



A Human Factors-driven Approach

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Flight Training Research –

Paving the Path for Future eVTOL Pilots



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The Dawn of Urban Air Mobility

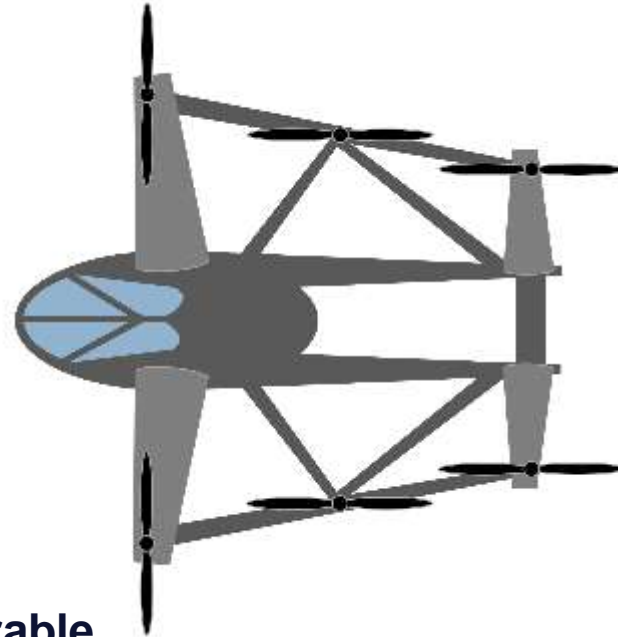
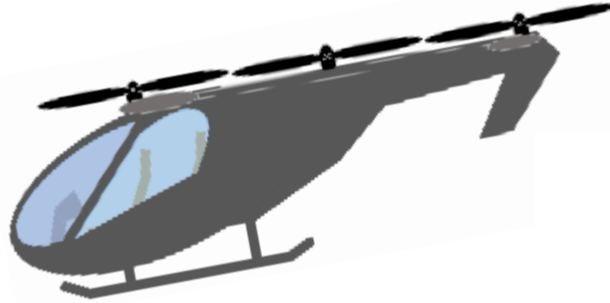
Currently, many eVTOL (electrical Vertical Take Off & Landing) vehicles are under full-speed development all across the globe.

The vehicle shown in this presentation shall only serve as a representative example of the broad range of different eVTOL vehicles that will soon form the backbone of urban air mobility (UAM).

Looking like helicopters, and sometimes like airplanes, it is difficult to classify these aircraft into the one or the other category.

