HUMAN FACTORS FOR DRONE OPERATIONS

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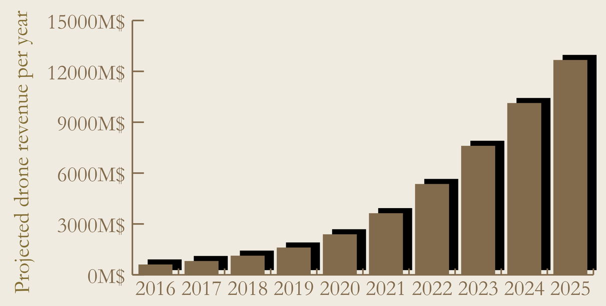
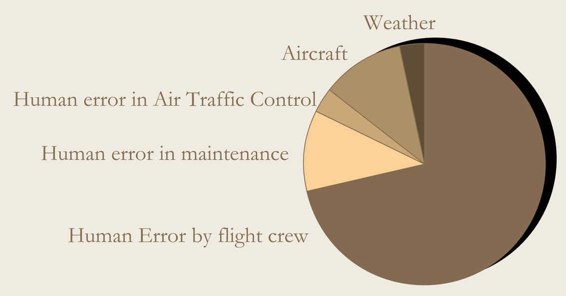
THE PROBLEM

The number of unmanned aerial systems or drones is expanding and proliferating tremendously.
Also within Belgian Defence, the number of drones in operational use is exploding from only a few units in the very recent past to a heterogeneous fleet of hundreds of units in the very near future.



Drones crash. Very often. This is due to the fact that drones are still a relatively new technology and that the knowledge required to handle these tools in a safe and secure way is still maturing.
International studies show that over 80% of the drone crashes are related to human factors.



Combining the two constatations mentioned above, it is clear that the proliferation of the use of drone technology could lead to a massive number of incidents and accidents in the near future.
It is also clear that - while there has been a lot of attention paid so far to the improvement of the aircraft themselves - this is not going to solve the problem (as most incidents are not caused by the aircraft).
It is therefore required to develop a strategy to incorporate human factors in the drone deployment process.

THE SOLUTION

From the wide heterogeneous fleet of drones and all the potential drone operators that are available, it is required to select the optimal aircraft(s) and the optimal operators to perform the job. This is not a trivial question, as this depends not only on the aircraft capabilities, the pilot training and experience but also on the mission characteristics.
Therefore, we develop a decision model that pairs a human performance model of the available drone pilots to the aircraft characteristics, enabling to decide which drone and pilot to task.

The drone operator must receive a theoretical and practical training that optimally prepares for the missions to be performed. In practice, this poses a difficulty, as it is very hard to assess the operator performance both qualitatively as quantitatively. Typically, only simplistic flight scenarios are considered during operator training, while these scenarios are not very representative for the scenarios the pilot will be confronted with on the job.
Therefore, we develop an operator assessment tool, measuring the performance of operators under realistic operating conditions, both in a qualitative and a quantitative manner.

Before being put to use, the capabilities and performance of new drones should be carefully assessed. Today this is still a very labour-intensive process, as there are few tools at the disposal of airworthiness certification agencies in order to partly automate this task.
Therefore, we develop an automatic tool for the assessment of drone performance, by running the drone through a number of standardized test scenarios, while taking into consideration a human operator performance model.

