisfaction
Staffing levels
Working conditions
EQUIPMENT
(C,N,S, ATM HMI)
EQPT functionalities & performances
EQPT maintenance
EQPT degraded modes
EQPT changes
MET
MET functionalities & performances
MET maintenance
MET degraded modes
MET changes
BUILDING
BUILDING functionalities & performances
BUILDING maintenance
BUILDING degraded modes
BUILDING changes
EXTERNAL SERVICES
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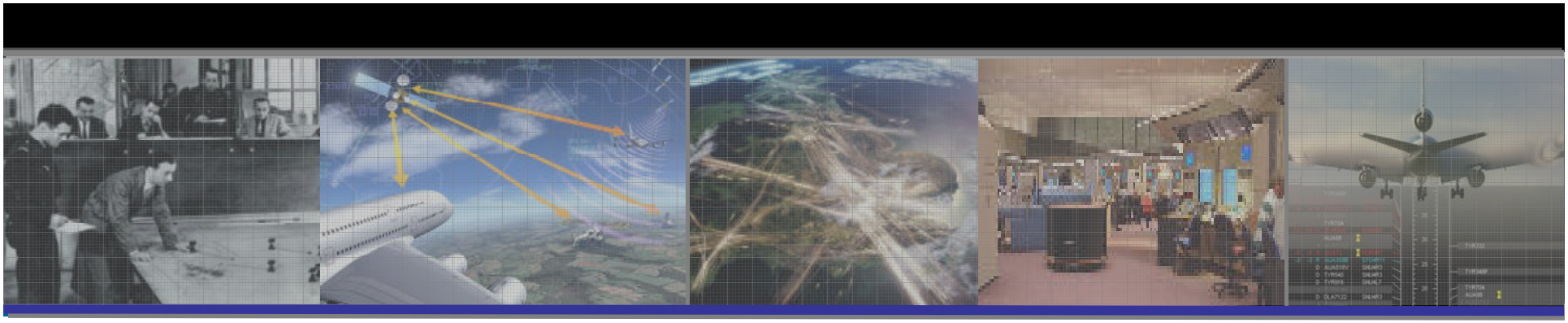
SMS structure and functions
SMS maintenance
SMS degraded modes
Impact of changes on SMS



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