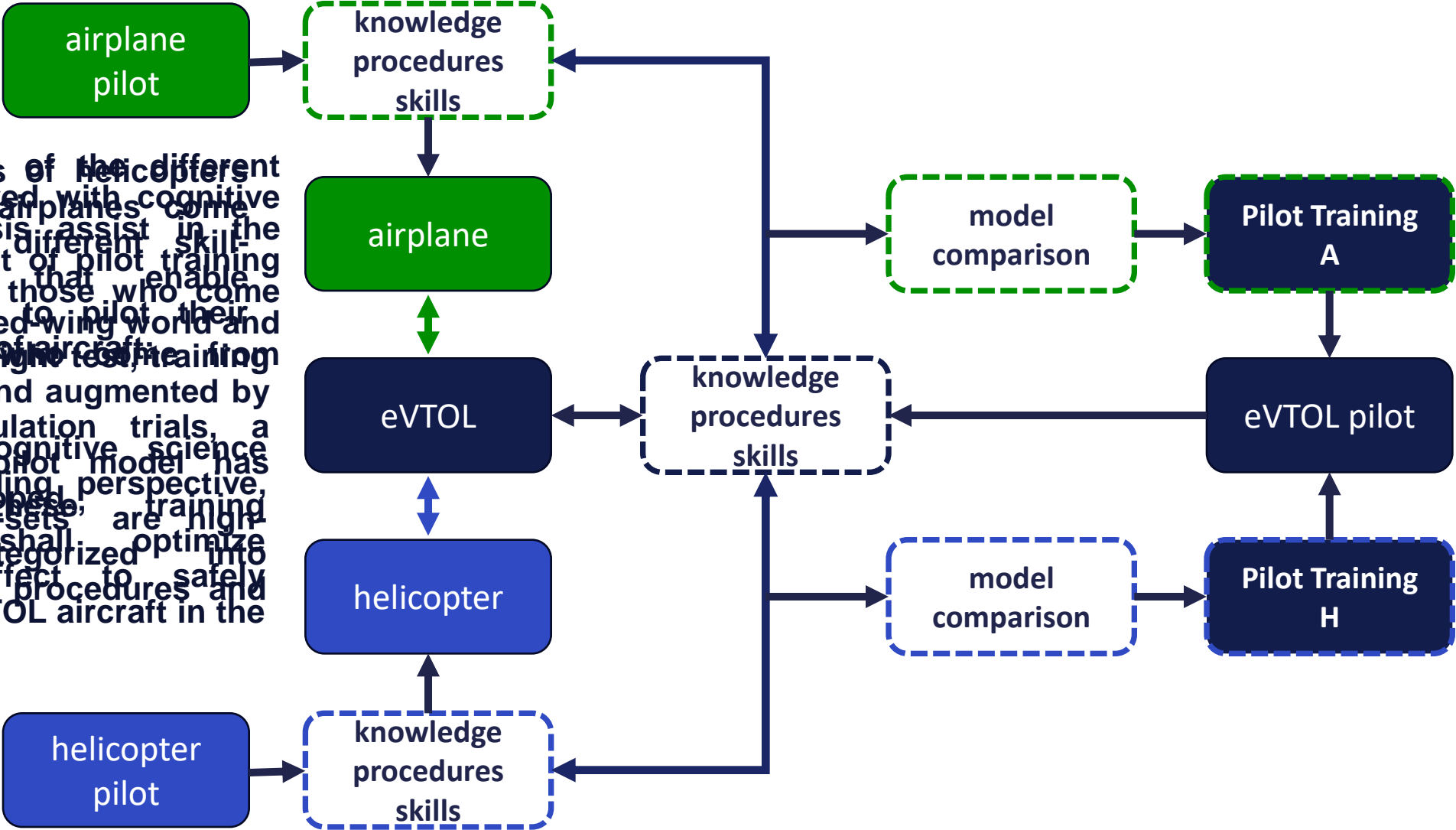
In fact, it is a little bit out of both worlds, but with a considerable amount of characteristics of its own. Thus, the question arises:

Who is going to fly these aircraft in the future?



Interplay of HF Research & Training Development

Comparison of the different models and airplanes come with different skill-sets that enable them to pilot their own kind of aircraft. Based on flight test training expertise and augmented by flight simulation trials, a cognitive pilot model has been developed. From a cognitive science and modelling perspective, their skill-sets are high level, categorized into knowledge, procedures and skills.



