THALES

An agile, user-centric approach to combat system concept design

Giorgio Venturi, Thales Naval Netherlands
Innovation department

13/06/2005

Research context

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

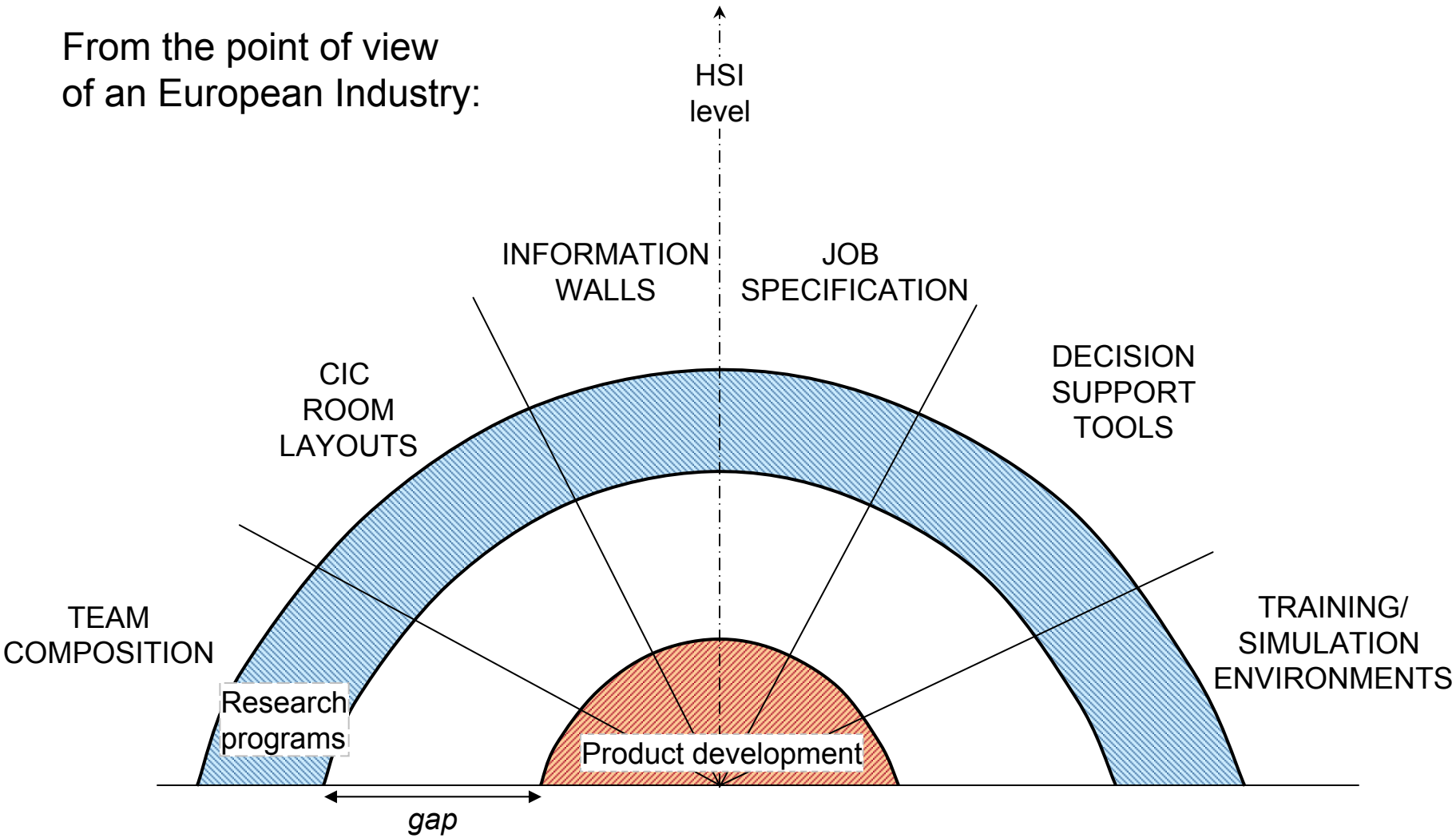
We needed in TNNL a common framework for a number of new product development activities in which human factors are and will be involved. These projects/programs share the following common features:

- Development of new concepts at different levels:
  - Team composition,
  - CIC room layouts,
  - Information walls,
  - Job specification,
  - Decision support tools,
  - Training/simulation environments.
- Concepts are driven by the current evolution in CONOPS.