THE METHODOLOGY

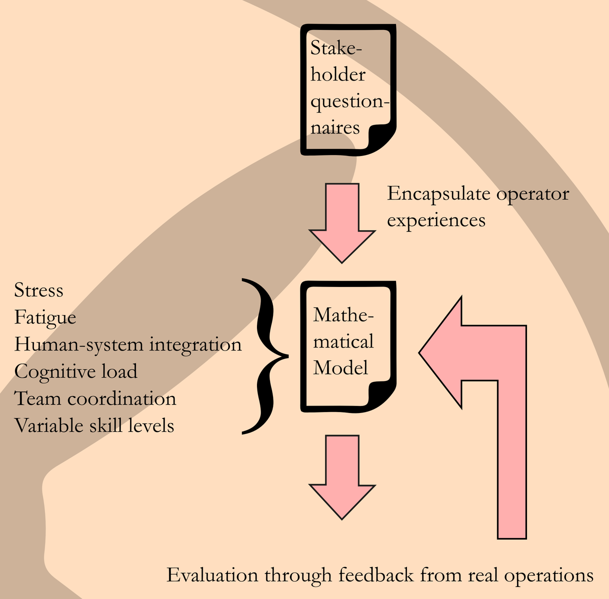
HUMAN PERFORMANCE MODELING

In this step, we develop a mathematical model describing the human perception-reaction behaviour and cognitive reasoning processes.

We start by developing a series of **questionnaires** that encapsulate the operational experience of pilots.

This data is encompassed in a **mathematical model** that takes into consideration parameters like stress, fatigue, cognitive load, etc. to predict the performance of the human under certain conditions.

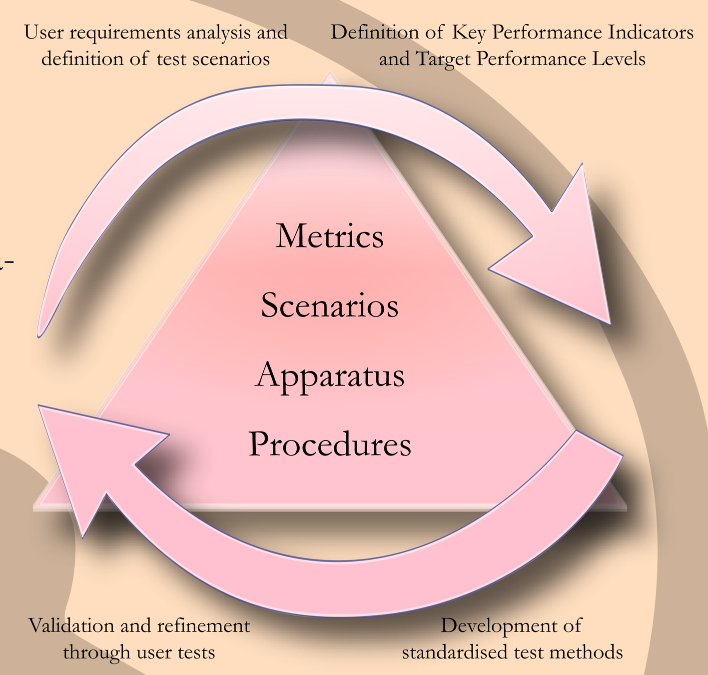
The crude initial model is fine-tuned continuously thanks to an **evaluation** by operational pilots that is fed back into the model.



STANDARDISED TEST METHODS

In this step, we develop standard test methods that measure baseline drone and drone operator capabilities necessary to perform operational tasks.
We start from the NIST test methods for response robots and compose descriptions of the following:

- **Procedures** acting as a script for the test administrator and the robot operator to follow.
- **Apparatus**, being inexpensive tools that enable the execution of the tests.
- **Scenarios** that detail the operational context of the test to be executed.
- **Metrics**, measuring quantitatively the performance of the drone and its operator.
- **Target performance levels** expressing capability objectives and acceptability thresholds



SIMULATION ENGINE

In this step, we build upon the readily available open-source 3D drone simulation engine AirSim by Microsoft and within this simulation engine we:

- Integrate the human performance model
- Integrate non-standard drones
- Integrate the standardised test methods
- Incorporate realistic validation scenarios