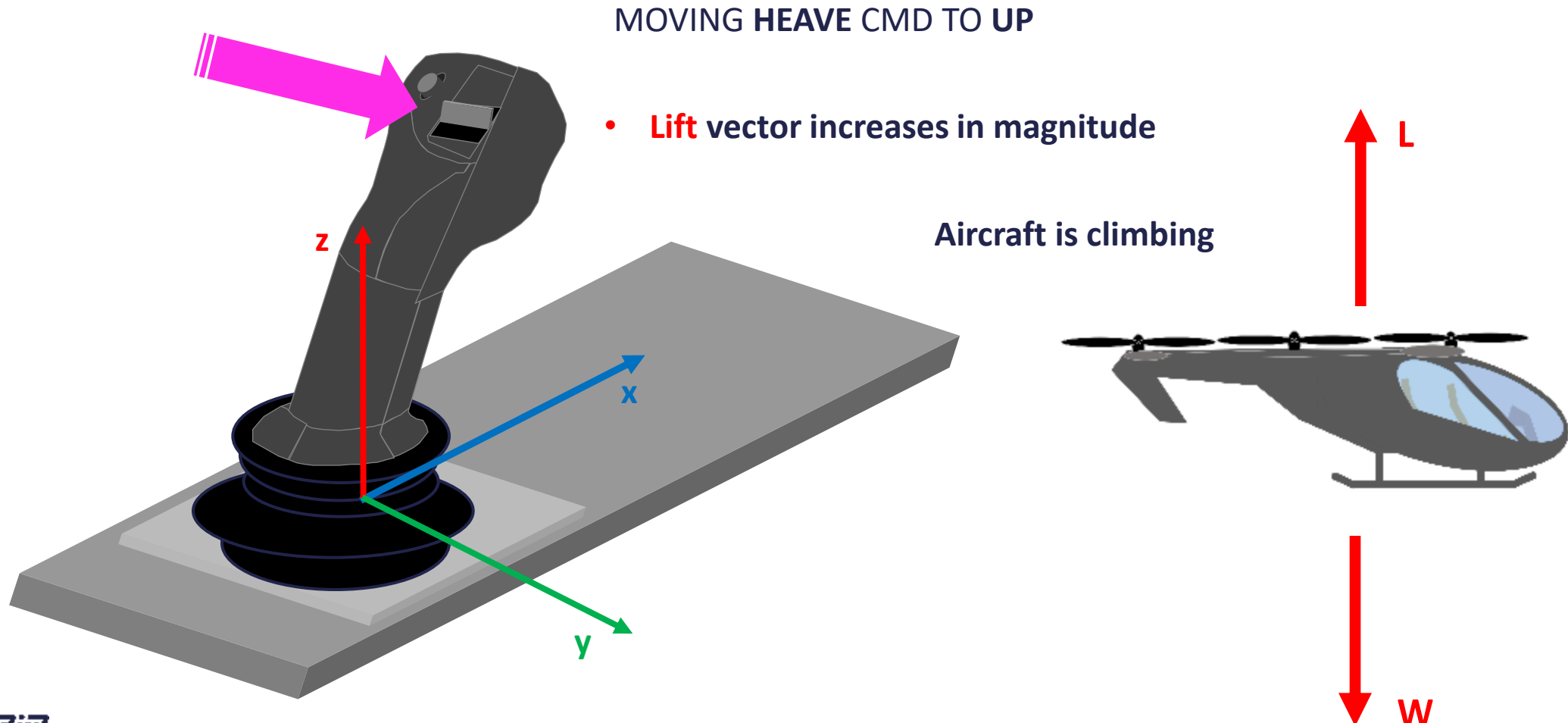
Interplay of HF Research & Training Development

For optimizing the training methodology for a certain task, we employed algorithms that stem out of learning theory. Below is a simplified representation, on which we will base an example on the next slide:

PROCEDURES ARE EQUAL		LEARNING TRANSFER: LOW ROAD	LEARNING METHOD: TRIAL & ERROR	DIFFERENCE SCOREN 1: IDENTICAL PROCEDURES
PROCEDURES ARE EQUAL – INSTRUMENTS DIFFER	NO DIFFERING CONCEPT			DIFFERENCE SCORE 2: NEW INSTRUMENTS & CONTROLS
PROCEDURES EXIST ON BOTH AIRCRAFT BUT ARE NOT EQUAL	SOURCE (S) & TARGET (T) PROCEDURE SHARE COMMON CONCEPT			DIFFERENCE SCORE 3: CHANGED ACTION SEQUENCE BASED ON REOCCURRING PRINCIPLES
PROCEDURES EXIST ON BOTH AIRCRAFT BUT ARE NOT EQUAL	S & T WITHOUT COMMON CONCEPT, BUT CONCEPT T NOT INTERFERING WITH OTHER	LEARNING TRANSFER: HIGH ROAD POSITIVE	LEARNING METHOD: METAPHORIC/ LEARNING FROM MODEL	DIFFERENCE SCORE 5: CHANGED ACTION SEQUENCES AND/OR DECISION NOT BASED ON REOCCURRING PRINCIPLES
	T DOES NOT FOLLOW A CONCEPT			DIFFERENCE SCORE 6: NEW PROCEDURE NOT BASED ON REOCCURRING PRINCIPLES
	CONFLICT BETWEEN CONCEPT T AND ANOTHER CONCEPT	HIGH ROAD NEGATIVE	LEARNING METHOD: LEARNING FROM MODEL & LEARNING FROM ERRORS	
PROCEDURE COMPLETELY NEW	T FOLLOWS A CONCEPT	LEARNING TRANSFER: HIGH ROAD POSITIVE	LEARNING METHOD: METAPHORIC/ LEARNING FROM MODEL	DIFFERENCE SCORE 4: NEW PROCEDURES BASED ON REOCCURRING PRINCIPLES
	T DOES NOT FOLLOW A CONCEPT		LEARNING METHOD: LEARNING FROM MODEL	
	CONFLICT BETWEEN CONCEPT T AND ANOTHER CONCEPT	LEARNING TRANSFER: HIGH ROAD NEGATIVE	LEARNING METHOD: LEARNING FROM MODEL & LEARNING FROM ERRORS	DIFFERENCE SCORE 6: NEW PROCEDURE NOT BASED ON REOCCURRING PRINCIPLES