Research/product development gap

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

From the point of view
of an European Industry:



13/06/2005

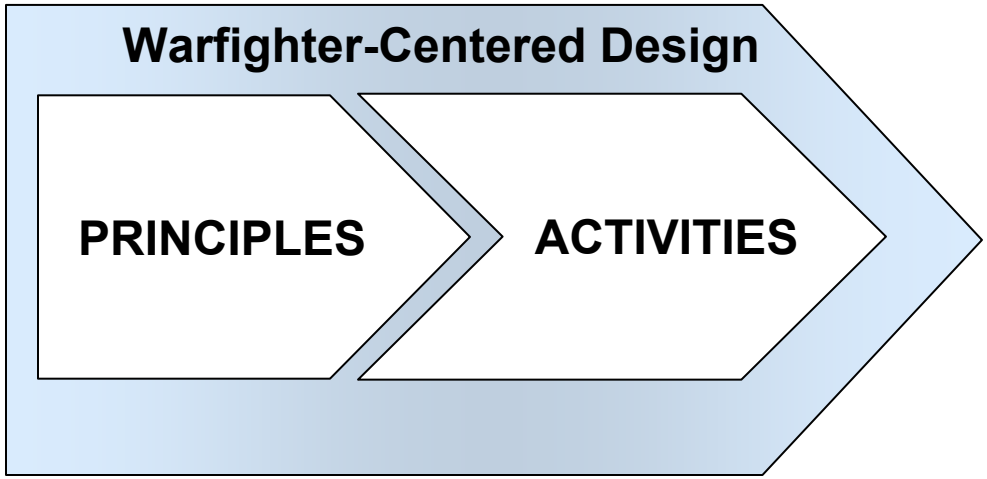
THALES

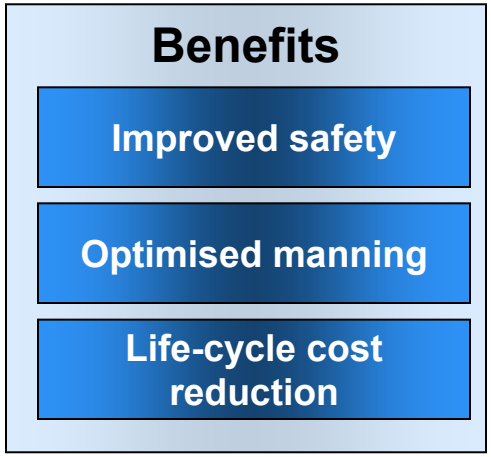
Main goals and objectives

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

Being aware of the massive body of knowledge in human factors engineering, we decided to synthesize the underlying **principles** and **activities** under the name of Warfighter Centered Design (WCD).

We also outlined in this paper the benefits we expect from such an “agile” approach.





Outline

- Introduction
- ➔ WCD principles and activities
- The Vincennes incident
- WCD business benefits

