Automation, integration and coupling of UAVs calculation workflows using ANSYS ACT
Classification of UAVs

Depending on the UAV type various calculation approaches can be used during UAV designing process.

Light UAVs (flying weight up to 50 kg):

<table>
<thead>
<tr>
<th>Класс</th>
<th>Категория</th>
<th>Обозначение в мире</th>
<th>Обозначение</th>
<th>Наименование</th>
<th>Взлетный вес, кг</th>
<th>Радиус действия, км</th>
<th>Практич. потолок, м</th>
<th>Продолж. полета, ч</th>
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<tbody>
<tr>
<td>Малые</td>
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<td>СР</td>
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<td>Б/Д</td>
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<td>SR</td>
<td>МА</td>
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<td>III</td>
<td>MR</td>
<td>СД</td>
<td>Средней дальности</td>
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<td>5000</td>
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<td>СД</td>
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<td>БД</td>
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<td>Беспилотный ударный (Б-У)</td>
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<td>DEC</td>
<td>Г</td>
<td>Ложная цель (Л-Ц)</td>
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<td>TGT</td>
<td>Г</td>
<td>Воздушный шар (В-Ш)</td>
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<td>ОП</td>
<td>ПП</td>
<td>Переносимый пилотируемый ЛА</td>
<td>≤ 200</td>
<td></td>
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</tbody>
</table>
Light UAVs

Airplane-like UAVs:

Helicopter-like UAVs:

Multirotor UAVs:
Multirotor UAV

Frame
- Strength
- Weight

Propeller
- Thrust
- Velocity
- Efficiency
- Weight

Motor
- Power unit
- Torque
- Efficiency
- Weight

Battery
- Capacity
- MaxCurrent
- Weight

Electronics
- Flight control
- Weight

• Payload
• Range
• Height
• Flight time
Airplane UAV

- Payload
- Range
- Height
- Flight time

### Fuselage
- Strength
- Weight

### Propeller
- Thrust
- Velocity
- Efficiency
- Weight

### Motor/Engine
- Power unit
- Torque
- Efficiency
- Weight

### Battery/Fuel
- Capacity
- MaxCurrent
- Weight

### Electronics
- Flight control
- Weight

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Simplified UAV design workflow

Prototype flight test

Flight dynamics calculation

Aerodynamics  Structural  Electromagnetics

High fidelity CAE simulation

CAD model

Aerodynamics  Structural  Electromagnetics

Low fidelity calculation tools

UAV specification
Simplified description of low fidelity calculation approach

**UAV specification:**
- Payload
- Range
- Height
- Velocity
- Lift ratio
- Flight time

**Weight estimation:**
- Frame/Fuselage
- Motor/Engine
- Propeller
- Electronics
- Battery/Fuel

**Battery/Fuel:**
- Capacity
- Weight

**Propeller:**
- Diameter

**Power Unit:**
- Number of drives

**Propeller aerodynamics:**
- Thrust curve
- Power curve

**Power unit operational conditions:**
- RPM
- Thrust
- Power
- Velocity/Prop pitch

**Motor/Engine:**
- RPM/KV
- Voltage
- Power/Torque
- Weight

**Aerodynamical calculation**
- Panel and vortex methods

**Electromagnetic calculation**
- Empirical expressions for EM powerdrives from engineer handbook

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Basic strength theory from engineer handbook

Data for initial iteration

Does the initial weight of battery/fuel correlate to calculated weight? If NO – revision of weight estimation should be performed and new calculation iteration until the convergence.
Prototype performance evaluation

Requirements

Preliminary design

CAD design

Prototyping

System modeling

High fidelity CAE simulations

- Evaluation of virtual prototype performance
- Flight dynamics simulation including flight control system debugging and optimization

Low fidelity calculation tools

- Preliminary design using analytical/empirical expressions from handbooks or special engineering software
- Estimation of performance, optimal operational conditions.
- Fast and reliable ‘What if study’

ANSA as a platform for calculation workflows automation

• Evaluation of virtual prototype performance
• Flight dynamics simulation including flight control system debugging and optimization

Prototyping

- Automated typical pre and post operations in accordance with guidelines
- Extension of solver capabilities
- Result evaluation in accordance with guidelines

Prototype performance evaluation

ANSA SCADE

ANSA Simpler

ANSA Workbench

ANSA EKM

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Unified Calculation Environment based on ANSYS platform

Development of math model based on high fidelity CAE tools

Low fidelity calculation tools for preliminary design

Virtual testbed for performance evaluation

Debugging of controlling algorithms

CAD modeling basing on results of low fidelity calculation tools

Preliminary design estimation, 'what if' study'

Customized GUI for data input (UAV specification)

Low fidelity calculation tools for preliminary design
Classification of UAVs

Depending on the UAV type various calculation approaches can be used during UAV designing process.

Heavy UAVs (flying weight up to 1000 kg):
ANSYS as a platform for coupling of parallel calculation workflows

- Aerodynamical and structural performance
- Power unit performance
- Flight control simulation
- EM compatibility, HF direction diagram, electrical components thermal behavior
- Aerodynamical interference

Расчет фюзеляжа на прочность с учетом его компоновки
ANSYS as a platform for coupling of parallel calculation workflows

- ANSYS can be considered as a platform with coupled modules performing calculations of various UAV components and tasks.
- The automated tool for UAV calculation can be implemented using ANSYS ACTs and ANSYS EKM.
Conclusion

Why do we need automation of the workflows, coupling and integration of various calculation approaches into Unified Calculation Environment based on ANSYS platform?

- To reduce calculation time and improve robustness coupling CAE tools with low fidelity calculation tools at preliminary design stage.
- To accumulate all the workflows, guidelines, software in a ‘single window’ system – customized ANSYS platform.
- To extend capability of various tools by each other.
- To reduce significantly total calculation time due to automation of typical pre post actions in ANSYS.
- To increase overall simulation efficiency by using system modeling approach for ‘virtual prototype simulation’.