Interplay of HF Research & Training Development

Example: some designs come with a single inceptor for all flight controls. In this example, the heave, which is the control for climb and descend commands, is a sliding switch on the pilot's side stick.



Interplay of HF Research & Training Development

Now, let us compare what the same kind of control interface would do on a conventional aeroplane:

MOVING TRIM Switch TO UP

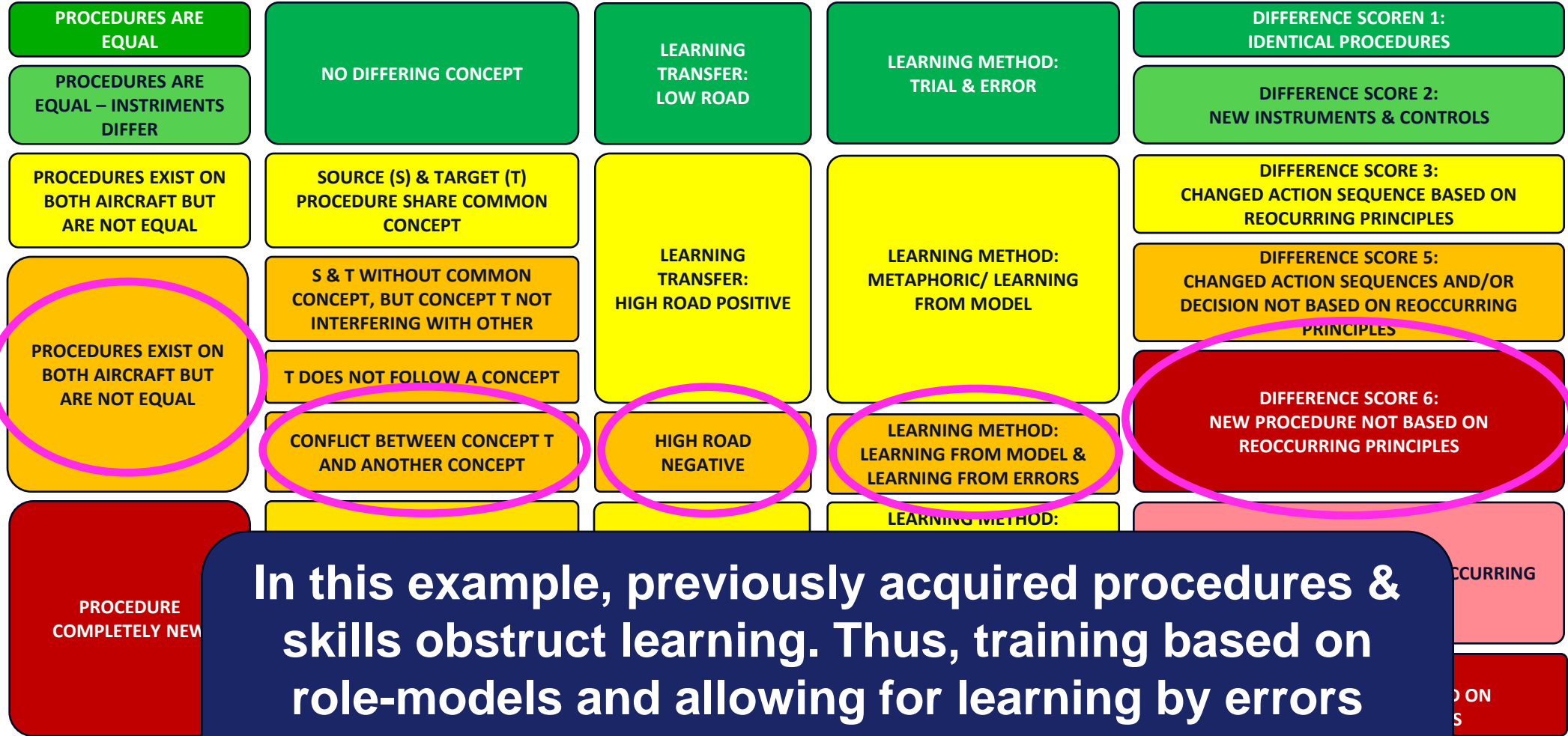
Comparing those pilot controls of the example, we face:

- procedures that exist on both aircraft but are not equal
- there is a conflict between the two procedures

Let's now see on the next slide, what this does to our categorization model

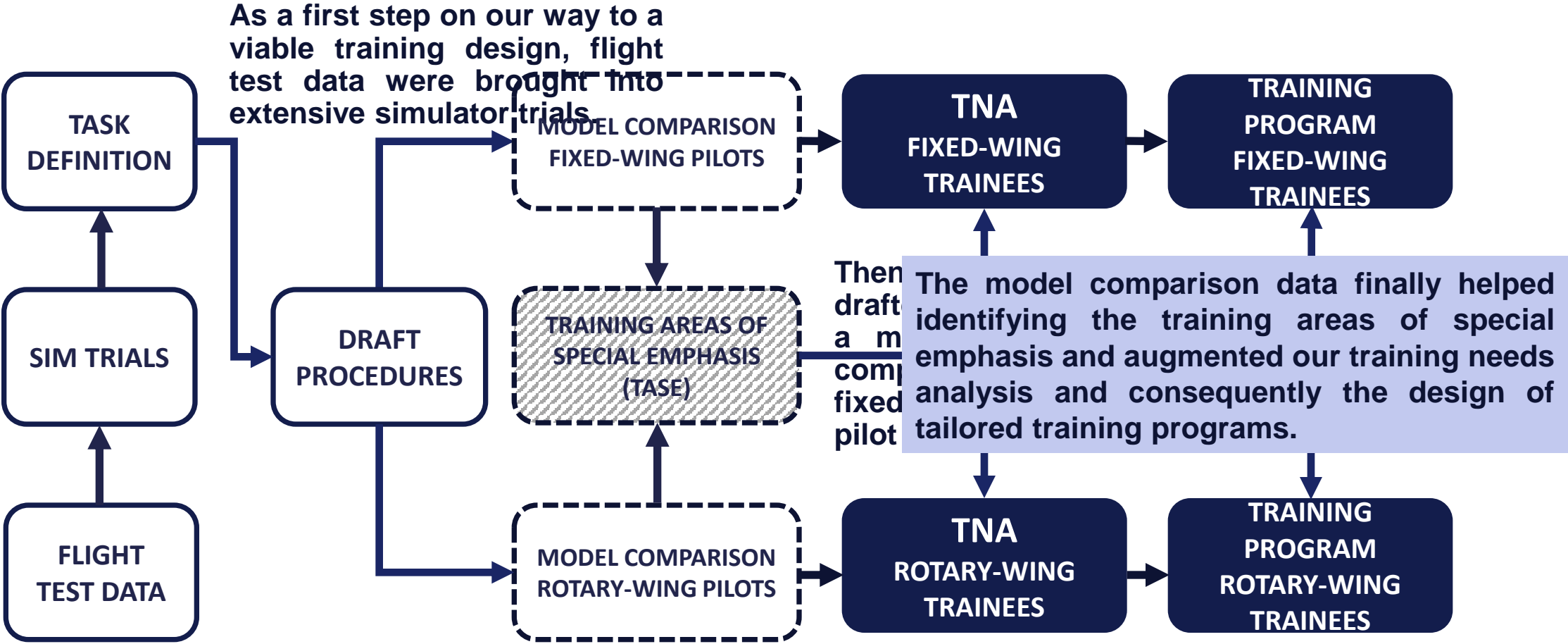
Interplay of HF Research & Training Development

For optimizing the training methodology for a certain task, we employed algorithms that stem out of learning theory. Below is a simplified representation, on which we will base an example on the next slide:

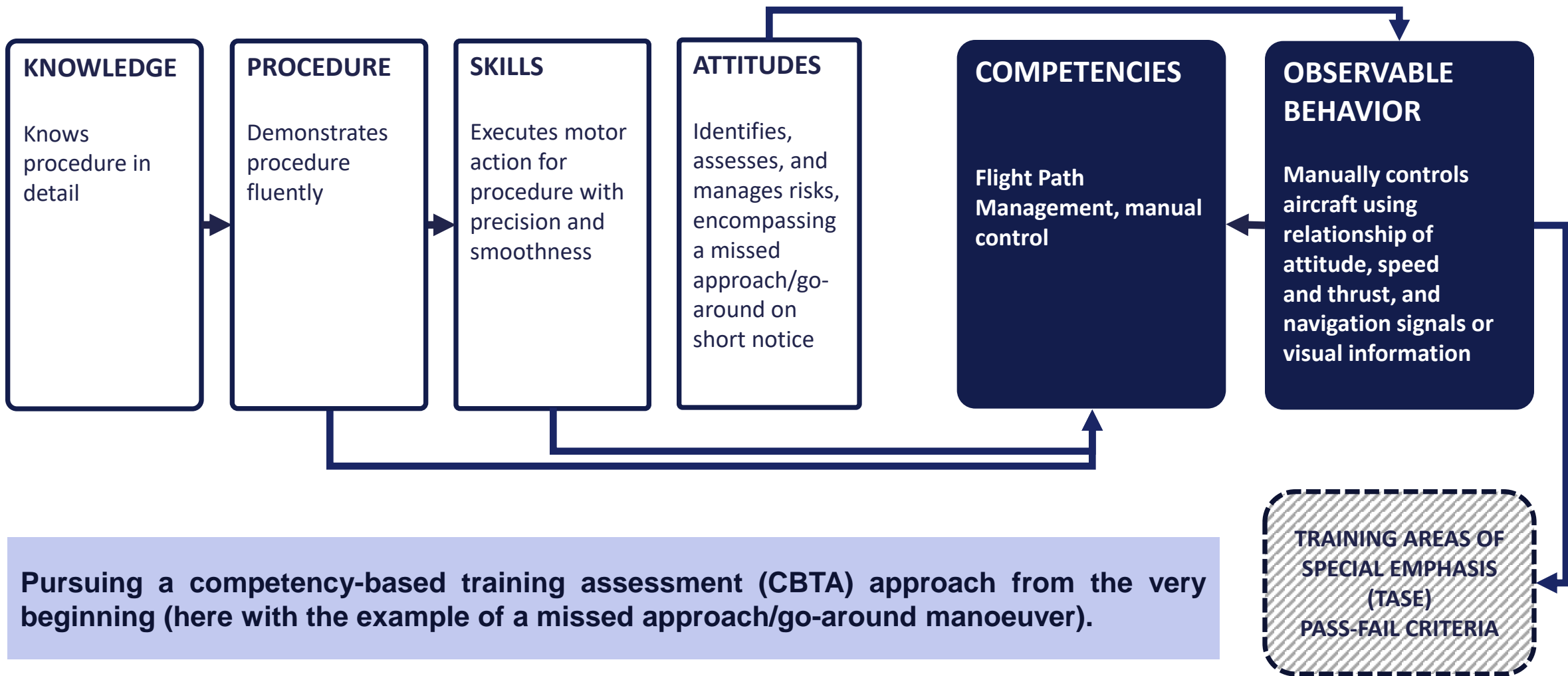


In this example, previously acquired procedures & skills obstruct learning. Thus, training based on role-models and allowing for learning by errors becomes essential here!

Training Design Path



Training Design Path



Training Devices



The training course was split into these classical three elements, and subsequently broken down into modules, each building on the other.

Let's have a look at the simulator training and the possible simulation devices on the next slide...