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

The principles of the WCD approach†

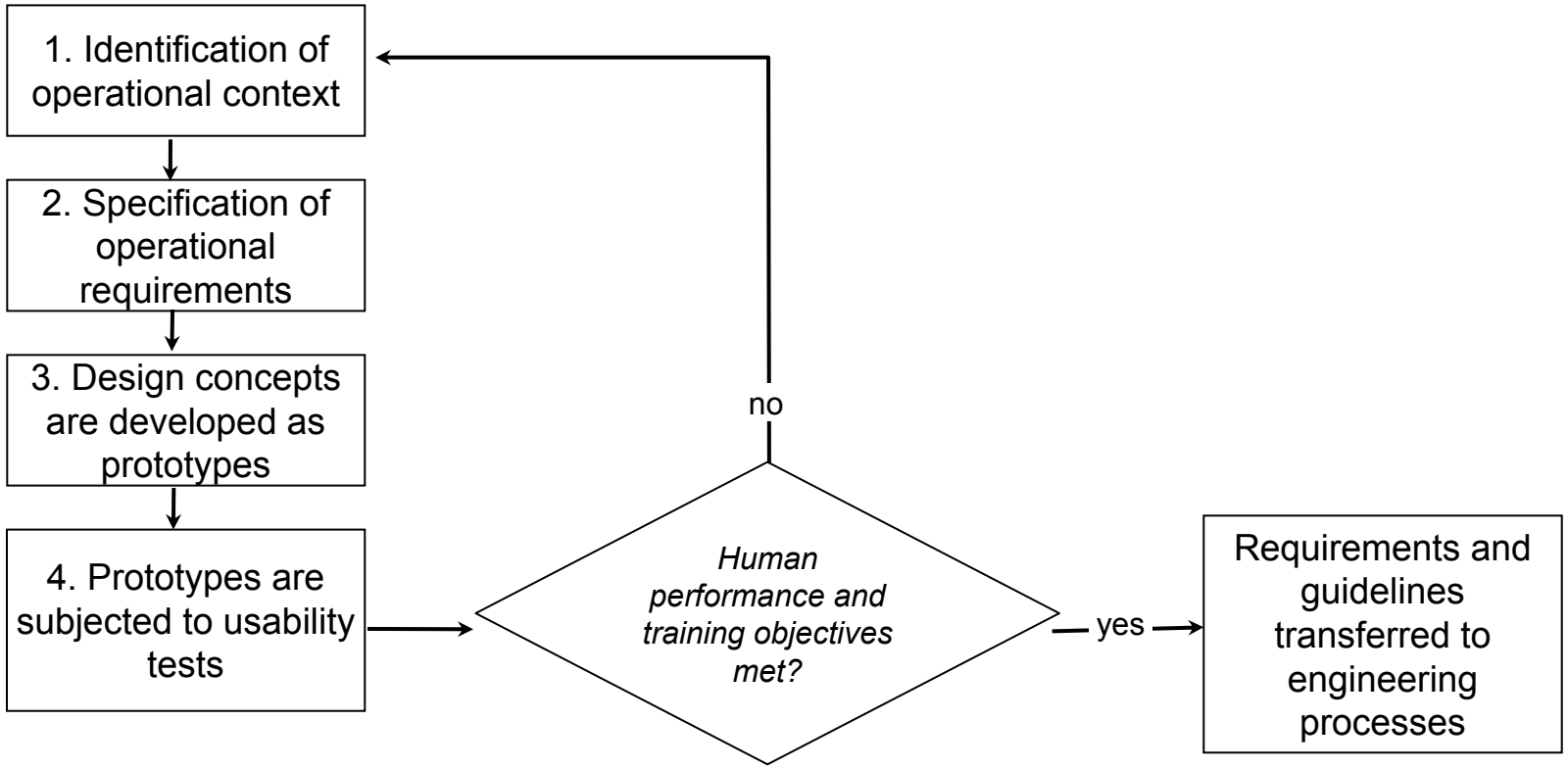
© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

1. Allocation of function
   A. appreciation of human capabilities and limitations,
   B. understanding of the particular demands of the task.
2. User involvement
   A. elicitation/analysis of user knowledge of task & environment
   B. user-based evaluation of the demonstrators
3. Iteration
   A. operational tasks are carried out w/the prototype.
   B. Formative evaluation is used to improve requirements&prototype
4. Multi-disciplinary teams

   (Warfighters, operational and HF experts, S. Engineers, etc.)

† ISO/IEC 13407 **Human-Centred Design Processes for Interactive Systems**. ISO/IEC 13407: 1999 (E).

WCD key activities



Iterative design is carried out in a number of iterations of the main four activities.

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

Business benefits of WCD

- Introduction
- WCD principles and activities
- ➔ The Vincennes incident
- WCD business benefits