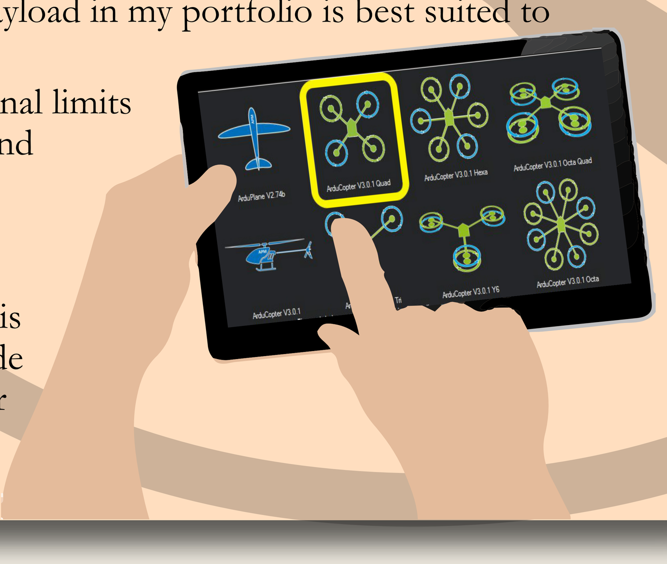
The incorporation of the human performance model allows to perform tests in a virtual environment with a virtual drone and a virtual human, which serves as valuable benchmarking data for training.

The incorporation of standardised test methods in a virtual environment allows to perform statistically relevant flight data collection, thereby enabling a quantitative evaluation.

MISSION PREPARATION TOOL

We develop a mobile tool that exploits results from the human performance model and from the standard test methods in order to allow the in-the-field commander to answers such as:

- What member of my team has the best operator skills to fulfil this mission?
- What RPAS in my portfolio is best suited to fulfil this mission?
- What RPAS sensor payload in my portfolio is best suited to fulfil this mission?
- What are the operational limits I should observe (wind speed, …)?
- What are the optimal flight parameters I should choose for this mission (flight altitude and trajectory, sensor payload, ...)



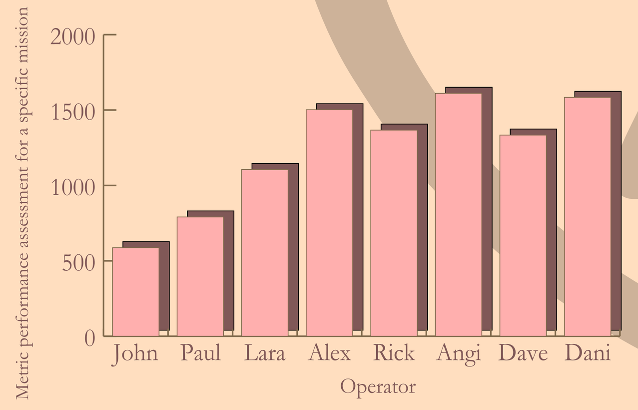
OPERATOR PERFORMANCE ASSESSMENT

We develop a tool that allows to accurately measure in a safe simulation environment the performance of **drone operators** under realistic operating conditions.

A realistic drone simulation environment will be developed (using the simulation engine described above) where operators will be evaluated while performing standardised test scenarios.

The operator performance will be compared to the human performance models in order to qualitatively and quantitatively assess the skill level of the operator.

These metrics can then be used by training responsibles to iteratively optimize the training curriculum for drone operators.



DRONE PERFORMANCE ASSESSMENT

We develop a tool that allows to accurately measure in a safe simulation environment the performance of new **drone systems** under realistic operating conditions..

Within the drone simulation environment, different drone operators (simulated using the human performance model) will operate drones in a series of standardised test scenarios.

Using this test methodology, a qualitative and quantitative performance assessment of the drones can be performed which is not dependent on the drone operator and which is also not dependent on external non-controllable factors.

This automated drone performance assessment tool can help designers save significant amounts of time and cost in running experiments, and can also help to improve the system safety and human performance and/or to prevent accidents.

Furthermore, this tool can also help aviation safety agencies to quantitatively assess the safety level of a specific drone for a specific mission.

This research work is carried out in the framework of a collaboration project between the following departments of the Belgian Royal Military Academy:
- The Department of Economics, Management and Leadership (DEML): Hans De Smet
- The Department of Mechanics, research pole Environmental Mechanics and Mobility Applications (EMMA) in the Research Unit of the Unmanned Vehicle Centre: Walter Bosschaerts
- The Department of Mathematics (MWMW): Robby Haelterman

This research project is funded by the Belgian Royal Higher Institute for Defence (RHID) and co-funded by VIAS