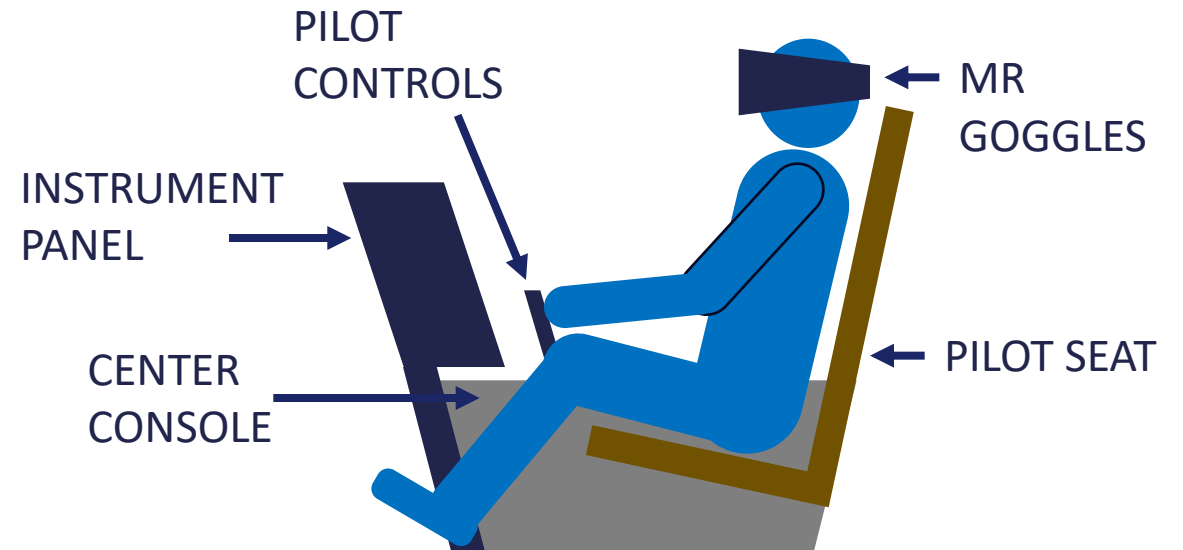
Training Devices

The Challenge:

- classical full-flight simulators are out of scope with little training benefit and no relation to the cost of the aircraft.
- training on the aircraft alone would impose too many risks and would be time consuming due to the limited endurance of an eVTOL's battery capacity.
- thus, something “in-between” needed to be found.

One Solution:

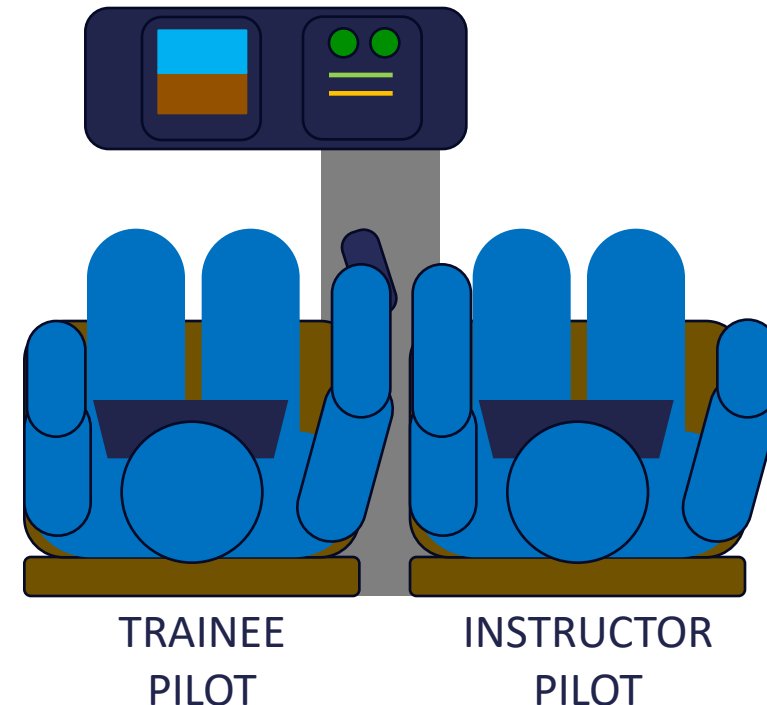
- Mixed-reality (MR) fixed-base simulation platform with a new dimension of immersion