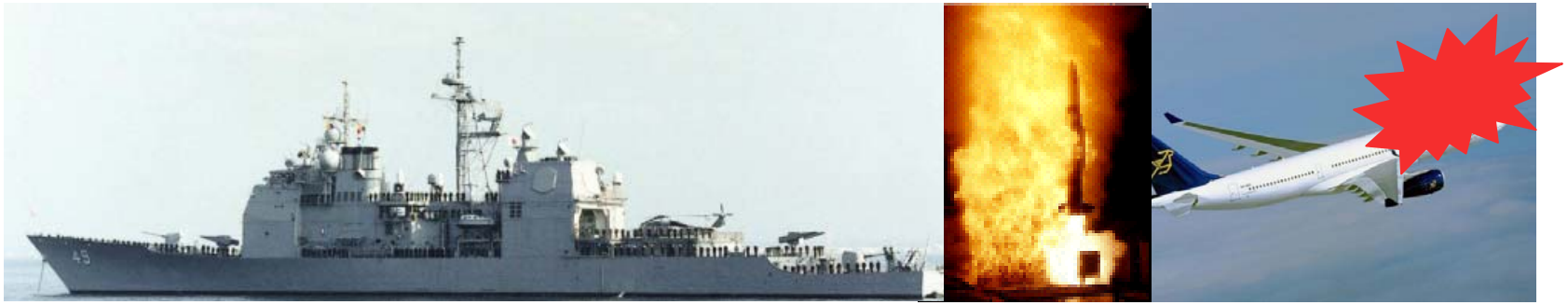
© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

What happens if HFE is ignored in the engineering of combat system…

July 3, 1998. Vincennes shoots down an airliner while engaging Iranian gunboats in the Persian Gulf. The airliner was wrongly classified by the crew as hostile and therefore engaged.

Despite the cause of the incident was focused on the human error, the system also played a part in it.

Vincennes Aegis combat system exhibited serious usability issues that could have been avoided through HFE:



© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

Aegis usability flaws (1): contact data

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

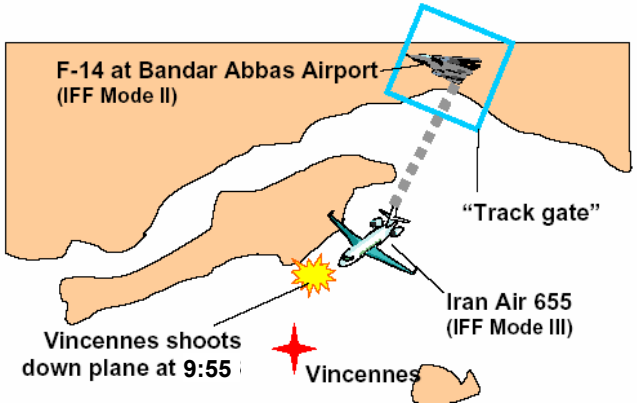
1) Although three large displays show every contact, “to get speed, range, and altitude,” the operator must explicitly select it that information, which is subsequently displayed on a tiny 12-inch monitor (the lower part of the console).

Most importantly, this display does not include the track’s altitude rate of change, forcing the operator to compare data taken at different times and make the calculation in his head, on scratch pads, or on a calculator—maybe during an engagement like in this case.

Aegis usability flaws (1): track gate

2) While the radar operator was examining the oncoming contact (Flight 655) with his trackball cursor, the IFF displayed its reading from the last "track gate" location.
What is the "track gate"?

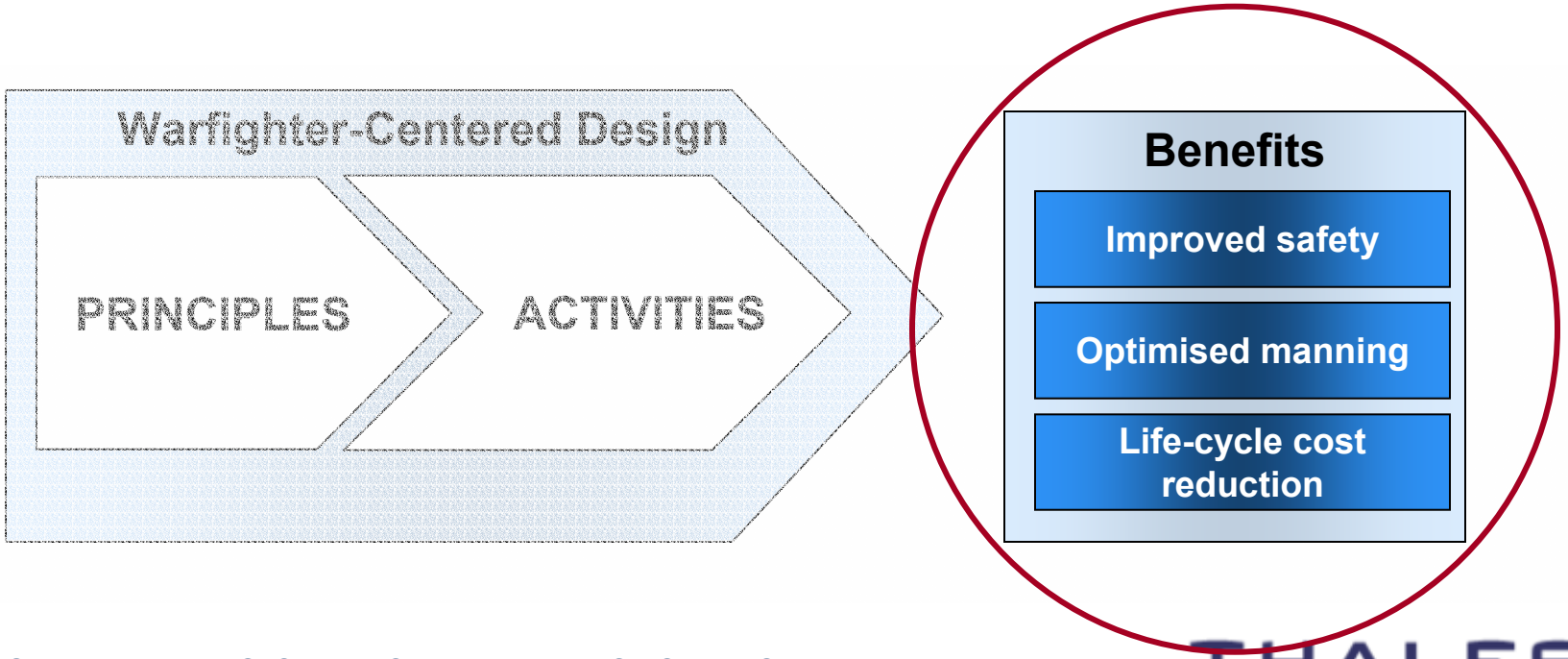
This "gate" is essentially a box that the ship's radar monitors for various signals (such as IFF); if it isn't explicitly moved, it stays in place. Thus, while the civilian Airbus plane was correctly emitting an IFF Mode III signal, the radar picked up the IFF Mode II signals from an F-14 still at the Bandar Abbas Airport.



© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

Business benefits of WCD

- Introduction
- WCD principles and activities
- The Vincennes incident
- ➔ WCD business benefits



© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

Safety analysis aims & process

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

Safety in HSI is normally dealt by Safety Analysis (SA).

- The objective of the SA is to achieve a minimal level of risk (within the constraints of operational effectiveness, time and cost).
- Main contribution of SA is defining a modelling and analysis process through which the risk deriving from the usage of complex systems can be elicited and estimated.