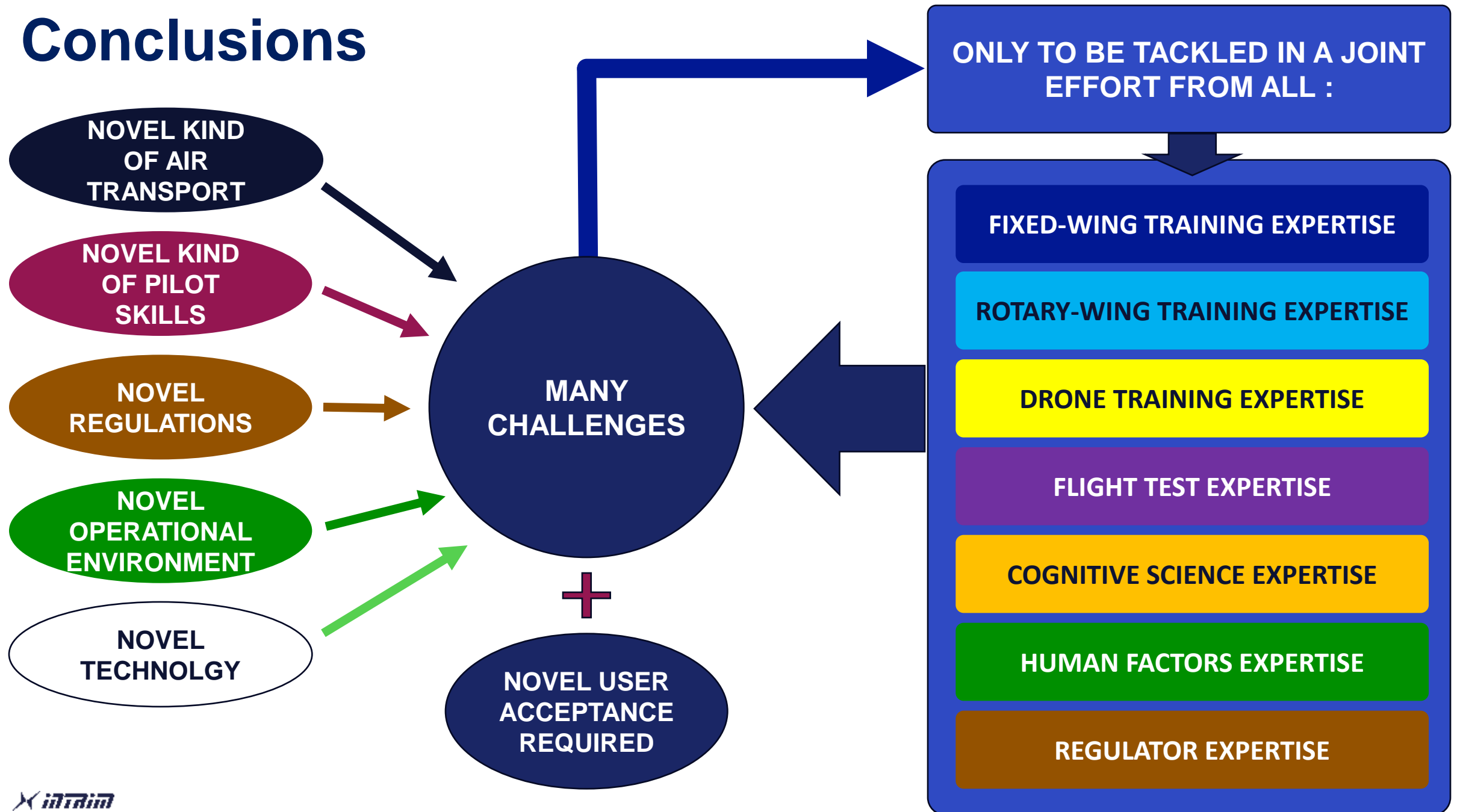
Training Devices

MR Simulation Platform:

- trainee fully immersed and yet able to interact with physical controls, indicators, and the instructor pilot.
- instructor pilot within the simulation just like on the real aircraft, able to better assess trainee's performance and being able to demonstrate (remember from learning transfer: “learning by model” – this is important)
- less cost, less space required, but priceless benefits compared to non-MR solutions and safer than training on the aircraft alone.



Conclusions



ACKNOWLEDGEMENTS



wishes to thank



and



for provision of their PilotSuite™ modelling tool

Thank you!

For anything you didn't dare asking today 😊
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