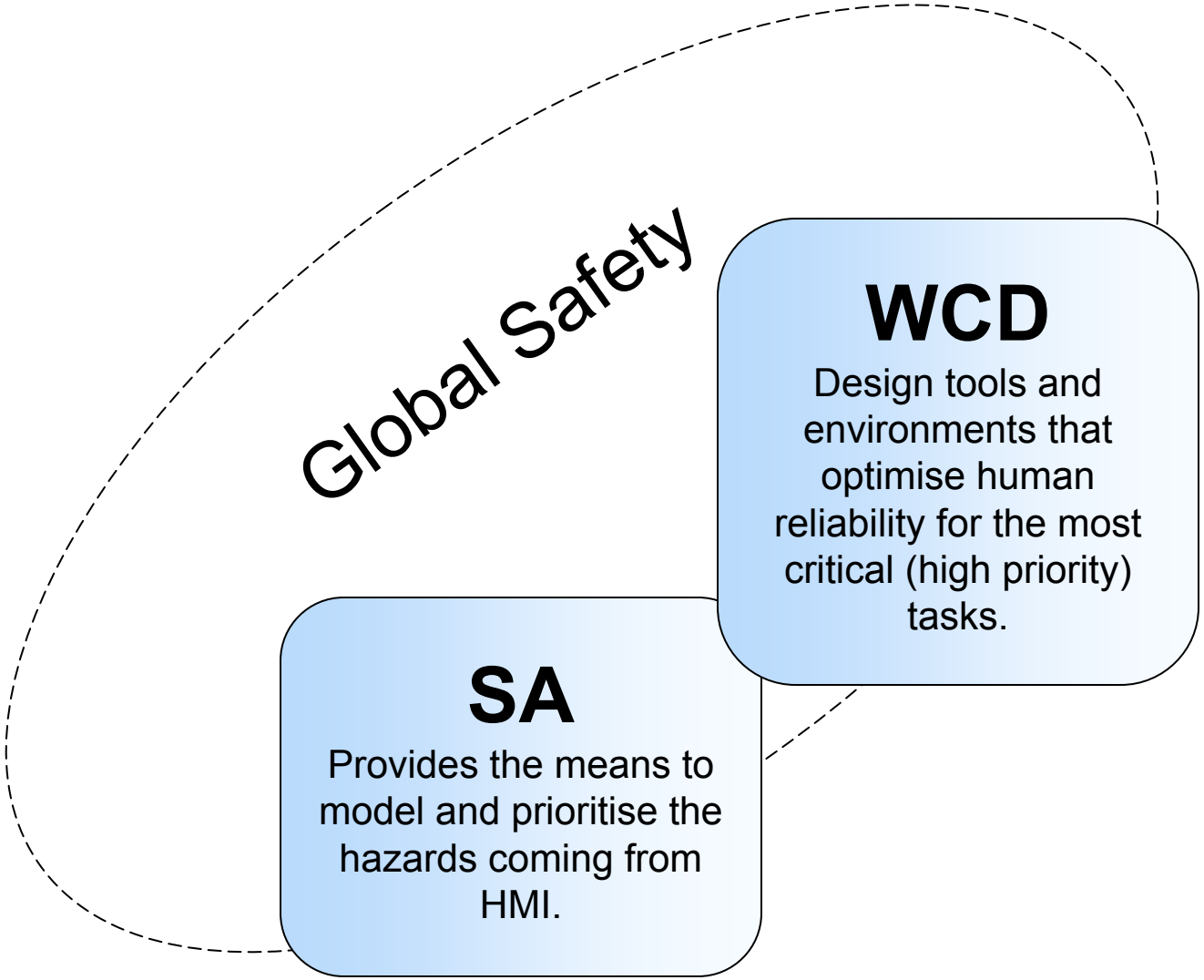
Safety analysis and human error modelling

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

Human can be outside or inside of the scope of the analysis, with some limitations.

- The first limitation regards if we can forecast the sources of human error in the combined breakdown of causes (FTA) or consequences (FMEA of Event Tree).
- The second limitation is estimating the hazard probability: it is only possible for typical levels of warfighters' tasks and workload.
- Third, analytical techniques cannot say <u>how</u> to reduce the risk related to human error.

The combination of WCD and SA improve global safety



© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

CONOPS evolution

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

Navies worldwide face today the challenge represented by these three operational trends:

1) Scenarios: from **blue water** – to→ **littoral** (brown water).

2) Warfare: from **symmetric** – to→ **asymmetric** (ex. terrorism, piracy).

3) Operations: from **combined** – to→ **joint**- and **coalition-based**.

Another trends must be faced with respect to the reduction of manning on board. All of this requires a major change not only at the system level (combat and shipwide), but also at the organizational (eg. CIC) and procedural (eg. AAW doctrines) levels.

Optimised manning and reduced life cycle costs

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

Through the warfighter-centered approach we can redesign the CIC room addressing all of those levels.

- For example, assuming that a CIC room has a crew of about 22 people, reducing it to 10 can save:
  - **700.000** € per year
  - **170.000** € for the initial training.
- For the whole lifecycle, the global saving amounts to about 15 millions of euros.

Reduced manning business benefit

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

$V_{reduced\ manning} = (n_1 - n_2) \times$ *yearly personnel cost* $\times$ *number of years* =

(22 – 10) x 50.000 x 25 = 15.000.000 €

for the whole system lifecycle, given:

- n_1=22 team members in the CIC room;
- n_2=10 team members in the redesigned CIC room;
- an average personnel costs of 50.000 € per year for each team component
- and an average life cycle of 25 years.

Discussion

We believe that there is still a big gap between the outcomes of major research programs and the equipment which is still in use on board of the ships today; as practitioners in the industry we strongly advocate human factors insertion in both:

- Concept Development and Experimentation (CD&E)
- System Engineering

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

Question and answers?

© THALES NEDERLAND B.V. AND/OR ITS SUPPLIERS Subject to restrictive legend on title page

Thank you for your attention!